Arklow Bank Wind Park 2

Environmental Impact Assessment Report

Volume II, Chapter 11: Marine Mammals

SSE Renewables

Revision	Date	Status	Author	Reviewed by	Approved by
1.0	07/05/2024	Final (External)	APEM Ltd	GoBe Consultants	Sure Partners Limited

Statement of Authority

Experts	Qualifications	Relevant Experience
APEM: Phoebe Meredith Author	M.Sc. Volcanology, University of Bristol (2019). B.Sc. (Hons) Geography, University of Exeter (2018).	Phoebe is an experienced consultant with a background in consenting of offshore wind developments. She joined APEM in 2021 as a Senior Marine Mammal Consultant where she managed multi-million-pound digital aerial survey programmes, working collaboratively with a range of team members such as aerial technicians, data operators, and image analysts, to collect baseline marine mammal (cetacean and pinniped) data for offshore wind developments off the UK and Irish coasts. Since joining APEM's Marine Mammal Consultancy team, Phoebe has contributed to several projects that demonstrate her understanding of cetacean ecology and potential threats posed to them through several desk-based studies, technical baseline reports, and reports to inform appropriate assessment, as well as providing advice to clients regarding visual and acoustic monitoring options for baseline data collection.
APEM: Ross Culloch Document audit	Ph.D. Behavioural Ecology and Ecological Modelling, Durham University. M.Sc. Marine Mammal Science, Bangor University. B.Sc. (Hons) Aquatic Bioscience, University of Glasgow.	Ross is an Associate Director and head of the Marine Mammal Consultancy team at APEM. Ross joined APEM in February 2022 from Marine Scotland Science (now Marine Directorate), bringing a wealth of expertise in the field of marine mammal ecology, conservation and management, and a practical understanding of the legislation and policy relating to marine mammals and the consenting of major marine infrastructure projects. Ross has 20 years of experience working on marine mammals, primarily in relation to conservation and management, and anthropogenic impacts including fisheries interactions, collision risk and underwater noise.

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Glossary

Term	Meaning
Arklow Bank Wind Park 1 (ABWP1)	Arklow Bank Wind Park 1 consists of seven wind turbines, offshore export cable and inter-array cables. Arklow Bank Wind Park 1 has a capacity of 25.2 MW. Arklow Bank Wind Park 1 was constructed in 2003/04 and is owned and operated by Arklow Energy Limited. It remains the first and only operational offshore windfarm in Ireland.
Arklow Bank Wind Park 2 – Offshore Infrastructure	"The Proposed Development", Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements under the existing Maritime Area Consent.
Arklow Bank Wind Park 2 (ABWP2) (The Project)	Arklow Bank Wind Park 2 (ABWP2) (The Project) is the onshore and offshore infrastructure. This EIAR is being prepared for the Offshore Infrastructure. Consents for the Onshore Grid Infrastructure (Planning Reference 310090) and Operations Maintenance Facility (Planning Reference 211316) has been granted on 26th May 2022 and 20th July 2022, respectively. • Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements to be consented in accordance with the Maritime Area Consent. This is the subject of this EIAR and will be referred to as 'the Proposed Development' in the EIAR. • Arklow Bank Wind Park 2 Onshore Grid Infrastructure: This relates to the onshore grid infrastructure for which planning permission has been granted. • Arklow Bank Wind Park 2 Operations and Maintenance Facility (OMF): This includes the onshore and nearshore infrastructure at the OMF, for which planning permission has been granted. • Arklow Bank Wind Park 2 EirGrid Upgrade Works: any non-contestable grid upgrade works, consent to be sought and works to be completed by EirGrid.
Array Area	The Array Area is the area within which the Wind Turbine Generators (WTGs), the Offshore Substation Platforms (OSPs), and associated cables (export, inter- array and interconnector cabling) and foundations will be installed.
Cable Corridor and Working Area	The Cable Corridor and Working Area is the area within which export, inter-array and interconnector cabling will be installed. This area will also facilitate vessel jacking operations associated with installation of WTG structures and associated foundations within the Array Area.
Cable Protection	External armouring applied to exposed cables or used at cable crossings, typically comprised of rock (berms or bags), ducting (polyurethane, steel, High Density Polyethylene (HDPE), cast iron or plastic) or concrete mattresses.
Cetacean	The order Cetacea includes whales, dolphins and porpoises and is collectively known as cetaceans.
Coefficient of Variation	The ratio of the standard deviation to the mean.
Confidence Interval	The measure of the degree of uncertainty or certainty in a sampling method.
Deflagration	A low order technique to neutralise explosives.
Environmental Impact Assessment (EIA)	An Environmental Impact Assessment (EIA) is a statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental

Term	Meaning
	information, which fulfils the assessment requirements of the Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment as amended by Directive 2014/52/EU of the European Parliament and of the Council (EIA Directive).
EirGrid	State-owned electric power transmission system operator (TSO) in Ireland and Transmission Asset Owner (TAO) for the Project's transmission assets.
Foundation	The load carrying support structure for the wind turbine generator tower or offshore substation platform topside. The foundation is the part of the structure from the interfacing flange with the turbine tower or topside-foundation interface, down to below seabed. This includes any secondary steel items associated with the structure. For the purposes of the EIAR the term 'foundation' includes the structure from the WTG tower or topside interface down to the lower end of the monopile commonly known as the 'substructure' and encompasses monopiles and transition pieces.
High order (UXO) detonation	Neutralisation of the UXO through full detonation of the original explosive content.
Landfall	The area in which the offshore export cables make landfall and is the transitional area between the offshore cabling and the onshore cabling.
Low order (UXO) detonation	Neutralisation of the UXO without full detonation of the original explosive material.
Maritime Area Consent (MAC)	A consent to occupy a specific part of the maritime area on a non-exclusive basis for the purpose of carrying out a Permitted Maritime Usage strictly in accordance with the conditions attached to the MAC granted on 22nd December 2022 with reference number 2022-MAC-002.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact.
Permanent Threshold Shift (PTS)	Following a marine mammal's exposure to high noise levels, if a threshold shift occurs and does not return to normal after several weeks then a Permanent Threshold Shift (PTS) has occurred. This results in a permanent auditory injury to the marine mammal.
Permitted Maritime Usage	The construction and operation of an offshore wind farm and associated infrastructure (including decommissioning and other works required on foot of any permission for such offshore wind farm).
Pinniped	Fin-footed group of marine mammals which are semi-aquatic. Pinnipeds comprise of the following families: Odobenidae (walrus); Otariidae (eared seals, sea lions, and fur seals); and Phocidae (earless seals). Pinnipeds are more broadly known as "seals".
Scour protection	A solution for preventing scour around subsea structures, typically comprised of rock or concrete mattresses.
Small Cetacean Abundance in the North Sea and Adjacent Waters (SCANS)	Large scale surveys aimed at estimating the abundance of porpoises and other cetaceans in order to assess the impacts of by-catch. SCANS (1994) and SCANS II (2005), SCANS III (2017) and SCANS VI (2022) have been completed.
Soft-start	The term 'soft-start' is applied to the gradual, or incremental, increase in energy with the aim to reduce sound exposure to marine mammals. For piling, this means a gradual increase in hammer blow energy from the initiation of piling activity until required blow energy is reached for installation of each pile,

Term	Meaning
	usually over a period of 30 minutes (not less than 20 minutes). Maximum hammer blow energy may not be required to complete pile installation.
Temporary Threshold Shift (TTS)	A temporary change in the hearing threshold of marine mammals following noise exposure. Hearing loss in this case is not permanent.
The Application	The full set of documents that will be submitted to An Bord Pleanála in support of the consent.
The Developer	Sure Partners Ltd.

Acronyms

Term	Meaning
AA	Appropriate Assessment
ABP	An Bord Pleanála
ABWP1	Arklow Bank Wind Park 1
ABWP2	Arklow Bank Wind Park 2
ADD	Acoustic Deterrent Device
BAS	Burial Assessment Study
BEIS	Department of Business, Energy, and Industrial Strategy
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CMS	Convention on Migratory Species
Co.	County
CPT	Cone Penetration Test
CSA	Continental Shelf Associates Ocean Sciences Inc.
CSIP	Cetacean Strandings Investigation Programme
CV	Coefficient of Variation
CWC	Coveney Wildlife Consulting Ltd
DAHG	Department of Arts, Heritage and the Gaeltacht
DAS	Digital Aerial Survey
DCCAE	Department of Communications, Climate Action and Environment
DCHG	Department of Culture, Heritage and the Gaeltacht
DCO	Development Consent Order
DECC	Department of the Environment, Climate and Communications
DEPONS	Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea
DHLGH	Department of Housing, Local Government and Heritage
DHPLG	Department of Housing, Planning and Local Government
DTAG	Digital Acoustic Recording Tag
EC	European Commission
EDR	Effective Deterrence Range
EIA	Environmental Impact Assessment

Term	Meaning
EIAR	Environmental Impact Assessment Report
EIS	Environmental Impact Statement
EMF	Electromagnetic Field
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EPS	European Protected Species
ES	Environmental Statement
EU	European Union
FHG	Functional Hearing Group
FLA	Foreshore Licence Application
HDD	Horizontal Directional Drilling
HDPE	High Density Polyethylene
HF	High Frequency
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
HWM	High Water Mark
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IEF	Important Ecological Receptor
IMO	International Maritime Organisation
INSPIRE	Impulse Noise Sound Propagation and Impact Range Estimator
iPCoD	Interim Population Consequences of Disturbance
IRCG	Irish Coast Guard
IWDG	Irish Whale and Dolphin Group
IWEA	Irish Wind Energy Association
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MAC	Maritime Area Consent
MARA	Maritime Area Regulatory Authority
MBES	Multibeam Echo Sounder
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Mammal Observer
MPCP	Marine Pollution Contingency Plan

Term	Meaning
MSFD	Marine Strategy Framework Directive
MU	Management Unit
MUL	Maritime Usage Licence
MWSQ	Marine Water and Sediment Quality
NAS	Noise Abatement System
NBAP	National Biodiversity Action Plan
NBDC	National Biodiversity Data Centre
NIS	Natura Impact Statement
NMPF	National Marine Planning Framework
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPWS	National Parks and Wildlife Service
NRW	Natural Resources Wales
OGI	Onshore Grid Infrastructure
O&M	Operations and Maintenance
OMF	Operations and Maintenance Facility
OREDP	Offshore Renewable Energy Development Plan
OSP	Offshore Substations Platforms
OSPAR	Oslo-Paris Conventions
PAM	Passive Acoustic Monitoring
PAMO	Passive Acoustic Monitoring Operator
PCW	Phocid (in water)
PEIR	Preliminary Environmental Information Report
PTS	Permanent Threshold Shift
RMS	Root Mean Square
RoI	Republic of Ireland
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SAM	Static Acoustic Monitoring
SBP	Sub-Bottom Profiler
SCANS	Small Cetacean Abundance in the North Sea
SCOS	Special Committee on Seals
SEA	Strategic Environmental Assessment

Term	Meaning
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentrations
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SOLAS	Safety of Life at Sea
SSS	Side Scan Sonar
SST	Sea Surface Temperature
TNT	Trinitrotoluene
TTS	Temporary Threshold Shift
UK	United Kingdom
US	United States
UXO	Unexploded Ordnance
VHF	Very High Frequency
VMP	Vessel Management Plan
WFD	Water Framework Directive
WTG	Wind Turbine Generators
ZoI	Zone of Influence

Units

Unit	Description
%	Percentage
<	Less than
>	More than
dB	Decibel (unit used to measure the intensity of sound)
GW	Gigawatt
Hz	Hertz
kg	Kilograms
kHz	Kilohertz
kJ	Kilojoules
km	Kilometres
km^2	Square kilometre
Kn	Knot
kV	Kilovolt (electrical potential)
m	Metre
m/s	Metres per second (wind speed)
mG	Milligauss
MW	Megawatt (power; equal to one million watts)
nm	Nautical mile
V/m	Volts per metre
μT	Microtesla
μV m	Microvolts per metre

11 Marine Mammals

11.1 Introduction

11.1.1.1 This chapter of the Environmental Impact Assessment Report (EIAR) presents the assessment of the potential impacts of the Arklow Bank Wind Park 2 (ABWP2) Offshore Infrastructure (hereafter referred to as 'the Proposed Development') on marine mammals. Specifically, this chapter considers the potential impact of the Proposed Development below the High-Water Mark (HWM) during the construction, operational and maintenance, and decommissioning phases.

11.1.1.2 This chapter draws upon information contained within the following chapters and technical reports:

- Volume II, Chapter 2: Policy and Legislation;
- Volume II, Chapter 4: Description of Development;
- Volume II, Chapter 5: EIA Methodology;
- Volume II, Chapter 6: Coastal Processes;
- Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology;
- Volume II, Chapter 15: Shipping and Navigation;
- Volume II, Chapter 23: Interactions;
- Volume III, Appendix 11.1: Underwater Noise Assessment;
- Volume III, Appendix 11.2: Marine Mammals Technical Report;
- Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling;
- Volume III, Appendix 15.1: Navigational Risk Assessment;
- Volume III, Appendix 25.1: Environmental Management Plan;
- Volume III, Appendix 25.2: Marine Mammal Mitigation Plan; and
- Volume III, Appendix 25.10: Environmental Vessel Management Plan.

11.1.1.3 It is intended that this EIAR chapter will provide stakeholders with sufficient information to determine the potential significant impacts of the Proposed Development on marine mammals.

11.1.1.4 In particular, this chapter:

- Presents the existing environmental baseline established from desk-based studies, site-specific surveys, and consultation;
- Identifies any assumptions and limitations encountered in compiling the information for the environmental baseline;
- Presents the potential environmental effects on marine mammals arising from the Proposed Development, based on the information gathered, and the analysis and assessments undertaken; and
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce, or offset the possible environmental effects of the Proposed Development on marine mammals.

11.2 Regulatory background

11.2.1.1 Legislation, policy, and guidance of relevance to this chapter is outlined in Table 11.1 and Table 11.2.

11.2.1.2 Further information on relevant planning policy and legislative requirements relating to the Environmental Impact Assessment (EIA) of the Proposed Development is presented in Volume II, Chapter 2: Policy and Legislation.

Table 11.1: Summary of regulatory background

Publisher	Name of document incl. reference	Key provisions
Statutory		
Legislation		
European Commission, 2011	European Communities (Marine Strategy Framework) Regulations 2011 (S.I. No. 249 of 2011);	Transposes European Union (EU) Directive 2008/56/EC (Marine Strategy Framework Directive (MSFD)) into Irish law. The MSFD manages the effect of human activity in the marine sector on marine ecosystems; namely in this case, construction, survey and energy production and associated underwater noise.
Department of the Arts, Heritage and the Gaeltacht (DAHG), 2000	Wildlife (Amendment) Act, 2000 (S.I. No. 397 of 1985);	The Wildlife Act (1976) provides specific protection to (most relevant) seals, whales, dolphins and porpoise. Under the Act it is an offence to disturb, harm, kill, or otherwise wilfully interfere with or destroy the breeding place of a protected species and if activity is likely to cause any of the above, measures must be taken to prevent.
European Commission, 2011	European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011)	All cetaceans in Northern European waters are listed under Annex IV of the EU Directive 92/43/EEC and in need of strict protection. Of these species, harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), harbour seal (*Phoca vitulina*) and grey seal (*Halichoerus grypus*) have protection under Annex II as species of

Publisher	Name of document incl. reference	Key provisions
		Community Interest, whose conservation requires the designation and enforcement of Special Areas of Conservation (SACs).
European Commission, 2003	European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003)	Transposes Directive 2000/60/EC (Water Framework Directive (WFD)) into Irish law. The WFD encapsulates inland, transitional (estuarine) and coastal surface waters and designates strict protection from water-borne pollution and potential flora / fauna loss as a result.
European Commission, 2023	European Union (Good Agricultural Practice for Protection of Waters) (Amendment) Regulations 2023; (S.I. No. 62/2023)	Transposes European Communities (Nitrates Directive, 2023) into Irish law. This directive links with the WFD specifically managing the potential for eutrophication of water bodies, inland, transitional, and coastal / marine, as a result of agricultural nitrate sources entering waterways. Eutrophication poses particular risk to life as excessive nitrates and phosphates in water bodies can adversely impact trophic chains at all levels.
European Union, 2016	European Union (Framework for Maritime Spatial Planning) Regulations 2016 (S.I. No. 352/2016); S.I. No. 352/2016 - European Union (Framework for Maritime Spatial Planning) Regulations 2016.	Transposes European Union Directive 2014/89/EU (Marine planning framework) into Irish law.
Planning Policy and Development Control		
Department of the Environment, Climate, and Communications (DECC), 2022	Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDPII) in Ireland: Environmental Report	Contains the AA screening process and SEA scoping report of the Maritime area associated with OREDPII. This resource

Publisher	Name of document incl. reference	Key provisions
	https://www.gov.ie/en/publication/71e36-offshore-renewable-energy-development-plan-ii-oredp-ii/#environmental-assessments	has some important information on existing baseline conditions in the maritime area and associated guidelines for developers.
Minister for Communications, Climate Action and Environment, 2020	European Union (Environmental Impact Assessment) (Environmental Protection Agency Act 1992) (Amendment) Regulations 2020 (S.I. No. 191/2020; S.I. No. 191/2020 - European Union (Environmental Impact Assessment) (Environmental Protection Agency Act 1992) (Amendment) Regulations 2020 (irishstatutebook.ie)	These Regulations amend the Environmental Protection Agency Act 1992 in respect of the transposition of the EIA Directive into Irish law
Department of Housing, Local Government and Heritage (DHLGH), 2021	Article 17 update to Ireland's Marine Strategy Part 2: Monitoring Programme (Article 11) 2021; https://www.gov.ie/en/publication/c5d15-marine-strategy-framework-directive-200856ec-article-17-update-to-irelands-marine-strategy-part-2monitoring-programme-article-11/	Update to Ireland's Marine Strategy Part 2: Monitoring Programme (Article 11), under the MSFD.
DHLGH, 2021	National Marine Planning Framework (NMPF) f0984c45-5d63-4378-ab65-d7e8c3c34016.pdf (www.gov.ie)	The NMPF details how marine activities will interact and coexist with each other in the maritime area. The NMPF directs decision makers and users towards efficient and sustainable use of marine resources via a number of policy objectives. The policy objectives of relevance to this chapter of the EIAR and how they have been addressed is set out in Table 11.2.
DHLGH, 2021	Maritime Area Planning Act 2021 (S.I. No. 50 of 2021); Maritime Area Planning Act 2021 (irishstatutebook.ie)	An Act to regulate the maritime area by means of the NMPF, MACs and establishment of a new regulatory body the Maritime Area Regulatory Authority (MARA).

Publisher	Name of document incl. reference	Key provisions
Guidelines and technical standards		
National Parks and Wildlife Service (NPWS), 2024.	Ireland’s 4th National Biodiversity Action Plan (NBAP) (2024;d424b166-763b-4916-8eba-8afff955c5e5.pdf (www.gov.ie)	The 4th NBAP sets the national biodiversity agenda for the period 2023-2030 through five strategic objectives
DAHG, 2014	Guidance to manage the risk to mammals from manmade sound sources in Irish waters (NPWS, 2014); Underwater sound guidance Jan 2014.pdf (npws.ie)	Guidelines on management of underwater noise and effects on marine mammals, including protocols, mitigation and recommendations
Department of Communications, Climate Action, and the Environment (DCCAE), 2018	Guidance on Marine Baseline Ecological Assessments & Monitoring Activities for Offshore Renewable Energy Projects 2018, (Parts 1 and 2); gov.ie - Guidance Documents for Offshore Renewable Energy Developers (www.gov.ie)	Guidelines on data collection and analysis requirements for offshore renewable energy developments.
Non-Statutory		
Planning Policy and Development Control		
Irish Whale and Dolphin Group (IWDG), 2020	IWDG Policy on Offshore Windfarm Development	Report describing the best practice in the protection of cetaceans during the development process for offshore windfarms and other marine renewable energy installations.
Irish Wind Energy Association (IWEA), 2021	Best Practice Guidelines for the Irish Wind Energy Industry, 2021; Microsoft Word - LE11-563-01_Rpt001-2.doc (windenergyireland.com)	Guidance to development of renewable energy in Ireland.
Guidelines and technical standards		

Publisher	Name of document incl. reference	Key provisions
Environmental Protection Agency (EPA), 2022	Guidelines on the Information to be Contained in Environmental Impact Assessment Reports https://www.epa.ie/publications/monitoring--assessment/assessment/EIAR_Guidelines_2022_Web.pdf	These Guidelines apply to the preparation of all Environmental Impact Assessment Reports undertaken in the State (Ireland).
EPA, 2011	Assessment and Monitoring of Ocean Noise in Irish Waters 2011; Water | Environmental Protection Agency (epa.ie)	Guidance on effects of anthropogenic noise in Irish waters.
Chartered Institute of Ecology and Environmental Management (CIEEM), 2018	Guidelines For Ecological Impact Assessment in The United Kingdom (UK) And Ireland; Combined-EcIA-guidelines-2018-compressed.pdf (cieem.net)	Guidelines to the preparation of all Environmental Impact Assessment Reports undertaken in the UK and Ireland.
Department of Housing, Planning and Local Government (DHPLG), 2019	Draft Revised Wind Energy Development Guidelines	The Guidelines offer advice to planning authorities on planning for wind energy through the development plan process and in determining applications for planning permission.

Table 11.2: National Marine Planning Framework Policy Objectives

NMPF Policy Objective	Description	Section in which it is addressed
Biodiversity Policy 1	Proposals incorporating features that enhance or facilitate species adaptation or migration, or natural native habitat connectivity will be supported, subject to the outcome of statutory environmental assessment processes and subsequent decision by the competent authority, and where they contribute to the policies and objectives of this NMPF. Proposals that may have significant adverse impacts on species adaptation or migration, or on natural	See section 11.7.3.

NMPF Policy Objective	Description	Section in which it is addressed
	native habitat connectivity must demonstrate that they will, in order of preference and in accordance with legal requirements: a) avoid, b) minimise, or c) mitigate significant adverse impacts on species adaptation or migration, or on natural native habitat connectivity.	
Biodiversity Policy 4	Proposals must demonstrate that they will, in order of preference and in accordance with legal requirements: a) avoid; b) minimise; or c) mitigate significant disturbance to, or displacement of, highly mobile species.	See sections 11.7.3, 11.9.1, 11.9.2, 11.9.6, 11.9.7, 11.10.1, 11.10.2, 11.10.6, and 11.10.7.
Protected Marine Sites Policy 1	Proposals must demonstrate that they can be implemented without adverse effects on the integrity of Special Areas of Conservation (SACs) or Special Protection Areas (SPAs). Where adverse effects from proposals remain following mitigation, in line with Habitats Directive Article 6(3), consent for the proposals cannot be granted unless the prerequisites set by Article 6(4) are met.	A Natura Impact Statement – Stage 2 Appraisal to Inform An Appropriate Assessment Of Implications On European Sites has been prepared for this planning application.
Underwater Noise Policy 1	Proposals must take account of spatial distribution, temporal extent, and levels of impulsive and / or continuous sound (underwater noise) that may be generated and the potential for significant adverse impacts on marine fauna. Where the potential for significant impact on marine fauna from underwater noise is identified, a Noise Assessment Statement must be prepared by the proposer of	See sections 11.9.1, 11.9.2, 11.9.6, 11.9.7, 11.10.1, 11.10.2, 11.10.6, and 11.10.7.

NMPF Policy Objective	Description	Section in which it is addressed

	development. The findings of the Noise Assessment Statement should demonstrably inform determination(s) related to the activity proposed and the carrying out of the activity itself.
	
	The content of the Noise Assessment Statement should be relevant to the particular circumstances and must include:
	
	• Demonstration of compliance with applicable legal requirements, such as necessary assessment of proposals likely to have underwater noise implications, including but not limited to:
	  o Appropriate Assessment (AA);
	  o Environmental Impact Assessment (EIA);
	  o Strategic Environmental Assessment (SEA);
	  o Specific response to 'strict protection' requirements of Article 12 of the Habitats Directive in relation to certain species listed in Annex IV of the Directive; and
	  o Species protected under the Wildlife Acts.
	• An assessment of the potential impact of the development or use on the affected species in terms of environmental sustainability;
	• Demonstration that significant adverse impacts on marine fauna resulting from underwater noise will, in order of preference and in accordance with legal requirements be:
	a) avoided,
	b) minimised, or
	c) mitigated, or	

NMPF Policy Objective	Description	Section in which it is addressed
	d) if it is not possible to mitigate significant adverse impacts on marine fauna, the reasons for proceeding must be set out. This policy should be included as part of statutory environmental assessments where such assessments require consideration of underwater noise.	

11.3 Consultation

11.3.1.1 Consultation activities have been undertaken with various statutory and non-statutory authorities as part of the EIA for the Proposed Development. A summary of the key issues raised to date that are specific to marine mammals, together with how these issues have been considered in production of this EIAR chapter is presented in Table 11.3.

Table 11.3: Summary of consultation relating to marine mammals

Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
January 2019	Irish Whale and Dolphin Group (IWDG)	Discussion of: • Sources of information including regional monitoring data; • Site-specific survey methods (historical data and aerial surveys); • Mitigation measures to be applied during construction; • Requirement for site-specific noise modelling for piling; and • Return of humpback whales (*Megaptera novaeangliae*) to Irish waters.	The baseline environment section presents the most up-to-date information available, from site-specific surveys and from published sources and includes information provided during consultation (section 11.5.2). Factored In Measures are presented in Table 11.15. The effects of subsea noise were based on project-specific modelling (Volume III, Appendix 11.1: Underwater Noise Assessment).
January 2019	NPWS	Discussion of: • Sources of data for baseline assessment; • Site-specific noise modelling to be undertaken; • Irish guidance on injury/disturbance to marine mammals recommends consideration of onset of temporary threshold shift (TTS); and • Potential for use of Acoustic Deterrent Devices (ADDs).	Sources of data are presented in Table 11.4. The assessment of effects of subsea noise has followed the approach recommended by the Department of Arts, Heritage and the Gaeltacht (DAHG) (2014) and is based on project-specific noise modelling (Volume III, Appendix 11.1: Underwater Noise Assessment), and includes modelling and assessment of TTS for the relevant Functional Hearing Groups (FHGs). ADDs are a potential mitigation device that can be effectively used to deter marine mammals from entering a zone in which they could be injured by noise emissions associated with the Proposed Development, or encouraging them to leave such a zone. The use of ADDs for mitigation was

Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
			discussed with NPWS, who were open to considering this approach as an option.
January 2019	Seal Rescue Ireland	Discussion of: • Site-specific surveys and baseline data; and • Characteristics of seals and location of haul out sites.	The baseline environment is informed by site-specific surveys (Table 11.5) and by the most recent information gathered through a desk-based study (Table 11.4). Volume III, Appendix 11.2: Marine Mammals Technical Report describes in detail the ecology and distribution of seals within the defined study areas.
August 2020	Department of Culture, Heritage and the Gaeltacht (DCHG)	Comments on the Proposed Development marine mammal risk assessment for the geotechnical surveys (relevant to this EIAR): • Inclusion of the most recent aerial survey data for seals in Ireland; and • Inclusion of TTS in the subsea noise assessment.	The most recent aerial survey data (Morris and Duck, 2019) has been included in the baseline (see Table 11.4). TTS for the relevant FHGs have been included in the assessment of the effects of noise on marine mammals, noting that as a short-term hearing impediment TTS ranges were not used to define the mitigation zone; instead, the range at which a permanent auditory injury (a Permanent Threshold Shift; PTS) occurs was used.
October 2020	IWDG – Scoping response	Comments on the Scoping Report (submitted September 2020): • Inclusion of relevant legislation and guidance including Convention on Migratory Species (CMS) guidance; • Clarification regarding consideration of underwater noise during operation by assessment; • Study area and scope for baseline data to allow assessment of subsea noise impact; • Static Acoustic Monitoring (SAM) to develop a noise profile of the site before,	Relevant guidance and legislation are provided in section 11.2. and section 11.7 Operational noise is considered in Table 11.11. Study area and scope of baseline data is presented in Table 11.5 and Table 11.4. (Volume III, Appendix 11.2: Marine Mammals Technical Report). Confirmatory PAM surveys are planned and will included click detectors (e.g. C-PODs/F-PODs) and broadband devices (e.g. soundtraps). Monitoring has been proposed to understand the potential for behavioural disturbance to marine

Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
		during and after construction; • Concern regarding assigning unidentified 'seal species' as grey seal and 'small cetacean species' as harbour porpoise; • Predictive noise modelling for piles should be carried out with and without the use of noise abatement systems (NAS); • The use of Passive Acoustic Monitoring (PAM) as part of mitigation strategy; and • Mitigation measures should include PAM and a minimum of two PAM Operators (PAMOs).	mammals during piling. Such monitoring will include both visual monitoring and the use of PAM. The details of this monitoring are set out in Volume II, Chapter 25: Summary of Factored In Measures, Mitigation and Monitoring. Unassigned 'small cetacean species' have not been assigned to harbour porpoise to calculate density estimates within this assessment. Grey seal density estimates from site-specific surveys have not been used in assessment due to insufficient numbers of species recorded to consider the estimate robust. Predictive noise modelling has been carried out for both Project Design Options with Factored In Measures to include a soft start. NAS (e.g. piling sleeves or bubble curtains to reduce noise at source) have not been included as part of the project design and therefore have not been modelled. Mitigation is outlined in the Marine Mammal Mitigation Plan (MMMP) (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan Table 11.15) and follow statutory guidance (DAHG, 2014) and will include the use of both Marine Mammal Observers (MMOs) and PAMOs.
December 2020	IWDG – meeting	Discussion of Scoping Response, including: • Effect of operational noise, including vessel traffic; • Baseline data sources and approach to analysis; • 24-hour mitigation, including use of ADDs; • NAS; and • Monitoring.	As above.

Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
August 2023	IWDG – Scoping response	Comments on the Scoping Report (submitted 2023): • Establishment of baseline underwater noise levels; • DAHG (2014) guidance is currently under review and updated guidance will likely take a significantly different form; and • Underwater noise during operation and potential overlap of TTS ranges from other turbines.	Relevant guidance and legislation are provided in section 11.2. Operational noise has been scoped out for marine mammals, with justification of this provided in Table 11.11.

11.4 Study area

11.4.1.1 Marine mammals are highly mobile and differ in their foraging distances and seasonal distribution based on their ecology and behaviour; therefore, for the purposes of baseline characterisation, two marine mammal study areas were defined (Figure 11.1):

- Marine Mammal Study Area: for all species, this area encompasses the Array Area, and Cable Corridor and Working Area of the Proposed Development, plus a 4-kilometre (km) corridor extending around the Array Area and covering the area west of the Array Area to the coast. This combined area is also covered by the site-specific digital aerial surveys (DAS) (2018 to 2020).
- Marine Mammal Management Unit (MU) Study Area: as marine mammals are highly mobile, the baseline characterisation also considers marine mammal ecology, behaviour, abundance, and distribution within the appropriate species MU for cetaceans (Inter-Agency Marine Mammal Working Group (IAMMWG), 2023). The marine mammal MU Study Area will enable consideration of the scale of movement and population structure for each species. For pinnipeds, this area is defined by survey regions presented in Morris and Duck (2019) whilst giving consideration to the MUs relevant to the neighbouring waters of the United Kingdom (UK).

11.4.1.2 The Proposed Development is located within the following MUs for each species:

- Harbour porpoise (*Phocoena phocoena*) – Celtic and Irish Seas MU;
- Bottlenose dolphin (*Tursiops truncatus*) – Irish Sea MU;
- Risso's dolphin (*Grampus griseus*) – Celtic and Greater North Seas MU;
- Short-beaked common dolphin (*Delphinus delphis*) – Celtic and Greater North Seas MU;
- Minke whale (*Balaenoptera acutorostrata*) – Celtic and Greater North Seas MU;
- Grey seal (*Halichoerus grypus*) – East region of Republic of Ireland (RoI); and
- Harbour seal (*Phoca vitulina*) – East region of RoI.

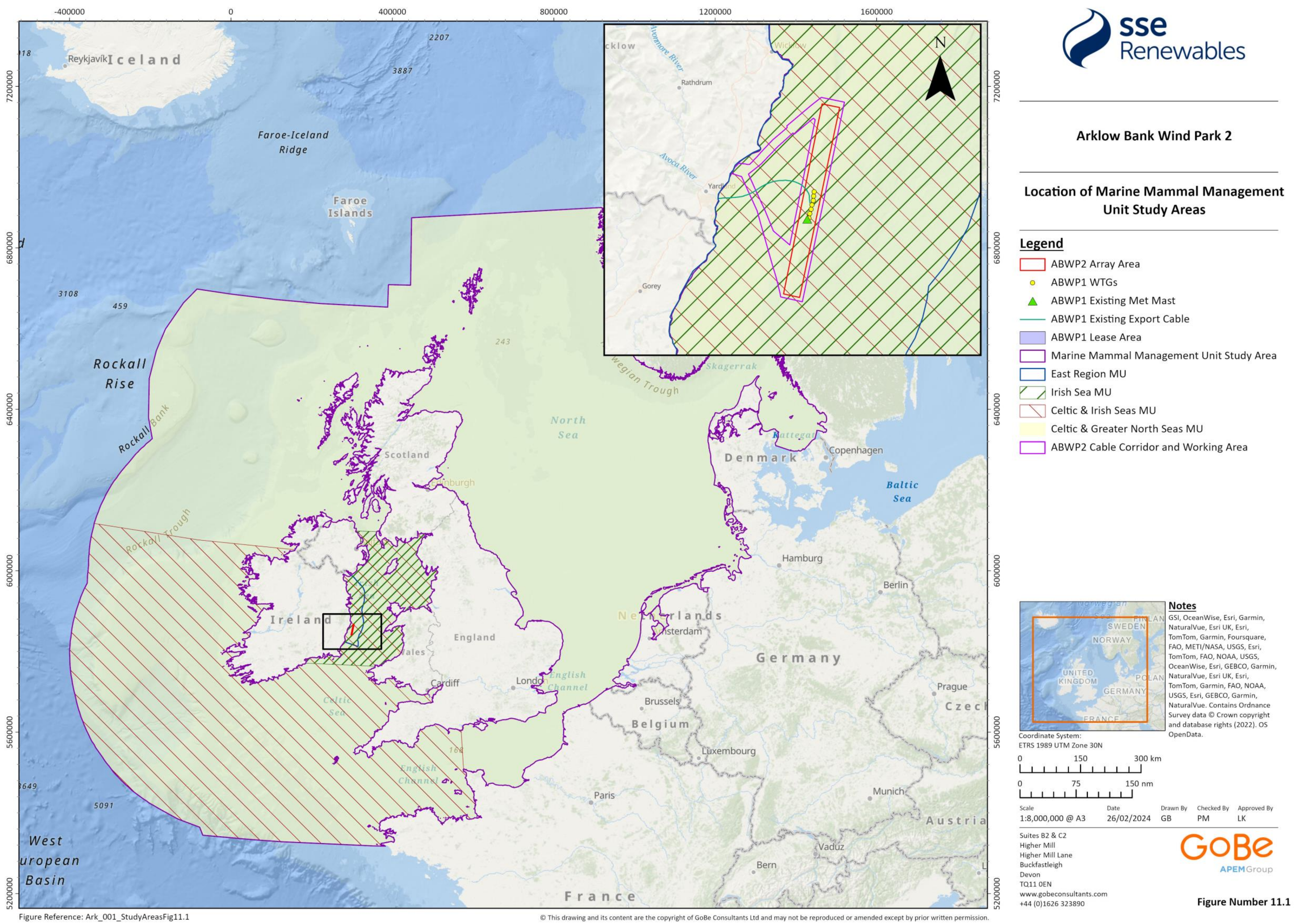

Figure 11.1: Location of Marine Mammal Study Area and Marine Mammal Management Unit Study Area

11.5 Methodology

11.5.1 Methodology to inform the baseline

Desktop studies

11.5.1.1 Information on the marine mammal species within the Marine Mammal Study Area and MU Study Areas was collected through a detailed desktop review of existing studies and datasets. These reports are summarised in Table 11.4.

Table 11.4: Summary of key desktop reports and data resources

Title	Source	Year	Author
Aerial thermal imagery surveys	NPWS	2003	Cronin *et al.* (2004)
Seal counts from aerial imagery surveys	NPWS	2005	O'Cadhla *et al.* (2007)
Irish cetacean review	IWDG	2000 to 2009	Berrow *et al.* (2010)
Atlas of marine mammals in Irish offshore waters	IWDG	2005 to 2011	Wall *et al.* (2013)
Marine mammal surveys	NPWS and IWDG	2008 to 2011	Berrow *et al.* (2008; 2013)
Inshore surveys for cetaceans	IWDG	2011	Berrow *et al.* (2011)
Aerial thermal imagery surveys	NPWS	2011 to 2012	Duck and Morris (2013)
Small Cetacean Abundance in the North Sea (X) - III	SMRU	2016	Hammond *et al.* (2017; 2021); Lacey *et al.* (2022)
'ObSERVE' programme aerial data	Department of Communications, Climate Action and Environment (DCCAE) and NPWS	2015 to 2017	Rogan *et al.* (2018a)
Aerial thermal imagery surveys	NPWS	2017 to 2018	Morris and Duck (2019)
Harbour and grey seals at sea usage maps	Sea Mammal Research Unit (SMRU)	2005 to 2019	Carter *et al.* (2022)
Modelled distributions and abundance of cetaceans of Wales and surrounding waters	Natural Resources Wales (NRW)	1990 to 2020	Evans and Waggitt (2023)

Title	Source	Year	Author
Biodiversity maps for Ireland	National Biodiversity Data Centre (NBDC)	various	NBDC online mapping tool[1]
Special Committee on Seals (SCOS) series	SMRU	1996 to 2022	SCOS (2021; 2022)
SCANS-IV	SMRU	2022	Gilles *et al.* (2023)
MUs for cetaceans	Joint Nature Conservation Committee (JNCC)	2023	IAMMWG (2023)

Site specific surveys

11.5.1.2 In order to inform the EIAR, site-specific surveys were undertaken. A summary of the surveys used to inform the marine mammals impact assessment is outlined in Table 11.5 below.

11.5.1.3 Site-specific surveys include data collected in support of Arklow Bank Wind Park 1 (ABWP1) and recent surveys commissioned to inform the baseline for the Proposed Development.

11.5.1.4 The site-specific surveys for ABWP1 include historical boat-based visual surveys undertaken between June 2000 and June 2009, and acoustic monitoring data were also obtained to the northwest of the ABWP1 wind turbines. These data were collected for a total of 25 days during August and September 2002 (Table 11.5). Historical data has been included as it is informative to trends in occurrence and distribution, although does not hold substantial weight in informing the baseline characterisation.

11.5.1.5 Twenty-four months of DAS data (March 2018 to February 2020 and April 2020) are available to inform the baseline for this EIAR (Table 11.5). An additional survey was conducted in April 2020 to account for a missed survey in April 2019. Across these surveys, all calendar months were surveyed twice to capture seasonal seabird and marine mammal species presence across the Marine Mammal Study Area.

Table 11.5: Site specific surveys

Data source	Date(s) of survey	Overview of survey	Survey contractor	Reference to further information
Acoustic monitoring	August to September 2002	Static acoustic data logger	Coveney Wildlife Consulting Ltd (CWC)	CWC (2002); Volume III, Appendix 11.2: Marine Mammals Technical Report.
Historical boat-based visual survey	July 2000 to June 2005	Visual boat-based survey	CWC	CWC (2003; 2004; 2005); Volume III, Appendix 11.2: Marine Mammals Technical Report.
Historical boat-based visual survey	July 2005 to June 2006	Visual boat-based survey	Fulmar Ecological Services	Fulmar Ecological Services (2006); Volume III,

[1] https://maps.biodiversityireland.ie/Map

Data source	Date(s) of survey	Overview of survey	Survey contractor	Reference to further information
				Appendix 11.2: Marine Mammals Technical Report.
Historical boat-based visual survey	July 2006 to June 2009	Visual boat-based survey	Cork Ecology	Cork Ecology (2007; 2009; 2010); Volume III, Appendix 11.2: Marine Mammals Technical Report.
Baseline DAS	March 2018 to February 2020 (excluding April 2019) plus April 2020	DAS	HiDef Aerial Surveying Limited	HiDef (2020a; b); Volume III, Appendix 11.2: Marine Mammals Technical Report.
MMO daily sightings data	July to August 2019	Boat-based sightings during mitigation for geophysical survey campaign	IWDG Consulting	IWDG Consulting (2019); Volume III, Appendix 11.2: Marine Mammals Technical Report.
MMO daily sightings data	July to August 2020	Boat-based sightings during mitigation for geophysical survey campaign	Gavin & Doherty Geosolutions Ltd	Gavin & Doherty Geosolutions Ltd (2020a); Volume III, Appendix 11.2: Marine Mammals Technical Report.
MMO daily sightings data	October to November 2020	Boat-based sightings during mitigation for geotechnical survey campaign	Gavin & Doherty Geosolutions Ltd	Gavin & Doherty Geosolutions Ltd (2020b); Volume III, Appendix 11.2: Marine Mammals Technical Report.
MMO daily sightings data	July to August 2023	Boat-based sightings during mitigation for geotechnical nearshore and offshore survey campaigns	Gavin & Doherty Geosolutions Ltd	Gavin & Doherty Geosolutions Ltd (2023a; b); Volume III, Appendix 11.2: Marine Mammals Technical Report.

Identification of designated sites

11.5.1.6 All designated sites within the Marine Mammal Study Area and MU Study Areas, and qualifying interests that could be affected by the construction, operational and maintenance, and decommissioning phases of the Proposed Development were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the MU Study Area were identified using a number of sources. These included the EPA and NPWS websites.
- Step 2: Information was compiled on the relevant qualifying interest for each of these sites which may make them a sensitive receptor in terms of marine mammals. For example, changes in underwater noise levels may affect animal behaviour.

- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  – A designated site directly overlaps with the Proposed Development; or
  – Sites and associated qualifying interests were located within the potential Zone of Influence (ZoI) for impacts associated with the Proposed Development.

11.5.1.7 The designated sites and relevant qualifying interests for marine mammals are presented in Table 11.6 and Figure 11.2.

Table 11.6: Designated sites and relevant qualifying interests for marine mammals.

Designated Site	Closest Distance to the Array Area (km)	Closest Distance to Cable Corridor and Working Area (km)	Relevant Qualifying Interest
Blackwater Bank Special Area of Conservation (SAC)	19.76	47.27	• Harbour porpoise
Carnsore Point SAC	73.83	70.70	• Harbour porpoise
Rockabill to Dalkey Island SAC	70.39	72.50	• Harbour porpoise
Codling Fault Zone SAC	63.31	66.62	• Harbour porpoise
West Wales Marine / Gorllewin Cymru Forol SAC	93.50	98.58	• Harbour porpoise
North Anglesey Marine / Gogledd Môn Forol SAC	114.17	119.72	• Harbour porpoise
Lambay Island SAC	62.87	80.53	• Grey seal • Harbour seal • Harbour porpoise
Lleyn Peninsula and the Sarnau / Pen Llŷn a'r Sarnau SAC	73.32	116.20	• Bottlenose dolphin • Grey seal
Cardigan Bay / Bae Ceredigion SAC	82.73	117.03	• Bottlenose dolphin • Grey seal
Pembrokeshire Marine / Sir Benfro Forol SAC	129.78	130.08	• Grey seal
Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC	214.68	214.98	• Harbour porpoise

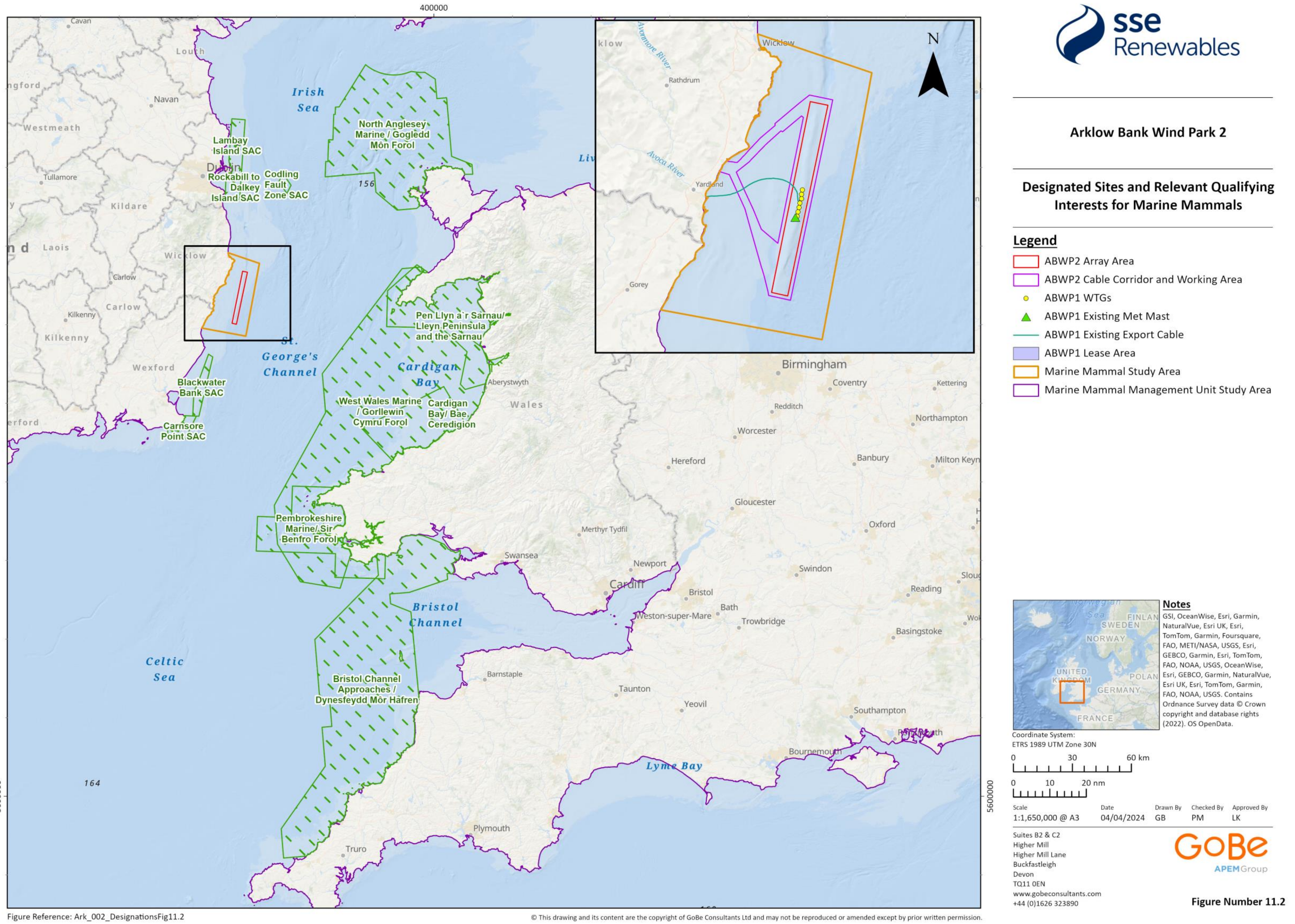

Figure 11.2: Designated Sites and Relevant Qualifying Interests for Marine Mammals

11.5.2 Baseline environment

11.5.2.1 A technical report has been prepared to provide a detailed characterisation of the receiving baseline (Volume III, Appendix 11.2: Marine Mammals Technical Report). A review of the key findings from that technical report has been incorporated into the description of the baseline environment.

11.5.2.2 This EIAR chapter should therefore be read alongside Volume III, Appendix 11.2: Marine Mammals Technical Report which describes the range of species, and the abundance and density of marine mammals that could potentially be impacted by the Proposed Development, informed by desktop studies and site-specific data collected covering the Marine Mammal Study Area and the wider species specific MU Study Areas relevant to the location of the Proposed Development (see section 11.5.1 for details of sources used).

11.5.2.3 A review of the data available have confirmed the likely presence of the following marine mammal species in the vicinity of the Proposed Development:

- Harbour porpoise;
- Bottlenose dolphin;
- Risso's dolphin;
- Short-beaked common dolphin (hereafter referred to as common dolphin);
- Minke whale;
- Grey seal; and
- Harbour seal.

11.5.2.4 Therefore, these species will be considered within the quantitative impact assessment.

11.5.2.5 The most robust and relevant density estimates within each MU were determined for each receptor with a justification of density estimates used included in the species accounts below. Density estimates and population assessments for the marine mammal species in the Marine Mammal Study Areas are presented in Table 11.7. These values provide a measure to quantify the scale of effect of given impacts within the impact assessment. Where possible, site-specific estimates from the DAS are provided for a species, where this was not possible, the reason for this is outlined in the relevant species-specific sections below.

11.5.2.6 Where possible, density estimates derived from site-specific DAS have been used, however it is important to note that the site-specific density estimates are not representative of animal densities across the wider scale for large-scale impacts such as disturbance from piling.

11.5.2.7 The reference populations for cetaceans and their relevant MU as identified by the IAMMWG for practical management purposes for cetaceans in Irish and UK waters are presented in IAMMWG (2023). As MUs have not been defined for seals in Irish waters, the reference population is identified based on the latest aerial surveys of seals in Ireland (Morris and Duck, 2019), and extrapolated to a population estimate for grey seal using the conversion factor developed by Lonergan *et al.* (2013), and for harbour seal using the conversion factor presented by SCOS (2022).

Table 11.7: Marine mammal density (animals/km) and population estimates utilised for quantitative impact assessment

Species	Density (animals/km^2)	Density source	Reference population	Reference population estimate	Reference population source
Harbour porpoise	0.38	Site-specific DAS	Celtic and Irish Seas MU	62,517	IAMMWG (2023)

Species	Density (animals/km^2)	Density source	Reference population	Reference population estimate	Reference population source
	0.2803	Gilles *et al.* (2023)			
	Grid-cell specific	Derived from SCANS-III density surfaces (Lacey *et al.*, 2022)			
Bottlenose dolphin	0.0201	Rogan *et al.* (2018a)	Irish Sea MU	293	IAMMWG (2023)
	0.2352	Gilles *et al.* (2023)			
	Grid-cell specific	Derived from SCANS-III density surfaces (Lacey *et al.*, 2022)			
Risso's dolphin	0.031	Hammond *et al.* (2021)	Celtic and Greater North Seas MU	12,262	IAMMWG (2023)
Common dolphin	0.0272	Gilles *et al.* (2023)	Celtic and Greater North Seas MU	102,656	IAMMWG (2023)
	Grid-cell specific	Derived from SCANS-III density surfaces (Lacey *et al.*, 2022)			
Minke whale	0.045	Rogan *et al.* (2018a)	Celtic and Greater North Seas MU	20,118	IAMMWG (2023)
	0.017	Hammond *et al.* (2021)			
	Grid-cell specific	Derived from SCANS-III density surfaces (Lacey *et al.*, 2022)			
Grey seal	0.08	Grid cell-specific average across the Array Area and Cable Corridor and Working Area	East region of RoI	1,662	Scaled from count data (Morris and Duck, 2019)

Species	Density (animals/km^2)	Density source	Reference population	Reference population estimate	Reference population source
		extracted from Carter *et al.* (2020)			
Harbour seal	0.0003	Grid cell-specific average across the Array Area and Cable Corridor and Working Area extracted from Carter *et al.* (2020)	East region of RoI	182	Scaled from count data (Morris and Duck, 2019)

Harbour porpoise (*Phocoena phocoena*)

11.5.2.8 Harbour porpoises are listed under Annex IV of the Habitats Directive as a European Protected Species (EPS) and under Annex II of the Habitats Directive as a species of Community Interest. As an Annex II species of the Habitats Directive, the designation of SACs is required as a component of their conservation. There are several SACs where harbour porpoises are listed as a qualifying feature, the closest of which is Blackwater SAC which is 19.76 km from the Array Area (Table 11.6). In Ireland, harbour porpoises have a 'favourable' conservation status and a 'stable' population trend (NPWS, 2019).

11.5.2.9 They are the most abundant cetacean species in Irish waters and have a wide distribution (Berrow *et al.*, 2010; Rogan *et al.*, 2018a; Wall *et al.*, 2013). Within the Celtic and Irish Seas MU, harbour porpoise abundance is estimated as 62,517 individuals (95% confidence interval (CI): 48,324 – 80,877, coefficient of variation (CV): 0.13) (IAMMWG, 2023).

11.5.2.10 They were recorded during the geotechnical survey campaign of the Proposed Development in 2023, where one sighting of three individuals was recorded (Gavin & Doherty Geosolutions Ltd, 2023b). They were the most frequently recorded marine mammal species during site-specific DAS, with a total of 263 sightings in 23 of 25 surveys (HiDef, 2020a) and a mean corrected density estimate of 0.38 animals/km^2. Site-specific DAS confirmed the presence of harbour porpoise within the Marine Mammal Study Area year-round, although abundance and density was higher in summer months (HiDef, 2020a), which has been confirmed by several other studies in this region (Berrow *et al.*, 2008; Rogan *et al.*, 2018a). It is important to note that site-specific density estimates are not representative of animal densities across the wider scale, and therefore should not be used to assess large scale impacts such as disturbance from piling. However, the site-specific density estimates are the best fine-scale data available for assessing the use and importance of the area, therefore the mean corrected density of 0.38 animals/km^2 is taken forward to the quantitative impact assessment (HiDef, 2020b). In addition to this, the SCANS-IV (Gilles *et al.*, 2023) density estimate of 0.2803 animals/km^2 is the most recent large spatial scale estimate available, and is therefore taken forward to the quantitative assessment for impacts that may extend beyond the boundary of the Proposed Development (Table 11.7).

Bottlenose dolphin (*Tursiops truncatus*)

11.5.2.11 Bottlenose dolphins are also listed under Annex IV of the Habitats Directive as an EPS and under Annex II of the Habitats Directive as a species of Community Interest. As an Annex II species of the Habitats Directive, the designation of SACs is required as a component of their conservation. There are two SACs within the MU Study Area where bottlenose dolphin are listed as a qualifying feature: Cardigan Bay SAC and Lleyn Peninsula and the Sarnau SAC (Table 11.6) which supports a semi-resident population, where NRW consider connectivity of this population between the two sites (NRW, 2022). In Ireland, bottlenose dolphins have a 'favourable' conservation status and a 'stable' population trend (NPWS, 2019).

11.5.2.12 They are widespread and abundant in Irish waters (Berrow *et al.*, 2010; Wall *et al.*, 2013). Within the Irish Sea MU, bottlenose dolphin abundance is estimated as 293 individuals (95% CI: 108 – 793, CV: 0.54) (IAMMWG, 2023). Two different ecotypes of bottlenose dolphin occur commonly within Irish and UK waters: a coastal ecotype and an offshore ecotype (Berrow *et al.*, 2013; Hague *et al.*, 2020; Wall *et al.*, 2013). Coastal ecotypes comprise semi-resident populations in coastal areas, such as the Shannon Estuary, and show high site fidelity (Ingram and Rogan, 2002; Rogan *et al.*, 2018b). Whereas, photographic identification studies have found that offshore bottlenose dolphins are highly mobile and capable of travelling large distances, with the same individuals undertaking movements around the entire Irish coast (O'Brien .*et al.*, 2010), as well as evidence of movement through potential corridors linking SACs in the Shannon Estuary, Cardigan Bay, and the Moray Firth, and confirming individual exchange between previously considered discrete populations in the UK and Ireland (Robinson *et al.*, 2012). Therefore, it must be considered that the bottlenose dolphin population along the West coast of Ireland may demonstrate connectivity to individuals found on the East coast of the UK.

11.5.2.13 One group of bottlenose dolphin was recorded during site-specific DAS, confirming their presence within the Marine Mammal Study Area (HiDef, 2020a). However, it was not possible to provide an abundance and/or density estimate for bottlenose dolphin from the site-specific DAS due to the low number of sightings across the survey period. Similarly, bottlenose dolphins were only observed once in stratum 5 (where the Proposed Development is located) during the ObSERVE surveys, with a greater abundance recorded on the south and west coasts of Ireland (Rogan *et al.*, 2018a). As recent large-scale surveys have provided contrasting density estimates, the quantitative impact assessment will use both a density estimate of 0.0201 animals/km^2 from the ObSERVE surveys (Rogan *et al.*, 2018a) and a density estimate of 0.2352 animals/km^2 from SCANS-IV surveys (Gilles *et al.*, 2023) (Table 11.7).

Risso's dolphin (*Grampus griseus*)

11.5.2.14 Risso's dolphins are listed under Annex IV of the Habitats Directive as an EPS of Community Interest. In Ireland, Risso's dolphin have a 'favourable' conservation status and a 'stable' population trend (NPWS, 2019).

11.5.2.15 Risso's dolphins are frequently recorded in Irish waters and have a wide distribution with sightings in both deep offshore shelf and slopes waters and in coastal areas (Berrow *et al.*, 2010; Rogan *et al.*, 2018a). Within the Celtic and Greater North Seas MU, Risso's dolphin abundance is estimated as 12,262 individuals (95% CI: 5,227 – 28,764, CV: 0.46) (IAMMWG, 2023).

11.5.2.16 They were not recorded during site-specific DAS (HiDef, 2020a), although six sightings of between one and eight individuals have been previously recorded during historic site-specific boat-based surveys carried out from 2000 to 2008, confirming their presence within the Marine Mammal Study Area. However, it was not possible to provide an abundance and/or density estimate for Risso's dolphin due to the low number of sightings across the survey period. Sightings of Risso's dolphins have also been recorded during the ObSERVE and SCANS surveys of the wider area (Gilles *et al.*, 2023; Hammond *et al.*, 2021; Rogan *et al.*, 2018a). Although only one individual was recorded in stratum 5 (where the Proposed Development is located) during the ObSERVE surveys (Rogan *et al.*, 2018a). Therefore, given the relatively low numbers of this species recorded across the historic and recent site-specific surveys and the broad-scale surveys, the best and most recent density estimate available for the quantitative assessment is 0.031 animals/km^2 from SCANS-III (Hammond *et al.*, 2021) which represents the most conservative estimate available (Table 11.7).

Common dolphin (*Delphinus delphis*)

11.5.2.17 Common dolphins are listed under Annex IV of the Habitats Directive as an EPS of Community Interest. In Ireland, common dolphins have a 'favourable' conservation status and a 'stable' population trend (NPWS, 2019).

11.5.2.18 Common dolphins are the most frequently recorded dolphin species in Irish waters and have a broad distribution, occurring in both offshore and coastal waters (Berrow *et al*., 2010). A single MU is used for common dolphin: the Celtic and Greater North Seas MU (IAMMWG, 2023). The abundance estimate for this MU is 102,656 individuals (95% CI: 58,932 – 178,822, CV: 0.29).

11.5.2.19 A total of 22 common dolphins were recorded on two occasions, in November 2019 and in January 2020 during site-specific DAS, confirming their presence within the Marine Mammal Study Area (HiDef, 2020a). However, it was not possible to provide an abundance and/or density estimate for common dolphin from the site-specific DAS due to the low number of sightings across the survey period. Therefore, given the relatively low numbers of this species recorded across the historic and recent site-specific surveys and the broad-scale surveys, the best density estimate available is 0.0272 animals/km^2 from the SCANS-IV surveys (Gilles *et al*., 2023; see Table 11.7).

Minke whale (*Balaenoptera acutorostrata*)

11.5.2.20 Minke whales are listed under Annex IV of the Habitats Directive as an EPS of Community Interest. In Ireland, minke whales have a 'favourable' conservation status and a 'stable' population trend (NPWS, 2019).

11.5.2.21 Minke whale are the most abundant species of baleen whale in Irish waters and have a patchy distribution within the Irish Sea (Reid *et al*., 2003; Rogan *et al*., 2018a). Within the Celtic and Greater North Seas MU, minke whale abundance is estimated as 20,118 individuals (95% CI: 14,061 – 178,822, CV: 0.18) (IAMMWG, 2023).

11.5.2.22 They were not recorded during the site-specific DAS (HiDef, 2020a), although sightings have been recorded during the ObSERVE and SCANS surveys of the wider area (Gilles *et al*., 2023; Hammond *et al*., 2021; Rogan *et al*., 2018a). Furthermore, the ObSERVE surveys confirmed a higher presence of minke whale during the spring and summer months (Rogan *et al*., 2018a). The species is expected to be largely absent in autumn and winter due to offshore movement during these months. The highest density estimate for the quantitative assessment is 0.045 animals/km^2 from the ObSERVE surveys (Rogan *et al*., 2018a), and this represents the most conservative estimate available; this estimate will only be used for impacts within stratum 5 (where the Proposed Development is located). A density estimate of 0.017 animals/km^2 from SCANS-III (Hammond *et al*., 2021) will be used for to assess the large-scale impacts that may extend beyond the boundary of the Proposed Development (Table 11.7).

Grey seal (*Halichoerus grypus*)

11.5.2.23 Grey seals are listed under Annex II of the Habitats Directive as a species of Community Interest; therefore, the designation of SACs is required as a component of their conservation. There are several SACs where grey seals are listed as a qualifying feature, the closest of which is Lambay Island SAC which is 62.87 km from the Array Area (Table 11.6). In Ireland, grey seals have a 'favourable' conservation status and an 'increasing' population trend (NPWS, 2019).

11.5.2.24 Foraging ranges of up to 448 km from a haul-out have been reported for grey seals, based on the analysis of telemetry data (Carter *et al*., 2022). However, typical foraging distances tend to be shorter, for example, McConnell *et al*. (1999) reported that 88% of trips undertaken were local and repeated and were within 65 km of the haul-out site.

11.5.2.25 Grey seals have a wide distribution and occur around the coast of Ireland year-round (Morris and Duck, 2019; O'Cadhla *et al*., 2007). For the purposes of this impact assessment, grey seals have been assessed within the East region of Ireland (Figure 11.1; Table 11.7). The population size of the East region of Ireland has been scaled by estimating the average proportion of grey seals hauled-out at the time of survey (25.15%, 95% CI: 25.45 – 29.07%) (SCOS, 2022), resulting in an estimate of 1,662 individuals (Table 11.7).

11.5.2.26 During the Proposed Development geotechnical survey campaign in 2023, there were four sightings of individual grey seals and one sighting of a grey seal and an unidentified seal (Gavin & Doherty Geosolutions Ltd, 2023a). A total of 15 grey seals were sighted across eight of the 25 site-specific DAS, confirming their presence within the Marine Mammal Study Area year-round (HiDef, 2020a). However, it was not possible to provide an abundance and/or density estimate for grey seal from the site-specific DAS due to the low number of sightings across the survey period (see Volume III, Appendix 11.2: Marine Mammals Technical Report). There is a lack of at-sea density estimate due to a lack of telemetry data in Irish waters. However, telemetry data from grey seals tagged in UK waters has shown connectivity between the east and north coasts of Ireland, Wales, Southwest England, and the southwest coast of Scotland (Carter *et al.*, 2020). The average grey seal density across grid cells within the Array Area and Cable Corridor and Working Area is 0.08 animals/km^2 (extracted from Carter *et al.* (2020)).

11.5.2.27 Grey seals gather in colonies on land (known as haul-outs) where they breed, rest, moult and engage in social activity (Bonner, 1990). Preferred haul-out locations around the coast of Ireland include uninhabited islands, isolated beaches, rocky skerries and sea caves (O'Cadhla *et al.*, 2007). The closest haul-out to the Proposed Development is on the coast at Arklow, county (Co.) Wicklow. (Duck and Morris, 2013; Morris and Duck, 2019). Grey seals also haul-out at nearby established breeding colonies at Lambay Island, to the north of the Proposed Development, and at Wexford Harbour to the south of the Proposed Development (Duck and Morris, 2013; Morris and Duck, 2019).

Harbour seal (*Phoca vitulina*)

11.5.2.28 Harbour seals are listed under Annex II of the Habitats Directive as a species of Community Interest, therefore designation of SACs is required as a component of their conservation. Lambay Island SAC is the only SAC for which harbour seals are a designated feature that falls within the East region of the RoI (Table 11.6). In Ireland, harbour seals have a 'favourable' conservation status and a 'stable' population trend (NPWS, 2019).

11.5.2.29 Foraging ranges of up to 273 km from a haul-out have been reported for harbour seals, based on analysis of telemetry data (Carter *et al.*, 2022). However, typically, harbour seals normally forage within 50 km of their haul-out site and show high site fidelity (Carter *et al.*, 2022).

11.5.2.30 Harbour seal occur throughout Irish waters in estuarine, coastal, and marine environments (Cronin *et al.*, 2004; Morris and Duck, 2019). For the purposes of this impact assessment, harbour seals have been assessed within the East region of Ireland (Figure 11.1; Table 11.7). The population size of the East region of the RoI has been scaled by estimating the average proportion of harbour seals hauled-out at the time of survey (72%, 95% CI: 0.54 – 0.88) (Lonergan *et al.*, 2013), resulting in an estimate of 182 individuals (Table 11.7). Two sightings of harbour seals were recorded during site-specific DAS, confirming their presence within the Marine Mammal Study Area (HiDef, 2020a). However, it was not possible to provide an abundance and/or density estimate for harbour seal from the site-specific DAS due to the low number of sightings across the survey period. The average harbour seal density across grid cells within the Array Area and Cable Corridor and Working Area is 0.0003 animals/km^2 (extracted from Carter *et al.* (2020)).

11.5.2.31 Harbour seals favour inshore bays and islands, and coves and estuaries to haul-out, and are known to haul-out at Lambay Island to the north of the Proposed Development and at Wexford Harbour to the south of the Proposed Development (Duck and Morris, 2013; Morris and Duck, 2019). The closest haul-out to the Proposed Development is on the coast at North Bull Island to the south of Dublin Bay (Morris and Duck, 2019).

11.5.3 'Do nothing' scenario

11.5.3.1 Annex IV of the EIA Directive sets out the information required to be included in an EIAR. This includes "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge". In the event that the Proposed Development does not proceed, an assessment of the future baseline conditions has been carried out and is described within this section.

11.5.3.2 The future trajectories of marine mammal populations are challenging to predict because monitoring at the appropriate temporal and/or spatial scales does not exist at present (Martin *et al.,* 2023). Therefore, it is challenging to fully understand the baseline dynamics of some marine mammal populations, including all cetacean species within this assessment.

11.5.3.3 The potential impacts of anthropogenic-induced climate change on marine mammal populations are poorly understood, largely due to difficulties in obtaining sufficient evidence (Martin *et al.,* 2023; Evans and Bjørge, 2013). In UK and Irish waters, the main potential impact is range shifts as species try to remain within preferred thermal habitats and/or in response to changes in prey abundance and distribution because of increasing sea surface temperatures (SSTs) (Albouy *et al.,* 2020; Simmonds and Elliott, 2008; MacLeod, 2009; Lambert *et al*., 2011; Martin *et al.,* 2023).

11.5.3.4 There is increasing evidence in the UK and Ireland that the northern extent of species is shifting further northwards (Martin *et al.,* 2023). Range shifts have been observed over the past decade in several inshore bottlenose dolphin populations (Martin *et al.,* 2023). For example, evidence suggests that the semi-resident population previously observed on the southern coasts of Devon and Cornwall may now be extending throughout the English Channel, with sightings further north in the Bristol Channel and as far east as Sussex (Corr *et al.,* 2023). However, a study analysing trends in strandings data found that there was little to no change in the proportion of warmer water species, such as common dolphin, stranding in the Oslo-Paris Conventions (OSPAR) III South region, which is the OSPAR region that the Proposed Development is located in (Williamson *et al.,* 2021). It was concluded that the northward shift was not captured by strandings data in this region because southern regions of the UK and Ireland are already part of the range of warmer water adapted species (Williamson *et al.,* 2021).

11.5.3.5 Observed shifts in marine mammal distribution are considered to represent a functional response of marine mammal species to distribution shifts of their cold-blooded prey which are more sensitive to environmental changes, such as increased SSTs and decreased salinity (Albouy *et al.,* 2020; Vikingsson *et al.,* 2015; Nøttestad *et al.,* 2015; Dye *et al.,* 2020). For example, the observed shift in harbour porpoise distribution in the North Sea over the last 20 years has been linked to changing sandeel (*Ammodytes*) distributions (Hammond *et al.,* 2008; Paxton *et al.,* 2016).

11.5.3.6 There is no clear evidence that climate change has directly affected either grey seal or harbour seal to date, although it is likely to be a key driver of seal population declines in the future (Evans and Bjørge, 2013). UK harbour seal populations have already experienced widespread declines and while the main cause is unknown, the prevalence of domoic acid, a neurotoxin derived from toxic algae, could be a contributing factor, and could be exacerbated by increased SSTs (SCOS, 2022).

11.5.3.7 In addition, sea level rise and increase in storm frequency and associated wave surges could result in changes to physical habitats. This could affect the availability of seal haul-out sites and breeding locations in caves or low-lying coasts, which may be modified or lost as a result, potentially leading to increased pup mortality (Gazo *et al*., 2000; Lea *et al*., 2009).

11.5.3.8 Susceptibility of marine mammal species to disease and contaminants could also be impacted because of climate change as it has the potential to increase pathogen development and survival rates, disease transmission, and host susceptibility (Martin *et al.,* 2023). Higher SSTs could impact disease prevalence by altering the range shifts of both hosts and pathogens which may introduce novel pathogens to new species and regions, and may also increase thermal stress of marine mammal species, increasing their susceptibility to some diseases (Cohen *et al.,* 2018; Tracy *et al.,* 2019; Sanderson and Alexander, 2020). This is supported by an increase in reports of diseases affecting marine organisms, including marine mammals, worldwide (Burek *et al.*, 2008; Harvell *et al.*, 2002; Lafferty *et al.*, 2004; Van Bressem *et al.*, 2009).

11.5.3.9 Species responses to climate change are complex and sensitivities are likely exacerbated by anthropogenic pressures such as construction, pollution, and fishing (Poloczanska *et al.*, 2016), which also influences the distribution and abundance of marine mammal populations. These potential impacts include: probable mortality due to bycatch from fisheries (particularly for harbour porpoise and common dolphin) (Avila *et al.,* 2018; Leeney *et al.,* 2008; Taylor *et al.,* 2023); removal of prey species by overfishing (DeMaster *et al.,* 2001; Matthiopoulos *et al.,* 2008); direct or indirect effects of contamination (from pollution incidents, sewage discharge, or litter disposal at sea) (e.g. Helm *et al.,* 2015; Lane *et al.,* 2015; Mearns *et al.,* 2016); injury or disturbance from noise pollution in the marine environment (e.g. from shipping, drilling, piling, seismic surveys, military activity, dredging and disposal, aggregate extraction, and unexploded ordnance (UXO) detonations) (e.g. Culloch *et al.,* 2016; Pirotta *et al.,* 2012, 2014; Stone *et al.,* 2017; Wisniewska *et al.,* 2018; Graham *et al.,* 2019); and death or injury due to collision with physical objects (e.g. vessels or renewable energy infrastructure) (e.g. Wells *et al.*, 2008; Luksenburg, 2014).

11.5.3.10 Although anthropogenic activities may be associated with adverse effects on marine mammals, all marine mammal species included in this assessment were assessed as having a ‘favourable’ conservation status in Irish waters, with grey seal showing an increasing population trend (NPWS, 2019).

11.5.4 Data limitations

Data to inform the baseline

11.5.4.1 The data assumptions and limitations highlighted in Volume III, Appendix 11.2: Marine Mammals Technical Report are typical of difficulties encountered with undertaking field surveys of marine mammals using boat-based and aerial survey methods, and include:

- Historical boat-based survey design issues;
- Poor survey weather conditions;
- Bias in data; and
- Survey timings.

11.5.4.2 An overview of each of these data limitations is provided in Table 11.8 below.

Table 11.8: Identified data limitations associated with data to inform the baseline

Limitation	Description
Historical boat-based survey design issues	The historical site-specific boat-based survey was designed for recording both seabirds and marine mammals. Therefore, the observers were not dedicated MMOs and as a result, there is the possibility that some animals were missed during surveys.
Poor survey weather conditions	Poor weather conditions can limit the ability to carry out surveys by aeroplane or by vessel. Two surveys were conducted in July 2019, where one survey was carried out at the start of July and the next survey at the end of July to compensate for a missed survey (due to weather) in April 2019. An additional survey was undertaken in April 2020 to reflect potential seasonal species distribution in the month of April.

Limitation	Description
Bias in data	There is the possibility of both availability bias (where an animal is underwater and therefore not available for detection) and detection bias (where an animal is on the surface but the detection is missed). Harbour porpoise are the only species where sufficient sightings were recorded to provide site-specific density estimates from DAS for use within this assessment. The relative density estimate of harbour porpoise was corrected for availability bias using the published correction factor of 0.425 from Teilmann *et al.* (2013) to provide an estimate of absolute density. This correction factor is based on a tagging study in the Baltic/North Sea investigating dive duration of harbour porpoise during different months of the year and times of day (Teilmann *et al.,* 2013). The correction factor from this study that was applied to the DAS data was the lower estimate of availability of 0.425 (i.e. most conservative), based on winter months, specifically February, when surfacing time was found to be lower than in other seasons (Teilman *et al.,* 2013).
Survey timings	Both DAS data and boat-based data represent a snapshot over a short time period each month, during daylight hours and in fair weather. Therefore, it was not possible for HiDef to explore if changes in sighting rates (obtained from the DAS data) were influenced by environmental conditions. Differences in sighting rates between months may be due to seasonal changes, but environmental conditions also have the potential to influence these results.

11.5.4.3 Despite the limitations described in Table 11.8, the baseline assessment provides an informative account of the marine mammals within the Marine Mammal Study Area and MU Study Areas. The site-specific data has also been supported by information collated via the detailed desktop review, and therefore these data limitations are not expected to constrain the ability to draw conclusions within this assessment.

Population modelling

11.5.4.4 Population modelling was completed using the interim Population Consequences of Disturbance (iPCoD) framework for the Proposed Development in isolation to assess whether disturbance resulting from pile driving is predicted to result in population level impacts to five marine mammal species that were identified in the baseline of the EIAR as key receptors. The species assessed are harbour porpoise, bottlenose dolphin, minke whale, grey seal, and harbour seal, noting that iPCoD is not available for Risso's dolphin and common dolphin. The assessment was based on the maximum number of animals predicted to be disturbed per piling day, as presented in sections 11.9.1 and 11.10.1.

11.5.4.5 iPCoD uses a stage structured model of population dynamics with nine age classes and one stage class (adults 10 years and older). The model is used to run a number of simulations of future population trajectory with and without the predicted level of impact, to allow an understanding of the potential future population level consequences of predicted behavioural responses.

11.6 Impact assessment methodology

11.6.1 Key parameters for assessment

11.6.1.1 The assessment of significance of effects has been carried out on both of the two discrete Project Design Options detailed in Volume II, Chapter 4: Description of Development. This approach has allowed for a robust and full assessment of the Proposed Development.

11.6.1.2 The two Project Design Options and parameters relevant to each potential impact are detailed in Table 11.9 and Table 11.10.

Table 11.9: Project design parameters and impacts assessed – Project Design Option 1

Potential impact	Phase C	Phase O	Phase D	Project Design Option 1
Injury and/or disturbance to marine mammals from underwater noise during piling	✓	×	×	**Construction phase** Foundation installation: Wind Turbine Generators (WTGs) installed on monopile foundations: • Installation of 56 WTGs with a pile diameter between 7 m and 11 m within the Array Area; • Maximum of one foundation installed at any one time (within any 24 hour period); • Maximum hammer energy up to 6,600 kJ, average hammer energy up to 4,400 kJ and a strike rate of 30 strikes per minute; • Soft start energy of 825 kJ modelled with slow ramp up of energy for 30 minutes; • Anticipated maximum duration of piling at 5 hours and 10 minutes per pile with an average duration of 4 hours per pile and; • Total of 75 days when piling may occur over a maximum construction period of 5 years. Offshore Substations Platforms (OSP) installed on monopile foundations: • Installation of 2 OSPs with a pile diameter between 7 and 14 m within the Array Area; • Maximum of one foundation installed at any one time (within any 24 hour period); • Maximum hammer energy up to 6,600 kJ and an average hammer energy up to 6,000 kJ; • Soft start energy of 825 kJ modelled with slow ramp up of energy for 30 minutes; • Average maximum duration of 5 hours and 10 minutes per pile and; • Total of 4 days when piling may occur over a maximum construction period of 5 years.
Injury and/or disturbance to marine mammals from vessel activities	✓	✓	✓	**Construction phase** Injury and/or disturbance to marine mammals from vessel activities during construction: • Maximum of 66 installation vessels in the Array Area at any one time (including 12 installation vessels along the Cable Corridor and Working Area at any one time, and maximum of 7 installation vessels in the vicinity of the landfall at any one time); • A maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder

Potential impact	Phase C	O	D	Project Design Option 1
				clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels; and • Maximum construction schedule of 24 hours a day, 7 days a week for a maximum construction period of 5 years. Within this period, offshore export cable installation may take place over a period of 12 months.
				Operational and maintenance phase Injury and/or disturbance to marine mammals from vessel activities during operation and maintenance: • Maximum of 1,359 vessel round trips per year comprised of crew transfer vessels, jack-up vessels, cable repair vessels and other vessels, from local ports or transiting from a previously operational location. • Up to 30 operational and maintenance (O&M) vessels on site at any one time; and • Operational phase up to 36.5 years.
				Decommissioning phase Injury and/or disturbance during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase.
Changes in fish and shellfish community affecting prey resources	✓	✓	✓	**Construction phase** Project Design Option 1 as described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology for the following impacts: • Temporary subtidal habitat loss/disturbance; • Increased suspended sediment concentrations (SSC) and associated sediment deposition; • Injury and/or disturbance to fish and shellfish from underwater noise and vibration during pile driving and cable installation; and • Accidental pollution.
				Operational and maintenance phase Project Design Option 1 as described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology for the following impacts:

Potential impact	Phase C	Phase O	Phase D	Project Design Option 1
				• Temporary subtidal habitat loss/disturbance; • Increased SSC and associated sediment deposition; • Accidental pollution; • Long-term habitat loss as a result of the presence of foundation structures, scour protection, and cable protection; • Alteration of seabed habitats arising from changes in physical processes as a result of the presence of foundation structures, scour protection, and cable protection; and • Changes in Electromagnetic Fields (EMF) from subsea cabling.
				Decommissioning phase Project Design Option 1 as described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology for the following impacts: • Temporary subtidal habitat loss/disturbance; • Increased suspended sediment concentrations (SSC) and associated sediment deposition; and • Accidental pollution.
Accidental pollution	✓	✓	✓	**Construction phase** Accidental pollution in the Array Area during construction from: • Installation of 56 WTGs and 2 OSPs within the Array Area; • Installation of inter-array cables between 110 – 122 km in length, OSP interconnector cables between 25 – 28 km in length, and offshore export cables between 35 – 40 km in length; • Maximum of 66 installation vessels in the Array Area at any one time (including 12 installation vessels along the offshore Cable Corridor and Working Area at any one time, and maximum of 7 installation vessels in the vicinity of the landfall at any one time; • A maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels; and

Potential impact	Phase C	Phase O	Phase D	Project Design Option 1
				• A maximum of 294 helicopter return trips over the construction phase and a maximum of 118 helicopter return trips per year.
				Operational and maintenance phase Accidental pollution in the Array Area during O&M from: • Up to 30 O&M vessels on site at any one time; • Maximum of 1,359 vessel round trips per year comprised of crew transfer vessels, jack-up vessels, cable repair vessels and other vessels, from local ports or transiting from a previously operational location. • A maximum of 485 helicopter return trips per year; • Presence of 56 WTGs and 2 OSPs and; • Maintenance activities of 56 WTGs and 2 OSPs
				Decommissioning phase Accidental pollution in the Array Area during decommissioning from: • Decommissioning of 56 WTGs and 2 OSPs.
Changes in electromagnetic fields (EMF) from subsea electrical cabling	×	✓	×	**Operational and maintenance phase** Presence of inter-array, OSP interconnector, and offshore export cables: • 66 kV inter-array cables between 110 – 122 km in length; • 220 kV OSP interconnector cables between 25 – 28 km in length; • 220 kV offshore export cables between 35 – 40 km in length; • Burial depth between 0-1.5 m for inter-array cables and 0-2.5 m for OSP interconnector and offshore export cables; • Up to 15% of inter-array cable routes, up to 50% of OSP interconnector cable routes, and up to 20% of export cable routes requiring protection; • Operational phase up to 36.5 years.
Injury and/or disturbance to marine mammals from underwater noise during UXO clearance	✓	×	×	**Construction phase** The type, size, and number of possible UXO that may require clearance is currently unknown.

Potential impact	Phase C	Phase O	Phase D	Project Design Option 1
				An illustrative assessment is presented using charge weights (TNT equivalent) ranging from 25 to 800 kg, with an additional donor weight of 0.5 kg, for high order detonation. A charge weight of 0.5 kg is used to provide an illustrative assessment of a low order (deflagration) detonation.
Injury and/or disturbance to marine mammals from underwater noise during site surveys	✓	✓	×	**Construction phase** The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of different survey equipment and expected source levels have been used for this assessment. Injury and/or disturbance to marine mammals from underwater noise during site surveys: • Geophysical (non-impulsive sonar based) surveys including Multibeam Echosounder (MBES), Side scan sonar (SSS), and Sub-bottom Profiler (SBP); • Geophysical surveys including seismic refraction and sparker; and • Geotechnical surveys including seismic cone penetration test (CPT), vibrocore, and grab sampling. **Operational and maintenance phase** Injury and/or disturbance to marine mammals from underwater noise during site surveys: • Geophysical surveys (inter-array cables) every six months for the first two years and annually thereafter; • Geophysical surveys (inter-connector cables) every six months for the first two years and annually thereafter; and • Geophysical surveys (export cables) every six months for the first two years and annually thereafter. The exact equipment to be deployed during the geophysical site surveys is unknown. Therefore, it is assumed that the equipment described in the construction phase will be used for the purposes of this assessment. Injury and/or disturbance during operational and maintenance phase is anticipated to be similar in nature to the construction phase.

Table 11.10: Project design parameters and impacts assessed - Project Design Option 2

Potential impact	Phase C	Phase O	Phase D	Project Design Option 2
Injury and/or disturbance to marine mammals from underwater noise during piling	✓	×	×	**Construction phase** <u>Foundation installation:</u> WTGs installed on monopile foundations: • Installation of 47 WTGs with a pile diameter between 7 m and 11 m within the Array Area; • Maximum of one foundation installed at any one time (within any 24 hour period); • Maximum hammer energy up to 6,600 kJ, average hammer energy up to 4,400 kJ and a strike rate of 30 strikes per minute; • Soft start energy of 825 kJ modelled with slow ramp up of energy for 30 minutes; • Maximum duration of piling at 5 hours and 10 minutes per pile with an average duration of 4 hours per pile and; • Total of 63 days when piling may occur over a maximum construction period of 5 years. OSPs installed on monopile foundations: • Installation of 2 OSPs with a pile diameter between 7 m and 14 m within the Array Area; • Maximum of one foundation installed at any one time (within any 24 hour period); • Maximum hammer energy up to 6,600 kJ and an average hammer energy up to 6,000kJ; • Soft start energy of 825 kJ modelled with slow ramp up of energy for 30 minutes; • Average duration of 5 hours and 10 minutes per pile and; • Total of 4 days when piling may occur over a maximum construction period of 5 years.
Injury and/or disturbance to marine mammals from vessel activities	✓	✓	✓	**Construction phase** Injury and/or disturbance to marine mammals from vessel activities during construction: • Maximum of 66 installation vessels in the Array Area at any one time (including 12 installation vessels along the offshore Cable Corridor and Working Area at any one time, and maximum of 7 installation vessels in the vicinity of the landfall at any one time); • A maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable

Potential impact	Phase C	Phase O	Phase D	Project Design Option 2
				protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels; and • Maximum construction schedule of 24 hours a day, 7 days a week for a maximum construction period of 5 years. Within this period, offshore export cable installation may take place over a period of 12 months.
				Operational and maintenance phase Injury and/or disturbance to marine mammals from vessel activities during operation and maintenance: • Maximum of 1,359 vessel round trips per year comprised of crew transfer vessels, jack-up vessels, cable repair vessels and other vessels, from local ports or transiting from a previously operational location. • Up to 30 O&M vessels on site at any one time; and • Operational phase up to 36.5 years.
				Decommissioning phase Injury and/or disturbance during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase.
Changes in fish and shellfish community affecting prey resources	✓	✓	✓	**Construction phase** Project Design Option 2 as described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology for the following impacts: • Temporary subtidal habitat loss/disturbance; • Increased SSC and associated sediment deposition; • Injury and/or disturbance to fish and shellfish from underwater noise and vibration during pile driving and cable installation; and • Accidental pollution
				Operational and maintenance phase Project Design Option 2 as described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology for the following impacts:

Potential impact	Phase C	Phase O	Phase D	Project Design Option 2
				• Temporary subtidal habitat loss/disturbance; • Increased SSC and associated sediment deposition; • Accidental pollution; • Long-term habitat loss as a result of the presence of foundation structures, scour protection, and cable protection. • Alteration of seabed habitats arising from changes in physical processes as a result of the presence of foundation structures, scour protection, and cable protection; and • Changes in Electromagnetic Fields (EMF) from subsea cabling.
				Decommissioning phase Project Design Option 2 as described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology for the following impacts: • Temporary subtidal habitat loss/disturbance; • Increased suspended sediment concentrations (SSC) and associated sediment deposition; and • Accidental pollution.
Accidental pollution	✓	✓	✓	**Construction phase** Accidental pollution in the Array Area during construction from: • Installation of 47 WTGs and 2 OSPs within the Array Area; • Installation of inter-array cables between 110 – 122 km in length, OSP interconnector cables between 25 – 28 km in length, and offshore export cables between 35 – 40 km in length and; • Maximum of 66 installation vessels in the Array Area at any one time (including 12 installation vessels along the offshore Cable Corridor and Working Area at any one time, and maximum of 7 installation vessels in the vicinity of the landfall at any one time.
				Operational and maintenance phase Accidental pollution in the Array Area during O&M from: • Maximum of 1,359 vessel round trips per year comprised of crew transfer vessels, jack-up vessels, cable repair vessels and other vessels, from local ports or transiting from a previously operational location. • Presence of 47 WTGs and 2 OSPs and;

Potential impact	Phase C	Phase O	Phase D	Project Design Option 2
				• Maintenance activities of 47 WTGs and 2 OSPs.
				Decommissioning phase Accidental pollution in the Array Area during decommissioning from: Decommissioning of 47 WTGs and 2 OSPs.
Changes in EMF from subsea electrical cabling	×	✓	×	**Operational and maintenance phase** Presence of inter-array, OSP interconnection and offshore export cables: • 66 kV inter-array cables between 110 – 122 km in length; • 220 kV OSP interconnector cables between 25 – 28 km in length; • 220 kV offshore export cables between 35 – 40 km in length; • Burial depth between 0-1.5 m for inter-array cables and 0-2.5 m for OSP interconnector and offshore export cables; • Up to 15% of inter-array cable routes, up to 50% of OSP interconnector cable routes, and 20% of export cable routes requiring protection; • Operational phase up to 36.5 years.
Injury and/or disturbance to marine mammals from underwater noise during UXO clearance	✓	×	×	**Construction phase** The type, size, and number of possible UXO that may require clearance is currently unknown. An illustrative assessment is presented using charge weights (TNT equivalent) ranging from 25 to 800 kg, with an additional donor weight of 0.5 kg, for high order detonation. A charge weight of 0.5 kg is used to provide an illustrative assessment of a low order (deflagration) detonation.
Injury and/or disturbance to marine mammals from underwater noise during site surveys	✓	✓	×	**Construction phase** The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of different survey equipment and expected source levels have been used for this assessment. Injury and/or disturbance to marine mammals from underwater noise during site surveys: • Geophysical (non-impulsive sonar based) surveys including MultiBeam Echosounder (MBES), Side scan sonar (SSS), and Sub-bottom Profiler (SBP); • Geophysical surveys including seismic refraction and sparker; and • Geotechnical surveys including seismic cone penetration test (CPT), vibrocore, and grab sampling.

Potential impact	Phase C	O	D	Project Design Option 2
				Operational and maintenance phase Injury and/or disturbance to marine mammals from underwater noise during site surveys: • Geophysical surveys (inter-array cables) every six months for the first two years and annually thereafter; • Geophysical surveys (inter-connector cables) every six months for the first two years and annually thereafter; and • Geophysical surveys (export cables) every six months for the first two years and annually thereafter. The exact equipment to be deployed during the geophysical site surveys is unknown. Therefore, it is assumed that the equipment described in the construction phase will be used for the purposes of this assessment. Injury and/or disturbance during operational and maintenance phase is anticipated to be similar in nature to the construction phase.

11.6.2 Impacts scoped out of the assessment

11.6.2.1 On the basis of the baseline environment and the description of development outlined in Volume II, Chapter 4: Description of Development, a number of impacts are proposed to be scoped out of the assessment for marine mammals. These impacts are outlined, together with a justification for scoping them out, in Table 11.11.

Table 11.11: Impacts scoped out of the assessment for marine mammals

Potential impact	Justification
Increased SSC and associated deposition	The potential for increased SSC and associated deposition has been scoped out of the assessment. Marine mammals are known to forage in turbid waters with low visibility levels. For example, harbour porpoises and harbour seals were found to forage under strong tidal flows in the UK (Pierpoint, 2008; Marubini *et al.*, 2009; Hastie *et al.*, 2016), indicating that suspended sediments are not likely to significantly impact foraging behaviour of marine mammals. This is because most marine mammals rely on hearing instead of vision for navigation, foraging and socialising, such as the use of echolocation by odontocetes (Hanke *et al.*, 2010; Hanke and Dehnhardt, 2013; Hanke *et al.*, 2013). With respect to seals, they are able to sense the environment by detecting water movements using mystacial vibrissae (whiskers) when vision is compromised. Whilst elevated levels of SSC arising during construction and maintenance activities may decrease light availability in the water column and produce turbid conditions, the maximum impact range is expected to be localised with sediments rapidly dissipating over one tidal excursion. The ZoI for suspended sediment, defined as a zone of 20 km around the boundary of the Array Area (see Volume II, Chapter 6: Coastal Processes) is not anticipated to overlap any key areas for marine mammals (i.e. SACs designated for marine mammals or in proximity to seal haul-outs) and the area affected is likely to be small in the context of the wider available habitat.
Remobilisation of contaminated sediments	The potential for remobilisation of contaminated sediments has been scoped out of the assessment. Sampling undertaken for ABWP1 (Ramboll, 2016) has demonstrated that contamination in the offshore sediments is low and at levels which are unlikely to result in adverse effects on marine mammals. Therefore, it is considered unlikely that there would be any pathways for an impact on marine mammals, including consideration of indirect effect through changes to the benthic or fish and shellfish communities (see Volume II, Chapter 9: Benthic Subtidal and Intertidal Ecology).
Injury and/or disturbance to marine mammals from operational underwater noise	The potential for injury and/or disturbance to marine mammals from operational underwater noise has been scoped out of the assessment. Operational noise derived from operational wind turbines is primarily of low frequency (well below 1 kHz) (Thomsen *et al.*, 2006). For porpoises, dolphins and seals, the hearing sensitivity below 1 kHz is relatively poor and thus it is expected that an auditory injury or disturbance at this frequency would result in little impact to vital rates or behavioural changes. A number of studies have reported the presence of marine mammals within windfarm footprints. For example, long-term monitoring at the Horns Rev and Nysted offshore windfarms in Denmark showed that both harbour porpoise and harbour seals were sighted regularly within the operational windfarm, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.*, 2008). Similarly, a monitoring programme at the Egmond aan Zee offshore windfarm in the Netherlands reported that significantly more porpoise activity was recorded within the offshore windfarm compared to the reference area during the operational phase (Scheidat *et al.*, 2011), indicating the presence of the offshore windfarm was not adversely affecting harbour

Potential impact	Justification
	porpoise presence. In addition, Russell *et al.* (2014) found that some tagged harbour and grey seals demonstrated grid-like movement patterns as these animals moved between individual offshore wind turbines, suggestive of these structures being used for foraging. Previous reviews have also concluded that operational noise will have negligible barrier effects (Madsen *et al.*, 2006; Teilmann *et al.*, 2006a; Teilmann *et al.*, 2006b; Brasseur *et al.*, 2012). The low frequency noise produced during operations may be more likely to overlap with the hearing range of low frequency cetaceans such as minke whales. Minke whale communication signals are known to be below 2 kHz (Edds-Walton, 2000; Mellinger *et al.*, 2006; Gedamke *et al.*, 2001; Risch *et al.*, 2013; Risch *et al.*, 2014). Tubelli *et al.*, (2012) estimated the most sensitive hearing range (the region with thresholds within 40 dB of best sensitivity) of minke whales extend from 30 to 100 Hz up to 7.5 to 25 kHz. Based on the noise modelling outputs of offshore wind turbines, Marmo *et al.* (2013) reported that operational noise from wind turbines with monopile or gravity foundations would be audible underwater to minke whales as far as 18 km away. Whilst there is potential for whale displacement to occur around operational offshore windfarms, using threshold parameters of behavioural responses presented in Southall *et al.* (2007), Marmo *et al.* (2013) predicted that fewer than 10% of minke whales detecting the noise would exhibit behavioural responses, even under a precautionary approach, due to the relatively low sound pressure levels of noise produced (Marmo *et al.*, 2013). It is expected that the underwater noise from operating wind turbines would have a small footprint relative to the wider marine area used by minke whales, which in the context of the relevant Management Unit (i.e. Celtic and Greater North Sea) (IAMMWG, 2023), is very large area in comparison. Norro *et al.* (2011) compared measurements of a range of different foundation methods and turbine ratings in the Belgian part of the North Sea, as well as comparing those to other European waters. The authors found a slight increase in Sound Pressure Level (SPL) compared to the ambient noise measured before the construction of the windfarms. They concluded that even the highest increases found within the dataset (20 to 25 dB re 1µ Pa) are likely to be within the natural range of variation in baseline noise and therefore, even with the long-term nature of this impact (lifespan of the windfarm), the operational noise would not cause a significant impact. Thomsen *et al.* (2023) used a simple propagation loss model to assess cumulative PTS and TTS over a 24 hour period. They assessed a 10 Megawatt (MW) and 20 MW turbine, and in both cases PTS impact ranges were small (no greater than 50 m from the sound source), with the authors concluding that the risk of cumulative PTS was negligible. Cumulative TTS was also negligible for the 10 MW turbine, whereas for the 20 MW turbine, impact ranges extended up to approximately 700 metres for low frequency cetaceans (e.g. minke whales). Thomsen *et al.* (2023) noted that this could be larger than the distance between wind turbines, and thus the entire windfarm could be considered as the impacted area (with respect to cumulative TTS for low frequency cetaceans). However, this is TTS onset, over a period of 24 hours for one functional hearing group, which as the authors acknowledge, given that these are highly mobile animals, it is unlikely TTS is a realistic impact. Other caveats noted are, the model is simple, and there are considerable uncertainties associated. Thomsen *et al.* (2023) also note that older turbine designs using gear boxes are approximately 10 dB louder, as compared to more recent turbine designs using direct drives. It is predicted therefore that any impact would be highly localised and unlikely to affect marine mammals.

11.7 Methodology for Assigning the Significance of Effects

11.7.1 Overview

11.7.1.1 The marine mammals impact assessment has followed the methodology set out in Volume II, Chapter 5: EIA Methodology. Specific to the marine mammals impact assessment, the following guidance documents have also been adhered to:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022);
- Guidance for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2019);
- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Judd, 2012);
- Guidance to Manage the Risk to Marine Mammals from Man-made Sound Sources in Irish Waters (DAHG, 2014);
- Guidance on Environmental Impact Statement (EIS) and Natura Impact Statement (NIS) Preparation for Offshore Renewable Energy Projects (DCCAE, 2017);
- Ireland's National Biodiversity Plan 2017-2021 (Biodiversity Working Group, 2020);
- Ireland's 4th National Biodiversity Action Plan 2023–2030 (DHLGH, 2024);
- Marine Strategy Framework Directive, as amended 2017 (EC, 2008);
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Part 1 (DCCAE, 2018a);
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Part 2 (DCCAE,
- 2018b);
- CMS Family Guidelines on Environmental Impact Assessments for Marine Noise-generating Activities (CMS, 2017);
- Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects (Southall *et al.*, 2019);
- Guidance to manage the risk to mammals from manmade sound sources in Irish waters (DAHG, 2014);
- Policy on Offshore Windfarm Development (IWDG, 2020); and
- Review of Management Unit boundaries for cetaceans in UK waters (IAMMWG, 2023).

11.7.2 Impact assessment criteria

11.7.2.1 The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of the receptors (Table 11.12) and the magnitude of potential impacts (Table 11.13). The terms used to define sensitivity and magnitude are based on those which are described in further detail in Volume II, Chapter 5: EIA Methodology.

11.7.2.2 Both sensitivity and magnitude are assessed on a four-level scale to align with the EPA (2022) guidance: **High, Medium, Low** and **Negligible**. Magnitude is also further assessed as to whether the magnitude of the impact is adverse, neutral, or positive (see Volume II: Chapter 5: EIA Methodology).

SENSITIVITY

11.7.2.3 Sensitivity refers to the potential of a receptor to be significantly affected (EPA, 2022). In defining the sensitivity for each receptor, the vulnerability, recoverability and value/importance of that resource or user group has been taken into consideration.

11.7.2.4 The criteria used to define the sensitivity of the receptors in this chapter are outlined in Table 11.12 and based on EPA (2022) guidance.

11.7.2.5 The value of the receptor is not included in the definitions of criteria used to determine the sensitivity of marine mammals as all marine mammals are considered to have a high value given that all are either listed under Annex II of the Habitats Directive as species of Community Interest and/or are listed under Annex IV of the Habitats Directive as EPS of Community Interest and in need of strict protection.

Table 11.12: Definitions of criteria relating to the sensitivity of the receptor

Receptor sensitivity	Definition
High	Adaptability: The receptor cannot avoid or adapt to an impact. Tolerance: The receptor has no tolerance to accommodate the proposed form of change. Recoverability: The effect on the receptor is anticipated to be permanent and the receptor will not have any ability to recover from an impact.
Medium	Adaptability: The receptor has limited ability to avoid or adapt to an impact. Tolerance: The receptor has limited tolerance to accommodate the proposed form of change. Recoverability: The effect on the receptor is anticipated to be long-term and the receptor will have limited ability to recover from an impact.
Low	Adaptability: The receptor has reasonable ability to avoid or adapt to an impact. Tolerance: The receptor has reasonable tolerance to accommodate the proposed form of change. Recoverability: The effect on the receptor is anticipated to be medium to short-term and the receptor will have the ability to fully recover from an impact.
Negligible	Adaptability: The receptor is able to avoid or adapt to an impact. Tolerance: The receptor is able to tolerate the proposed form of change. Recoverability: The effect on the receptor is anticipated to be temporary and the receptor will have the ability to fully recover from an impact.

MAGNITUDE

11.7.2.6 In assigning magnitude, the spatial extent, duration, frequency and reversibility of the impact from the construction, operational and maintenance, or decommissioning phases of the Proposed Development have been considered, where applicable.

11.7.2.7 The criteria used to define magnitude of impact in this chapter are outlined in Table 11.13 and based on EPA (2022) guidance.

Table 11.13: Definition of terms relating to the magnitude of an impact

Magnitude	Definition
High	Duration: The impact is anticipated to result in a permanent change to the receptor. Frequency: The impact will occur constantly throughout the relevant project phase. Probability: The impact is reasonably expected to occur. Consequences (adverse): The impact would have a permanent change on a sufficient number of individuals to affect the long-term viability of the population and/or favourable conservation status. Consequences (positive): Long term increase in the population size.

Magnitude	Definition
Medium	Duration: The impact is anticipated to result in a change to the receptor that will last for up to one year. Frequency: The impact will occur constantly throughout a relevant project phase. Probability: The effect is reasonably expected to occur. Consequences (adverse): The impact would have a temporary change on most individuals and a permanent impact on a small proportion of the population, although would not affect the long-term viability of the population. Consequences (positive): Increase in population health and/or size as a result of benefits to the supporting habitat.
Low	Duration: The impact is anticipated to result in a change to the receptor that will last days at most. Frequency: The impact will occur frequently throughout a relevant project phase. Probability: The effect is unlikely to occur. Consequences (adverse): The impact would result in a short-term and/or intermittent change to a small proportion of the population but is unlikely to alter the population trajectory. Consequences (positive): Short term benefit to the supporting habitat resulting in increased reproductive potential but unlikely to increase population health and/or size.
Negligible	Duration: The impact is anticipated to result in a change to the receptor that will last a day at most. Frequency: The impact will occur once or infrequently throughout a relevant project phase. Probability: The effect is unlikely to occur. Consequences (adverse): The impact would result in a very short term, recoverable change to a very small proportion of the population and would not alter the population size or trajectory. Consequences (positive): Very minor benefit to the supporting habitat influencing foraging efficiency of a limited number of individuals, but not increasing population health and/or size.

SIGNIFICANCE OF EFFECT

11.7.2.8 The significance of the effect upon marine mammals is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 11.14. Where a range of significance of effect is presented in Table 11.14, the final assessment for each effect is based upon expert judgement.

Table 11.14: Significance of effect matrix

			Baseline Environment - Sensitivity			
			High	Medium	Low	Negligible
Description of Impact -	Adverse Impact	High	Profound or Very Significant (significant)	Significant	Moderate*	Imperceptible
		Medium	Significant	Moderate*	Slight	Imperceptible

		Low	Moderate*	Slight	Slight	Imperceptible
	Neutral Impact	Negligible	Not Significant	Not Significant	Not Significant	Imperceptible
	Positive Impact	Low	Moderate*	Slight	Slight	Imperceptible
		Medium	Significant	Moderate*	Slight	Imperceptible
		High	Profound or Very Significant (significant)	Significant	Moderate*	Imperceptible

**Moderate levels of effect have the potential, subject to the assessor's professional judgement to be significant or not significant. Moderate will be considered as significant or not significant in EIA terms, depending on the sensitivity and/or magnitude of change relating to the factors evaluated. These evaluations are explained as part of the assessment, where they occur.*

11.7.3 Factored In Measures

11.7.3.1 The Project Design Options set out in Volume II, Chapter 4: Description of Development includes a number of designed-in measures and management measures (or controls) which have been factored into the Proposed Development and are committed to be delivered by the Developer as part of the Proposed Development.

11.7.3.2 These 'Factored In Measures' are standard measures applied to offshore wind development, including lighting and marking of the Proposed Development, use of 'soft-starts' for piling operations etc, to reduce the potential for impacts. Factored In Measures relevant to the marine mammal assessment are presented in Table 11.15. These measures are integrated into the description of development and have therefore been considered in the impact assessment (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development. This approach is in line with EPA guidance which states that 'in an EIAR it may be useful to describe avoidance measures that have been integrated into the proposed proposal' (EPA, 2022).

Table 11.15: Factored In Measures

Factored In Measures	Justification
Environmental Management Plan (EMP) providing the overarching framework for environment management during construction, operational and maintenance, and decommissioning phases of the Proposed Development. The EMP includes mitigation/monitoring measures and commitments made within the EIAR and a Marine Pollution Contingency Plan (MPCP) which will include key emergency contact details (e.g. EPA, Irish Coast Guard (IRCG).). An EMP is included in Volume III, Appendix	Measures will be adopted to ensure that the potential for release of pollutants from construction, operational and maintenance, and decommissioning is minimised. These mitigation measures are: Storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, specifically; • The Safety, Health and Welfare at Work (Chemical Agents) Regulations 2001 (as amended) (Schedule 4, Part 5);International Convention for the Prevention of Pollution from Ships (MARPOL) 1973 (as amended). (Annex II, and Annex III regulations); • International Convention for the Safety of Life at Sea (SOLAS) (Chapter VII); and • OSPAR Annex III: On the Prevention and Elimination of Pollution from Offshore Sources.

Factored In Measures	Justification
25.1: Environmental Management Plan.	Double skinning and labelling (direction of flow and contents) of pipes and clearly labelled storage tanks containing hazardous substances; • Storage of these substances in impenetrable bunds; • Working vessels shall handle all wastes in accordance with International Maritime Organisation (IMO) requirements and in accordance with the requirements of national legislation (i.e. Sea Pollution Acts 1991 to 1999; Sea Pollution (Miscellaneous Provisions) Act 2006) as applicable; • All waste and/or litter, including potential pollutants produced during construction, operational and maintenance, and decommissioning phases of the Proposed Development shall be stored and returned to shore for authorised disposal at suitable facilities; and • Vessel refuelling will only take place in port or under permit from the IRCG. In this manner, accidental release of contaminants from vessels will be strictly controlled, thus providing protection for marine life across all phases of the Proposed Development. Any accidental pollution of the marine environment shall be immediately reported to the IRCG and to any other local authorities who are likely to be affected by such pollution.
Cables will be buried where possible and protected where not possible as set out in Volume II, Chapter 4 Description of Development.	Commitment to the burial of cables where possible and protected where not possible, as set out in Volume II, Chapter 4: Description of Development. While burial of cables will not reduce the strength of potential EMF, it does increase the distance between the source of EMF (i.e. the operational cables) and marine mammal receptors, thereby potentially reducing the potential effect on those receptors.
Marine Mammal Mitigation Plan (MMMP) detailing the piling methodology, duration of piling, soft-start procedures, maximum piling energy and details of mitigation and monitoring parameters. A MMMP is included in Volume III, Appendix 25.2: Marine Mammal Mitigation Plan.	The implementation of a MMMP will mitigate for the risk of permanent auditory injury to marine mammals within a 'mitigation zone'. The mitigation zone is determined considering the potential for instantaneous auditory injury based on the initial hammer strike energy of 825 kJ (i.e. soft-start hammer energy). The soft-start will provide an audible cue to allow marine mammals to flee the area before piling at increased hammer energy commences. The soft-start will help to mitigate any potential for auditory injury. ADDs will be used prior to the soft-start to ensure marine mammals are deterred.
MMMP for UXO clearance detailing the clearance methodologies, and details of mitigation and monitoring parameters (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan).	A UXO MMMP will be implemented during any UXO clearance required. The MMMP will include measures to ensure the risk of instantaneous PTS to marine mammals is negligible. The exact mitigation measures contained with the UXO MMMP are yet to be determined because the number, size, condition, and location of UXO that may require clearance are currently unknown, but measures will be in line with the latest relevant guidance. Multiple measures are available and have been implemented elsewhere for UXO clearance, such as the use of ADDs and scarer charges to

Factored In Measures	Justification
	displace animals to beyond the instantaneous PTS impact range, or noise abatement techniques where appropriate.
MMMP for site surveys, detailing the survey equipment to be deployed, details of mitigation and monitoring parameters (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan).	Proposed mitigation has been described in the Annex IV Species Risk Assessment (RPS, 2023), although a MMMP will also be implemented during site surveys and will include measures to ensure the risk of PTS to marine mammals is negligible.
Environmental Vessel Management Plan (VMP) is informed by best practice guidance to minimise the risk to marine mammals from vessel activities (Volume III, Appendix 25.10: Environmental Vessel Management Plan).	The implementation of an Environmental VMP which includes best practice guidance measures to minimise the potential for collision risk, potential injury to, and disturbance of marine mammals from vessel activities.
Rehabilitation Schedule (Volume III, Appendix 4.1: Rehabilitation Schedule).	The Rehabilitation Schedule sets out the methodology and schedule for decommissioning of the Proposed Development. The Rehabilitation Schedule confirms that there will be no piling operations during decommissioning of the monopiles.
The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence for Site Investigations (FS007339).	The Developer was granted a Foreshore Licence (FS007339) for Site Investigations (associated with the Proposed Development) from the Minister for Housing, Local Government and Heritage in May 2022. The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence for Site Investigations (FS007339) being carried out. As such there is no temporal overlap between the activities consented in this Foreshore Licence and the Proposed Development and there will be no potential for cumulative effects.
The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence Application for Site Surveys FS007555 (should a licence be granted) are being carried out.	The Developer submitted a Foreshore Licence Application for Site Surveys to the Minister for Housing, Local Government and Heritage in April 2023 (FS007555) and this application is pending determination. The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence Application for Site Surveys FS007555 (should a licence be granted) are being carried out. As such there is no temporal overlap between the activities proposed in the Foreshore Licence Application and the Proposed Development.

11.7.4 Assessment methodology for injury and/or disturbance from underwater noise during pile driving

11.7.4.1 The noise levels generated by pile driving were predicted by Subacoustech Environmental Ltd using their Impulse Noise Sound Propagation and Impact Range Estimator (INSPIRE) model. Full details of the underwater noise modelling and the resulting impact areas and ranges are detailed in the Volume III, Appendix 11.1: Underwater Noise Assessment.

11.7.4.2 Project Design Option 1 is comprised of the installation of 56 WTG monopile foundations of 7 to 11 m diameter for WTG and 2 OSP monopile foundations of 7 to 14 m diameter (Table 11.9).

11.7.4.3 Project Design Option 2 is comprised of the installation of 47 WTG monopile foundations of 7 to 11 m diameter for WTG and 2 OSP monopile foundations of 7 to 14 m diameter (Table 11.10).

11.7.4.4 Piling activities for both design scenarios were modelled for WTG monopiles at three locations: the NW, C, and SW. In addition, two locations were modelled for OSP monopiles: N-OSP, and S-OSP.

11.7.4.5 For each location, two foundation scenarios were used for modelling:

- 11 m and 7 m monopile foundations at the NW and C WTG locations, installed with a maximum blow energy of 4,000 kJ;
- 11 m and 7 m monopile foundations at the SW WTG location, installed with a maximum blow energy of 6,600 kJ;
- 14 m and 7 m monopile foundations at the North OSP location, installed with a maximum blow energy of 4,000 kJ; and
- 14 m and 7 m monopile foundations at the South OSP location, installed with a maximum blow energy of 6,600 kJ.

11.7.4.6 The soft start and ramp up scenarios used for modelling are summarised in Table 11.16 and Table 11.17.

Table 11.16: Summary of the soft start and ramp up scenario used for both the 7 m and 11 m monopile foundation modelling at the NW and C WTG locations and the 7 m and 14 m monopile foundation modelling at the N-OSP locations

	825 kJ		1,550 kJ	2,275 kJ	3,000 kJ	3,300 kJ	3,600 kJ	4,000 kJ
Number of strikes	6	600	400	400	400	450	450	3,300
Duration	10 min	20 min	13 min 20 sec	13 min 20 sec	13 min 20 sec	15 min	15 min	110 min

Table 11.17: Summary of the soft start and ramp up scenario used for both the 7 m and 11 m monopile foundation modelling at the SW WTG location and the 7 m and 14 m monopile foundation modelling at the S-OSP location

	825 kJ		1,550 kJ	2,275 kJ	3,000 kJ	4,000 kJ	4,450 kJ	6,600 kJ
Number of strikes	6	600	400	400	400	2,750	450	4,000
Duration	10 min	20 min	13 min 20 sec	13 min 20 sec	13 min 20 sec	91 min 40 sec	15 min	133 min 20 s

Approach to PTS and TTS-onset

11.7.4.7 The PTS-onset thresholds used to assess the potential for auditory injury to marine mammals during pile driving are those presented in Southall *et al.* (2019) for impulsive noise (Table 11.18).The TTS-onset thresholds are also presented (Table 11.18) , whereby TTS is not regarded as injury given its temporary nature and any impacts relating to the effects of TTS are considered to be captured in the quantitative assessment of disturbance.

11.7.4.8 Impulsive sound sources, such as pile driving, have high peak sound pressure, short duration, fast rise-time, and broad frequency content at source.

11.7.4.9 Both instantaneous Sound Pressure Level (SPL_{peak}) and cumulative Sound Exposure Level (SEL_{cum}) PTS and TTS-onset thresholds have been presented by Southall *et al.* (2019) (Table 11.18) and are used within this assessment.

11.7.4.10 Southall *et al.* (2019) propose the SPL_{peak} being either unweighted or flat weighted across the entire frequency band of a Functional Hearing Group (FHG) because the direct mechanical damage to the auditory system that is associated with high peak sound pressures is not frequency dependent and is therefore restricted to the audible frequency range of a species. Unweighted SPL_{peak} values are therefore included in this assessment for instantaneous PTS and TTS (Table 11.18).

11.7.4.11 The SEL_{cum} thresholds considers the SEL received by an animal and the duration of exposure, accounting for the accumulated exposure over a 24-hour period. Southall *et al.* (2019) recommends the application of SEL_{cum} for the individual activity alone (i.e., not for multiple activities occurring within the same area or over the same time). To inform this impact assessment, sound modelling has considered the SEL_{cum} over a piling event. It is important to note that the physiological damage that sound energy can cause is mainly restricted to energy occurring in the frequency range of a species' hearing range. Therefore, for the cumulative SEL (SEL_{cum}), sound has been weighted based on species group specific weighting curves presented in Southall *et al.* (2019).

Table 11.18: PTS and TTS-onset thresholds for impulsive noise (Southall *et al.*, 2019)

Species	FHG	Cumulative PTS (SEL_{cum} dB re 1 µPa²s weighted)	Instantaneous PTS (SPL_{peak} dB re 1 µPa unweighted)	Cumulative TTS (SEL_{cum} dB re 1 µPa²s weighted)	Instantaneous TTS (SPL_{peak} dB re 1 µPa unweighted)
Harbour porpoise	Very High Frequency (VHF) cetacean	155	202	140	196
Dolphin species (bottlenose dolphin, Risso's dolphin, common dolphin	High Frequency (HF) cetacean	185	230	170	224
Minke whale	Low Frequency (LF) cetacean	183	219	168	213

Species	FHG	Cumulative PTS (SEL_{cum} dB re 1 µPa²s weighted)	Instantaneous PTS (SPL_{peak} dB re 1 µPa unweighted)	Cumulative TTS (SEL_{cum} dB re 1 µPa²s weighted)	Instantaneous TTS (SPL_{peak} dB re 1 µPa unweighted)
Seal species (in water) (grey seal, harbour seal)	Phocid (in water) (PCW)	185	218	170	212

11.7.4.12 To quantify the impact of underwater noise on marine mammals with regard to PTS and TTS, the instantaneous (SPL_{peak}) and cumulative (SEL_{cum}, over 24 hours) PTS and TTS-onset impact ranges (the area around the piling location within which the noise levels exceed the PTS or TTS-onset thresholds for the relevant FHG) are determined using the recent thresholds presented by Southall *et al.* (2019). Further information on the modelling approach and the methods used the calculate PTS and TTS-onset impact ranges is provided in Volume III, Appendix 11.1: Underwater Noise Assessment.

11.7.4.13 The ranges that indicate TTS-onset were modelled and are presented in this impact assessment for both Project Design Options. The current set of TTS-onset thresholds presented by Southall *et al.* (2019) (Table 11.18) define a TTS-onset as the exposure required to produce a 6 dB shift in the hearing threshold. However, data upon which these thresholds are based for TTS-onset in marine mammals from impulsive noise, such as pile driving, is extremely limited. It has been necessary to determine exposure functions for TTS in order to estimate the levels at which the onset of PTS could occur, as experiments inducing PTS in animals is considered unethical. Predicted exposures of 40 dB of TTS are considered to result in PTS onset (Southall *et al.*, 2007). For the purposes of developing these thresholds, TTS was considered to be “the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject’s normal hearing ability”, and which “is typically the minimum amount of threshold shift that can be differentiated in most experimental conditions” (Southall *et al.*, 2007). Thus, using a threshold for the onset of TTS would typically result in overestimates of potential ranges at which ecologically significant effects could occur. Furthermore, as TTS-onset is defined primarily as a means of predicting PTS-onset, there is currently no threshold for TTS-onset that would indicate a biologically significant amount of TTS. Therefore, it was not possible to carry out a quantitative assessment of the sensitivity, magnitude, or significance of the impact of TTS on marine mammals.

11.7.4.14 The number of individuals that may be affected by PTS relative to the reference population was quantified by multiplying the onset impact ranges by the density estimates for each species and calculating the proportion of the reference population.

Behavioural disturbance

DOSE-RESPONSE FUNCTIONS

11.7.4.15 A species-specific dose-response approach was used for the assessment of disturbance to marine mammals from underwater noise during pile driving. This approach was based on current best practice methodology to provide evidence-based estimates rather than the fixed behavioural threshold approach.

11.7.4.16 The application of a dose-response function is used to quantify the probability of a response from an animal to a stressor or stimulus, which will vary according to the dose of stressor or stimulus received by the animal (Dunlop *et al.*, 2017). Therefore, it is based on the assumption that not all animals in an impact zone will respond, unlike traditional methods of threshold assessment.

11.7.4.17 For the purpose of this assessment, the dose is the received single-strike SEL_{SS} which is considered to be best practice for this type of assessment (Southall *et al.*, 2021). SEL_{SS} contours at 5 dB intervals generated by noise modelling (see Volume III, Appendix 11.1: Underwater Noise Assessment) were overlain on species density surfaces to quantify the number of animals receiving each SEL_{SS}, and subsequently the number of animals likely to be disturbed based on the dose-response curve.

11.7.4.18 This impact assessment for cetaceans uses the dose-response curve that was developed by Graham *et al.* (2017b) for harbour porpoise using data collected during the first six weeks of piling during Phase 1 of the Beatrice offshore windfarm.

11.7.4.19 Following the development of this dose-response curve, additional data from the remaining piling events have been processed and showed that the responses of harbour porpoises to piling noise diminishes over the construction period (Graham *et al.*, 2019). Therefore, the use of the dose-response curve from the initial piling event in this assessment can be considered conservative.

11.7.4.20 In the absence of species-specific dose-response data for dolphins or minke whales, this dose-response curve has been adopted for all cetaceans, however it is considered that the application of the porpoise dose-response curve to other cetacean species is highly over-precautionary. This is because harbour porpoises are highly responsive to anthropogenic disturbance, with multiple studies showing response via avoidance and/or reduced vocalisation to various anthropogenic noise sources (e.g. Benhemma-Le Gall *et al.*, 2021; Brandt *et al.*, 2013; Brandt *et al.*, 2018; Thompson *et al.*, 2013; Thompson *et al.*, 2020; Sarnocińska *et al.*, 2020). Other cetacean species, including bottlenose dolphin and common dolphin, have shown less of a response to underwater noise in comparison to harbour porpoise (e.g. Fernandez-Betelu *et al.*, 2021; Kastelein *et al.*, 2006; Stone *et al.*, 2017).

11.7.4.21 For seals, the dose-response function used is derived from harbour seal telemetry data collected during pile driving activities at the Lincs offshore windfarm in 2011-2012 and is presented in (Whyte *et al.*, 2020). The study presented the percentage change in harbour seal density at the Lincs offshore windfarm and has conservatively assumed that all seals will be disturbed at SEL_{SS} >180 dB re 1 $\mu Pa^2{}_s$. There are no corresponding data for grey seals and, as such, the harbour seal dose-response function is applied to the grey seal disturbance assessment. This is considered an appropriate proxy for grey seal as both species are categorised within the same functional hearing group. However, it is likely to result in an over-estimation of grey seal response as this assessment has concluded that grey seals are less sensitive to behavioural disturbance than harbour seals, therefore the application of the harbour seal dose-response function to grey seal is considered conservative.

LEVEL B HARASSMENT – FIXED NOISE THRESHOLDS

11.7.4.22 In the absence of specific-specific empirical data for dolphin species and minke whale and given that the application of the harbour porpoise dose-response curve (Graham *et al.,* 2017b) is highly over-precautionary, the numbers of animals predicted to experience behavioural disturbance using the United States (US) National Marine Fisheries Service (NMFS) Level B harassment thresholds for strong disturbance (NMFS, 2005) are presented alongside the dose-response assessment methodology to provide context on the potential extent of disturbance.

11.7.4.23 In the US, under the 1994 Amendments to the Marine Mammal Protection Act, Level B harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild, by causing disruption of behavioural patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (NMFS, 2005).

11.7.4.24 The threshold predicts that Level B harassment will occur when an animal is exposed to received sound levels above 160 dB re 1 μPa (rms) from non-explosive impulsive sounds sources, such as seismic airguns, impact pile driving, or intermittent sound sources, such as non-tactical sonar or scientific (Guan and Brookens, 2021; NMFS, 2023).. The threshold is based on studies of whale responses to playbacks signals from air guns above 160 dB re 1μPa (rms), which showed that the animal's exhibited an avoidance response (Malme *et al.,* 1984). Beyond the 160 dB re 1 μPa (rms) threshold, the behavioural responses are likely to become less severe, for example, minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al.,* 2007). However, it is important to note that marine mammal responses to disturbance will, depend on the individual and the context. For example, previous experience and acclimatisation will affect whether an individual exhibits an aversive response to noise, particularly in a historically noisy area.

Underwater noise assumptions

11.7.4.25 The subsea noise model assumptions and limitations highlighted in Volume III, Appendix 11.1: Underwater Noise Assessment are summarised below:

- The modelling assumed the maximum hammer energy would be reached at all locations, whereas this is unlikely to be the case;
- The soft-start and ramp up procedure simulated does not allow for short pauses in piling (e.g. for realignment) and therefore the modelled SEL_{cum} is likely to be an overestimate since, in reality, these pauses will reduce the time between noise exposures that animals experience whilst fleeing;
- The modelling assessment assumed that all animals swim directly away from the noise source at a constant and conservative average speed. A constant fleeing speed of 3.25 m/s was used for minke whale (Blix and Folkow, 1995). and 1.5 m/s was used for all other species (Otani *et al*., 2000). The average speed of 1.5 m/s^{-1} recorded in Otani *et al.* (2000) was averaged across horizontal and vertical movements, however the authors note that horizontal speed was significantly faster than vertical speed and cite a maximum speed of 4.3 ms^{-1}. Similarly, Leatherwood *et al.* (1982) reported harbour porpoise swim speeds of approximately 6.2 ms^{-1}. Therefore, swim speeds are considered to be a precautionary estimate of flee speeds as marine mammals are expected to be able to swim at much faster speeds under stress conditions (Kastelein *et al*., 2018). The calculated PTS- and TTS-onset impact ranges therefore represent the minimum starting distances from the piling location for animals to flee and prevent them from receiving a dose higher than the threshold.
- The use of the SEL_{cum} metric is described as an equal-energy rule where exposures of equal energy are assumed to produce the same noise-induced threshold shift regardless of how the energy is distributed over time. This means that for intermittent noise, such as piling, the equal-energy rule overestimates the effects since the quiet periods between noise exposures will allow some recovery of hearing compared to continuous noise; and
- The model overestimates the noise exposure an animal receives since it does not account for any time that marine mammals spend at the surface and the reduced sound levels near the surface.

11.7.4.26 These assumptions lead to a conservative determination of the impact ranges, and therefore an extremely precautionary assessment.

ASSUMPTIONS ASSOCIATED WITH PTS-ONSET

11.7.4.27 There are no empirical data on the PTS-onset threshold for auditory injury for marine mammals, as to test this would be unethical. Therefore, PTS-onset thresholds are estimated based on extrapolating from TTS-onset thresholds developed by the NMFS (NMFS, 2018) and those previously presented by Southall *et al.* (2007). For impulsive noise, such as pile driving, TTS-onset is defined at the lowest level that exceeds natural recorded variation in hearing sensitivity (6 dB) and assume that PTS-onset occurs from exposures resulting in 40 dB or more of TTS measured approximately four minutes after exposure (NMFS, 2018).

11.7.4.28 Furthermore, the number of animals predicted to be within the PTS-onset impact ranges assume that all animals are impacted, although the dose response function adopted by Donovan *et al.* (2017) predicts that only 18-19% of animals will actually experience PTS at the PTS-onset threshold level. Therefore, the number of animals predicted to be within PTS-onset impact ranges are precautionary.

CHARACTERISTICS OF IMPULSIVE NOISE

11.7.4.29 Marine mammals have greater sensitivity to impulsive noise (with respect to hearing damage) which is reflected in the noise exposure risk thresholds as lower SELs are specified for impulsive noise compared to non-impulsive noise (Southall *et al.*, 2007). Therefore, PTS-onset is predicted to occur at lower weighted SEL_{cum} than for non-impulsive sounds (Southall *et al.*, 2007).

11.7.4.30 However, the sound signal of certain sound sources, such as impact piling, lose their impulsive characteristics as a result of propagation effects, and could potentially be characterised as non-impulsive beyond a certain distance (Southall *et al.*, 2019). Generally, the change in noise characteristics with increasing distance result in exposures becoming less physiologically damaging as the sharp transient peaks become less prominent (Southall *et al.*, 2007). This has implications for predicting potential impacts of offshore activities within this impact assessment, as a result of taking a more conservative approach. As the PTS-onset thresholds for impulsive noise are lower than for non-impulsive noise (Southall *et al.*, 2007), the estimated risk of auditory damage is therefore likely to be overestimated where impulsive noise becomes non-impulsive as a result of propagation.

11.7.4.31 Hastie *et al.* (2019) used the signal duration, rise time, crest factor, and peak pressure divided by signal duration to estimate the transition from impulsive to non-impulsive characteristics of impact piling noise during offshore wind turbine foundation installation at the Wash, southeast England and in the Moray Firth, northeast Scotland. The study found that the noise signal experienced a high degree of change in its impulsive characteristics with increasing distance, with the greatest change occurring within ~10 km from the source (Hastie *et al.*, 2019). Predicted PTS-onset impact ranges based on the impulsive noise thresholds used in this assessment may therefore be overestimates in cases where the impact ranges lie beyond this, resulting in the presentation of a precautionary assessment within this chapter.

11.7.4.32 It is important to note that there are no comparative studies that evaluate TTS-onset from impulsive noise for marine mammal species at present (Southall *et al.,* 2021).

PREDICTING THE RESPONSE OF AN ANIMAL TO UNDERWATER NOISE

11.7.4.33 The ability to predict the response of an animal to underwater noise and the number of animals potentially exposed to levels of noise that may cause an impact is uncertain. The high spatial and temporal variation in marine mammal abundance and distribution in any area makes it difficult to predict how many animals may be present within the range of noise impacts. As a result, all methods for determining at-sea abundance and distribution suffer from a range of biases and uncertainties.

11.7.4.34 Limited empirical data is available to inform predictions relating to the extent to which animals may experience auditory damage or display responses to noise. The current methods for predicting behavioural responses are based on received sound levels, but it is likely that factors other than noise levels alone will also influence the probability of response and the strength of response, such as previous experience, behavioural and physiological context, proximity to activities, duty cycle and pulse characteristics of the sound. However, it is not possible to adequately take these factors into account when predicting a behavioural response at present. This assessment makes use of the monitoring work that has been carried out during the construction of the Beatrice offshore windfarm and therefore uses the most recent and site-specific information on disturbance to harbour porpoise because of pile driving noise (Graham *et al.*, 2017a; Graham *et al.*, 2019).

TTS-ONSET ASSUMPTIONS

11.7.4.35 As outlined in 11.7.4.13., using a threshold for the onset of TTS typically results in overestimates of potential ranges at which ecologically significant effects could occur. Coupled with the precautionary assumptions in the model, particularly with respect to the SEL_{cum} metric, this means that estimates of TTS are likely to be unrealistic and very conservative, and therefore should be interpreted with caution.

11.7.4.36 In addition, it is important to note that there are no thresholds to determine a biologically significant effect on marine mammals from TTS, therefore a qualitative assessment of TTS has been presented within this chapter.

11.7.5 Assessment methodology for injury and/or disturbance from underwater noise during UXO clearance

11.7.5.1 The noise levels generated from UXO clearance were predicted by Subacoustech Environmental Ltd. Full details of the underwater noise modelling and resulting impact ranges are detailed in Volume III, Appendix 11.1: Underwater Noise Assessment.

11.7.5.2 As the detailed confirmatory surveys have not yet been completed, it is not possible at this time to determine how many items of UXO will require clearance. Alternatively, a review of recent information has been used to define parameters for consideration with respect to UXO clearance within this chapter.

11.7.5.3 A selection of explosive sizes has been considered based on what might be present, and in each case, it has been assumed that the maximum explosive charge in each device is present and detonates with the clearance. The range of charge weights (TNT equivalent) for the potential UXO devices that have been modelled are 25, 55, 120, 240, 525, 700, and 800 kg. In each case, an additional donor weight of 0.5 kg has been included to initiate detonation. Low-order deflagration has also been assessed, which assumes that the donor or shaped charge (charge weight of 0.5 kg) detonates fully to initiate a burnout of the explosive but without the follow-up detonation of the UXO. No mitigation has been considered within the modelling.

11.7.5.4 Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014). Unweighted UXO clearance source levels for each charge weight are presented in Table 11.19.

Table 11.19: Unweighted SPL_{peak} and SEL_{ss} source levels used for UXO modelling

Charge weight (kg) (TNT equivalent)	SPL_{peak} source level (dB re 1 μPa @ 1 m)	SEL_{ss} source level (dB re 1 $μPa^2s$ @ 1 m)
0.5 (low order)	272.1	217.1
25 + donor	284.9	228.0
55 + donor	287.5	230.1
120 + donor	290.0	232.3
240 + donor	292.3	234.2
525 + donor	294.8	236.4

700 + donor	295.8	237.2
800 + donor	296.2	237.5

Approach to PTS and TTS-onset

11.7.5.5 The PTS-onset thresholds used to assess the potential for auditory injury to marine mammals during UXO clearance are those presented in Southall *et al.* (2019) for impulsive noise (Table 11.18) as it is currently advised by UK statutory nature conservation bodies (SNCBs) (Natural England and the Marine Management Organisation) that these thresholds should be used for impact assessment from UXO detonation on marine mammals. This has been followed within this assessment as the most appropriate alternative given that Irish-specific guidance on UXO detonation does not exist. However, the suitability of these criteria is currently being discussed because there a lack of empirical evidence regarding UXO detonations using these metrics, particularly, the range-dependent characteristics of the peak sounds, and whether current propagation models can accurately predict the range at which these thresholds are reached.

11.7.5.6 The TTS-onset thresholds are also presented (Table 11.18), although it is important to note that there is currently no threshold for TTS-onset that would indicate a biologically significant impact as a result of TTS. Therefore, it was not possible to carry out a quantitative assessment of the sensitivity, magnitude, or significance of the impact of TTS on marine mammals. Any impacts relating to the effects of TTS are considered to be captured in the quantitative assessment of disturbance.

Behavioural disturbance

11.7.5.7 Unlike pile driving, there are no dose-response functions available that describe the magnitude and short-term nature of the behavioural impact of UXO detonation on marine mammals.

11.7.5.8 Both piling and explosive sound sources are categorised as ‘impulsive’, however the number of pulses and overall duration of noise emission which drive the behavioural response are drastically different. Behavioural responses to a single UXO detonation are expected to be a one-off startle response or aversive behaviour; whereas animals are anticipated to be continuously driven out of an impacted area by the series of pulses that are emitted during pile driving, enabling a dose-response to be quantified. Therefore, the empirically-derived dose-response curves used for assessment of behavioural disturbance for pile driving are not applicable to the assessment of UXO clearance.

11.7.5.9 Given that there are no appropriate dose-response functions available for behavioural disturbance from UXO detonation, other disturbance thresholds have been considered and are summarised in the sections below.

EFFECTIVE DETERRENCE RANGES (EDRS)

HIGH ORDER CLEARANCE

11.7.5.10 There is no guidance available from NPWS or IWDG on the methodology that should be used to assess disturbance from UXO clearance. Available guidance on assessing the significance of noise disturbance against the conservation objectives of harbour porpoise SACs in England, Wales, and Northern Ireland (JNCC, 2020) advises that an EDR of 26 km around the source location should be used to determine the area of impact from a high order UXO detonation.

11.7.5.11 The recommended 26 km EDR is derived from Tougaard *et al.* (2013) where the EDR is calculated using data from Dähne *et al.* (2013). This study was conducted at the first offshore windfarm in German waters where the piles of 12 jacket foundations with 2.4 to 2.6 m diameter were installed up to a penetration depth of 30 m using a hydraulic hammer with up to 500 kJ hammer energy (Dähne *et al.,* 2013).

11.7.5.12 While the advice acknowledges that there is no empirical evidence of harbour porpoise avoidance from UXO clearance (i.e. this guidance is based on pile driving), the guidance also states that the 26 km EDR is also to be used for the high order detonation of UXOs despite there being no empirical evidence of harbour porpoise avoidance' (JNCC, 2020), therefore it has been used in this assessment.

11.7.5.13 The 26 km EDR assumes that all animals are disturbed within this radius (2,123.72 km^2) and has been applied to all marine mammal species for high order detonations given that agreed metrics of disturbance for other marine mammal species are not available and there is a lack of empirical data on the likelihood of response to explosives.

11.7.5.14 However, it is important to note that the behavioural disturbance from a single UXO detonation would not result in the same widespread and prolonged displacement that pile driving does (JNCC, 2020). Furthermore, there is no direct evidence to support the assumption that all marine mammal species will respond in the same way to a high order UXO clearance as harbour porpoise do to pile driving of jacket foundations (Dähne *et al.,* 2013).

LOW ORDER CLEARANCE

11.7.5.15 There is currently no formal guidance for disturbance from low order detonations, however a 5 km EDR has been frequently assumed for low order detonations and has therefore been adopted within this assessment (Sofia Offshore Windfarm, 2021). This EDR is based on data obtained during low order detonations using deflagration which measured the underwater noise produced at over 20 dB lower than high order detonation (Robinson *et al.,* 2020; Cheong *et al.,* 2020). As such, it is anticipated that there will be a corresponding reduction in the area over which sound may result in disturbance to marine mammals. Although the potential impacts in relation to disturbance relating to low order UXO clearance are yet to be verified empirically, an EDR of 5 km should be considered as precautionary.

11.8 Assessment of the significance of effects

11.8.1.1 The impacts of the construction, operational and maintenance and decommissioning phases of both Project Design Options forming the Proposed Development have been assessed for marine mammals. The potential impacts arising from the construction, operational and maintenance and decommissioning phases of the Proposed Development are listed in Table 11.9 and Table 11.10, along with the project parameters against which each impact has been assessed.

11.8.1.2 A description of the potential effect on marine mammals caused by each identified impact is provided in Section 11.9 and Section 11.10.

11.9 Assessment of Project Design Option 1

11.9.1 Impact 1 – Injury and/or disturbance to marine mammals from underwater noise during pile driving

11.9.1.1 This impact assessment focusses on elevations in underwater noise and vibration as a result of pile driving during construction, as this activity has the greatest potential for impact on marine mammals.

11.9.1.2 The potential impacts of subsea noise arising during non-percussive noise-generating activities such as dredging and trenching during the construction, operational and maintenance, and decommissioning phases have been scoped out of this assessment. Whilst there is potential for elevations in subsea noise during other construction activities, these activities are considered to result in very localised, short-term effects on marine mammals and therefore has been scoped out of the assessment. In addition, noise generated during wind turbine operation has also been scoped out (Table 11.11).

11.9.1.3 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.18) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.20; Southall *et al.*, 2019).

Table 11.20: Marine mammal hearing groups and ranges (Southall *et al.*, 2019)

Functional hearing group (FHG)	Relevant species	Generalised hearing range
VHF cetacean	Harbour porpoise	275 Hz to 160 kHz
HF cetacean	Bottlenose dolphin, Risso's dolphin, common dolphin	150 Hz to 160 kHz
Low Frequency (LF) cetacean	Minke whale	7 Hz to 35 kHz
PCW	Grey seal, harbour seal	50 Hz to 86 kHz

11.9.1.4 Impacts to marine mammals from underwater noise range from changes in behaviour and masking that affect communication and listening space, and/or locating prey (Basran *et al.*, 2020; Dunlop, 2016; Erbe *et al.*, 2016; Heiler *et al.*, 2016; Pine *et al.*, 2019; Pirotta *et al.*, 2012; Wisniewska *et al.*, 2018), displacement and disturbance (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Graham *et al.*, 2019; Pirotta *et al.*, 2014; Stone *et al.*, 2017), injury and mortality (Reichmuth *et al.*, 2019; Schaffeld *et al.*, 2019).

11.9.1.5 The potential for auditory injury is related to the level of the underwater sound, its frequency relative to the hearing bandwidth of the animals, and by the duration of exposure. Exposure to loud, underwater noise can lead to a reduction in hearing sensitivity (a shift in hearing threshold) which may be temporary (TTS) or permanent (PTS).

11.9.1.6 TTS has been included in the assessment as a precautionary measure because it has the potential to have negative effects on an animal's ability to use natural sounds, including communication, navigation, and prey location, and consequently, could lead to a reduction in the fitness of the animal.

11.9.1.7 This impact assessment will be divided into an assessment of auditory injury (PTS), TTS, and behavioural disturbance due to underwater noise during pile driving.

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY - PTS

11.9.1.8 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS (a permanent and irreversible hearing impairment) are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.9.1.9 At a Department of Business, Energy, and Industrial Strategy (BEIS)-funded expert elicitation workshop in 2018, experts discussed the nature, extent, and potentially consequences of PTS to marine mammal species in the UK (Booth and Heinis, 2018). Using the best and most recent data available on the effects of PTS on marine mammals, the experts concluded that PTS did not mean animals were deaf, and the magnitude and frequency band in which PTS occurs is critical to assessing the effect on vital rates.

11.9.1.10 The onset of PTS was defined by Southall *et al.* (2007) as a non-recoverable elevation of the hearing threshold of 6 dB. It has been assumed that PTS-onset occurs after TTS has grown to 40 dB, based on TTS growth rates obtained from scientific literature. Studies of auditory injury in relation to a typical piling sequence have suggested that hearing impairment caused by exposure to piling noise is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum (Kastelein *et al.*, 2013a). For piling noise, most energy is between ~30 – 500 Hz, with a peak between 100-300 Hz and energy extending above 2 kHz (Kastelein *et al.*, 2015; Kastelein *et al.*, 2016). Studies have shown that exposure to impulsive pile driving noise induces TTS in a relatively narrow frequency band in both harbour porpoise and harbour seals (Finneran, 2015), with statistically significant TTS occurring at 4 and 8 kHz, respectively (Kastelein *et al.*, 2016) and centred at 4 kHz (Kastelein *et al.*, 2012a; Kastelein *et al.*, 2012b; Kastelein *et al.*, 2013b; Kastelein *et al.*, 2017). As a result, at an expert elicitation workshop, it was agreed that any threshold shifts to hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al.*, 2017). It was also agreed that a PTS of 6 – 18 dB in a narrow frequency band in the 2 – 10 kHz region is unlikely to significantly affect the ability of individuals to survive and reproduce (Kastelein *et al.*, 2017).

HARBOUR PORPOISE (VERY HIGH FREQUENCY CETACEANS)

11.9.1.11 During an expert elicitation workshop, experts discussed the nature, extent, and potentially consequences of PTS to harbour porpoises; concluding that the probability of PTS significantly affecting the survival and reproduction of harbour porpoises was very low (Booth and Heins, 2018).

11.9.1.12 Furthermore, data collected during the construction of offshore windfarms have shown that harbour porpoise detections around the pile driving area decline for several hours prior to the commencement of pile driving (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018; Graham *et al.*, 2019). For example, during the installation campaigns of both Beatrice and Moray East offshore windfarms, harbour porpoise acoustic detections gradually declined by up to 33% during the 48-hour period prior to piling (Benhemma-Le Gall *et al.*, 2023). It is assumed that this is due to an increase in other construction-related activities and the presence of vessels in advance of pile driving which act as a deterrent to harbour porpoise, therefore reducing the risk of auditory injury (Benhemma-Le Gall *et al.*, 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity of the pile driving at the start of the activity. Consequently, the assessment of underwater noise in relation to pile driving, which assumes harbour porpoises will be present in the immediate vicinity during pile driving, is extremely precautionary.

11.9.1.13 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of harbour porpoise. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

DOLPHIN SPECIES (HIGH FREQUENCY CETACEANS)

11.9.1.14 The ecological consequences of PTS for bottlenose dolphin, Risso's dolphin, and common dolphin are uncertain but could result in effects that influence survival and reproductivity, as discussed in paragraph 11.9.1.8.

11.9.1.15 As described for harbour porpoise, studies have shown that there are frequency-specific differences in the onset and growth of noise-induced threshold shifts in relation to the characteristics of the noise source and hearing sensitivity of the receiving species. At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of bottlenose dolphins was very low, assuming an impact a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.9.1.16 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of dolphin species. As a result, bottlenose dolphins, Risso's dolphins, and common dolphins are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, bottlenose dolphins, Risso's dolphins, and common dolphins are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

MINKE WHALE (LOW FREQUENCY CETACEANS)

11.9.1.17 The low frequency noise produced during pile driving may be more likely to overlap with the hearing range of low frequency cetacean species such as minke whales. Although very little is known about minke whale hearing, it is likely that they use sound for communication and are thought to be capable of hearing sounds through their skull bones (Cranford and Krysl, 2015).

11.9.1.18 As for other FHGs above, it is assumed that animals experiencing PTS would suffer a biological effect that could impact on the health and vital rates of the animal (Erbe *et al.*, 2018) and could ultimately lead to reduced birth rate in females or mortality of individuals.

11.9.1.19 Tubeli *et al.* (2012) estimated the most sensitive hearing range for minke whales to extend from 30 to 100 Hz up to 7.5 to 25 kHz. This suggests that a 6 dB PTS in the 2 – 10 kHz range would only affect a small region of their hearing. Furthermore, several studies have demonstrated that minke whale communication signals are below 2 kHz (Edds-Walton, 2000; Gedamke *et al.*, 2001; Mellinger *et al.*, 2006; Risch *et al.*, 2013; 2014).

11.9.1.20 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of minke whale as only a small region of their hearing would be potentially affected. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, minke whales are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

GREY AND HARBOUR SEAL (PHOCIDS IN WATER)

11.9.1.21 Seals use sound both in air and water for communication, predator avoidance, and reproductive interactions, and are less dependent on hearing for foraging than cetaceans (Deecke *et al.*, 2002). Seals have very well developed tactile sensory systems that are used for foraging, but in certain conditions they may also listen to sounds produced by vocalising fish whilst hunting for prey (Dehnhardt *et al.*, 2001; Shulte-Pelkum *et al.*, 2007).

11.9.1.22 Any threshold shifts in hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al.*, 2017). At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of grey and harbour seals was very low, assuming a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.9.1.23 Calculations of SELs of tagged seals during the construction of the Lincs offshore windfarm (Southern North Sea, UK) estimated that at least 50% of tagged seals would have received a dose of sound greater than published thresholds for PTS (Hastie *et al.*, 2015), although it is important to note that published thresholds have since been updated in Southall *et al.* (2019) and therefore this estimate is now expected to be lower. For example, Whyte *et al.* (2020) found that the percentage of tagged seals predicted to experience PTS-onset varied from 0 to 17% depending on the onset threshold applied. The extent of offshore windfarm construction within the Wash over the last decade and the degree of overlap with foraging ranges of harbour seals in this region would suggest that a large number of individuals within the Wash population may have experienced levels of sound that have the potential to cause PTS (Russell *et al.*, 2016). However, the increase in the Wash harbour seal population during this period suggests that either the survival and fitness of individuals is not affected or that seals are not developing PTS despite predictions of exposure that indicate that they should be.

11.9.1.24 PTS is a permanent effect which cannot be recovered from, although, seals do not generally use hearing as the primary sensory function for locating prey and evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of seals. As a result, they are considered highly adaptable, reasonably tolerant, have no recoverability, and are of high value. Therefore, grey and harbour seals are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

BEHAVIOURAL DISTURBANCE

HARBOUR PORPOISE

11.9.1.25 Harbour porpoises are particularly vulnerable to disturbance because they are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently in order to maintain a high metabolic rate with little energy remaining for fat storage (Rojano-Doñate *et al.*, 2018; Wisniewska *et al.*, 2016). Therefore, there is a risk of changes to their overall fitness if they are displaced from high-quality foraging grounds or if their foraging efficiency is disturbed, and they are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. However, results from studies using Digital Acoustic Recording Tags (DTAGs) suggest that harbour porpoises are able to respond to short-term reductions in food intake and may have some resilience to disturbance (Wisniewska *et al.*, 2016).

11.9.1.26 Several studies have shown that harbour porpoises are displaced during periods of pile driving (e.g. Benhemma-Le Gall *et al.*, 2021; Brandt *et al.*, 2016; Graham *et al.*, 2019;). For example, monitoring of harbour porpoise during piling at Beatrice offshore windfarm in northeast Scotland indicated that porpoises were displaced from the immediate vicinity of the piling activity with a 50% probability of response occurring at approximately 7 km at the first piled location (Graham *et al.*, 2019). However, the 50% probability of response reduced to 1.3 km by the final piling location, suggesting that the response of harbour porpoise diminished over the construction period (Graham *et al.*, 2019).

11.9.1.27 This is further supported by studies at eight offshore windfarms in the German North Sea where declines in porpoise detection of >90% were recorded at noise levels above 170 dB compared to a baseline period of 24 to 48 hours (Brandt *et al.*, 2016). A decline in detections of 25% at noise levels between 145 and 150 dB showed a decrease in effect with increase in distance from the piling location (Brandt *et al.*, 2016). Furthermore, the detection rates showed that animals were only displaced from the area for a short period (one to three days) (Brandt *et al.*, 2011; Brandt *et al.*, 2016; Brandt *et al.*, 2018; Dähne *et al.*, 2013).

11.9.1.28 Recent studies at two offshore windfarms in Scotland showed that detections of clicks, associated with echolocation, and buzzing, associated with prey capture, in the short range (2 km) did not cease in response to piling, suggesting that porpoises were not completely displaced from the piling area (Benhemma-Le Gall *et al.*, 2021). Furthermore, the study suggests that animals that experience displacement may be able to compensate for missed foraging opportunities and increased energy expenditure of fleeing the piling area as detections of both clicks and buzzing were positively related to the distance from the piling activity (Benhemma-Le Gall *et al.*, 2021) which could be due to an increase in foraging activities beyond the piling impact range.

11.9.1.29 At an expert elicitation workshop in 2019, experts agreed that juvenile and adult survival were unlikely to be significantly affected by missed foraging opportunities as a result of disturbance from piling (Booth *et al.*, 2019). As a result, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

BOTTLENOSE DOLPHIN

11.9.1.30 A study of bottlenose dolphin response to impulsive noise (including the piling campaigns of Beatrice offshore windfarm and Moray East offshore windfarm, northeast Scotland), suggest that these activities did not cause displacement of the species from the southern coast of the Moray Firth (Fernandez-Betelu *et al.*, 2021). At the small temporal scale, dolphin detections increased, and the species remained within the predicted impacted area close to the offshore activities, for a median of two hours per day, on days with impulsive noise. This could be due to modifications in group size and/or behaviour, or changes in vocalisation rate or amplitude in response to impulsive noise generated by offshore activities. It is also important to note that bottlenose dolphin occurrence is largely influenced by various natural drivers, such as prey abundance, which could be deemed of higher importance in affecting their occurrence. Other studies in the Cromarty Firth, northeast Scotland have suggested small spatial and temporal scale disturbance of bottlenose dolphins from piling activities have occurred previously, as evidenced by a slight reduction of the presence, detection positive hours, and the encounter duration in the vicinity of construction works, although dolphins were not excluded entirely from the area (Graham *et al.*, 2017a).

11.9.1.31 There is potential for behavioural disturbance due to underwater noise to result in disruption in foraging and resting activities and an increase in travel and energetic costs (Marley *et al.*, 2017; Pirotta *et al.*, 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that while there is potential for disturbance to affect bottlenose dolphin behaviour and health, which will then impact vital rates and population dynamics, individuals are able to compensate for immediate behavioural responses to disturbances caused by vessel activity. This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. As a result, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

RISSO'S DOLPHIN

11.9.1.32 Limited information on the response of Risso's dolphin to pile driving exists and there are few studies to investigate the effects of other impulsive noise sources, such as seismic surveys. The frequency range of seismic airguns may be similar to that of low-frequency noise produced by pile driving, although its duration and cumulative acoustic energy levels will differ. A study on the effects of seismic operations in UK waters showed no response by Risso's dolphin to seismic airguns (Stone *et al.*, 2017). During controlled experiments where Risso's dolphin were exposed to simulated military sonar (SPLs of 135 dB re 1μPa), no clear behavioural response was recorded (Southall *et al.*, 2011).

11.9.1.33 The limited information available for the impacts of pile driving, construction-related activity and seismic surveys on Risso's dolphins make it challenging to assess the risk for this species. Based on evidence available, Risso's dolphin are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, Risso's dolphin are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

COMMON DOLPHIN

11.9.1.34 Limited information on the response of common dolphins to pile driving exists, with few studies investigating impacts of any impulsive sound source on this species. The majority of evidence for the response of common dolphins to seismic surveys (an impulsive sound source) shows no change in occurrence or sighting densities of common dolphin during active surveys (Kavanagh *et al.*, 2019; Stone *et al.*, 2017). Similarly, a monitoring study in northwest Ireland investigating the effects of construction-related activity, including but not limited to seismic surveys, multi-beam surveys, remotely operated vehicle (ROV) surveys, dredging, back filling, rock trenching, rock placement, rock breaking, pipe laying and umbilical laying, during the construction of a gas pipeline found no changes in occurrence of common dolphin as a result of these construction - related activities in the area (Culloch *et al.*, 2016).

11.9.1.35 The limited information available for the impacts of pile driving, construction-related activity and seismic surveys on common dolphins make it challenging to assess the risk to this species. However, there is evidence to suggest that common dolphins are able to adjust their whistle characteristics to account for masking as a result of anthropogenic noise (Papale *et al.*, 2015), suggesting some tolerance and adaptability. As a result, common dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during pile driving.

MINKE WHALE

11.9.1.36 Limited information on the behavioural responses of minke whales to underwater noise is available. A study on the behavioural sensitivity of minke whale reactions to sonar signals showed that they displayed prolonged avoidance, increase in swim speed directly away from the source, and cessation of feeding for a received SPL of 146dB re 1μPa and long-term (6 hour) avoidance of the area for a received SPL of 158dB re 1μPa (Sivle *et al.*, 2015). A study detailing minke whale responses to the Lofitech 'seal scarer' ADD showed minke whales within 500 m and 1,000 m of the source (source level of 204dB re 1 μPa @1 m) exhibiting responses of increased swim speeds and movement away from the source (McGarry *et al.*, 2017). Marine mammal monitoring showed that fine-scale temporal occurrence of minke whales was reduced by the presence of construction related activity (which did not include pile driving but did assess vessel presence as a proxy for other activities, including seismic surveys and multi-beam surveys) in Broadhaven Bay, northwest Ireland (Culloch *et al.*, 2016).

11.9.1.37 Minke whale are seasonal migrants to Irish (and UK) waters, where they forage on pelagic schooling fish during the summer months (Whooley, 2016). While information on the behavioural responses of minke whales to underwater noise is limited, it is anticipated that minke whales will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage. As a result, minke whales are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whales are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

GREY SEAL

11.9.1.38 Limited information on the behavioural responses of grey seals to underwater noise is available. Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the during the construction of the Luchterduinen windfarm and from 16 grey seals in 2015 during the construction of the Gemini windfarm (Aarts *et al*., 2018). The most common response suggested a change in behaviour from foraging to horizontal movement, although various other responses were recorded including, altered surfacing and diving behaviour, changes in swim direction, and no response (Aarts *et al*., 2018). Data from this study also showed that seals returned to the area on subsequent trips, despite receiving multiple exposures.

11.9.1.39 During an expert elicitation workshop in 2018, it was concluded that grey seals were considered to have a reasonable ability to compensate for missed foraging opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al*., 2019). In general, experts agreed that grey seals would be more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet and more adaptable in their foraging strategies (Booth *et al*., 2019). Experts also agreed that moderate-high levels of repeated disturbance would be required for any effect on grey seal fertility rates (Booth *et al*., 2019).

11.9.1.40 Grey seals are highly adaptable to a changing environment. They can adjust their metabolic rate and foraging strategies and can compensate for lost opportunities due to their generalist diet, mobility, and adequate fat stores (Smout *et al*., 2014; Stansbury *et al*., 2015). They are also able to tolerate periods of fasting as part of their life history because of their large body size and thick layer of blubber (i.e. more energy reserve) (Pomeroy *et al*., 1999). In addition, they are wide ranging and can travel large distances (up to 488 km) between different haul out and foraging regions, although on average, distances tend to be approximately 65 km (McConnell *et al*., 1999). As a result, grey seals are considered to be of high adaptability, reasonable to high tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Negligible sensitivity to behavioural disturbance from underwater noise during piling driving.

HARBOUR SEAL

11.9.1.41 Behavioural disturbance of harbour seals as a result of underwater noise during pile driving could have an effect on both survival if it results in the separation of a pup from its mother, and reproduction via body condition if it results in the animal spending less time feeding or conserving energy by resting (Booth *et al*., 2019).

11.9.1.42 A study of telemetry tagged harbour seals in the Wash, southeast England showed displacement during piling with a 19 to 83% reduction in abundance compared to during piling breaks (Russell *et al*., 2016). The study shows that abundance was significantly reduced up to 25 km from the piling activity (Russell *et al*., 2016). However, seals within the area returned to usage levels similar to non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term.

11.9.1.43 It is possible that displacement of harbour seals could result in an increased energetic cost if they are required to travel greater distances to compensate for missed foraging opportunities, which could potentially affect the reproductive success of a small number of individuals. However, during an expert elicitation workshop in 2018, the experts considered it unlikely that an individual would repeatedly return to an area where it had been previously displaced, and therefore unlikely to result in reduced foraging opportunities over a number of days that would be required to reduce body condition or fertility (Booth *et al*., 2019).

11.9.1.44 Harbour seals have been reported to travel up to 273 kilometres from a haul-out whilst foraging, although they tend to remain within 50 km of their haul-out site and show high site fidelity (Carter *et al*., 2022). The identified harbour seal haul-outs at Wexford Harbour, north Bull Island and Lambay island are situated approximately 50 km, 55 km and 62 km away from the Proposed Development, respectively, which suggests there is a low likelihood of harbour seals from these haul-outs using waters within the Proposed Development.

11.9.1.45 During the expert elicitation workshop in 2018, the experts also agreed that harbour seals have a reasonable ability to compensate for missed foraging opportunities from disturbance (from exposure to low frequency broadband pulsed noise such as piling driving) due to their generalist diet, adequate fat stores, mobility, and life-history traits (Booth *et al.*, 2019), for example, they have a thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods. Therefore, they are likely to have capacity to tolerate short-term displacement from foraging grounds during piling activity. As a result, harbour seals are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

Construction phase

MAGNITUDE OF IMPACT

PTS

11.9.1.46 The following section provides the quantitative assessment of the impact of PTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for auditory injury (PTS-onset) from pile driving for each marine mammal species are also presented in Table 11.21, Table 11.22, Table 11.23, Table 11.24, and Table 11.25. This includes the prediction of impact for each of the five modelling locations. A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.9.1.47 For harbour porpoise, the maximum instantaneous PTS-onset impact range was 750 m for the installation of an 11 m monopile at the SW WTG location (Table 11.23). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) using the site-specific DAS density estimate. Using the cumulative PTS-onset thresholds, the maximum impact range was 10,000 m (10 km) for the installation of either an 11 m monopile at the SW WTG location, or the installation of a 14 m monopile at the S-OSP location (Table 11.23). This equates to a maximum of 68 animals experiencing auditory injury (0.11% of the reference population) using the site-specific DAS density estimate. Using the density estimate from SCANS-IV, which covers a larger spatial scale, this would be <1 animal (<0.01% of the reference population) that would experience auditory injury due to instantaneous PTS-onset, and 50 animals (0.08% of the reference population) that would experience auditory injury due to cumulative PTS-onset (Table 11.23).

11.9.1.48 For dolphin species, the maximum instantaneous PTS-onset impact range was <50 m, therefore, no dolphins are expected to be impacted (Table 11.21; Table 11.22; Table 11.23; Table 11.24; Table 11.25). Using the cumulative PTS-onset thresholds, the maximum impact range for dolphin species was <100 m, and as such, no dolphins are expected to be impacted (Table 11.21; Table 11.22; Table 11.23; Table 11.24Table 11.24:; Table 11.25).

11.9.1.49 For minke whale, the maximum instantaneous PTS-onset impact range was 50 m for the installation of an 11 m monopile at the SW WTG location, therefore no whales are expected to be impacted (Table 11.23). Using the cumulative PTS-onset thresholds, the maximum impact range was 19,000 m (19 km) for the installation of an 11 m monopile at the SW WTG location (Table 11.23). This equates to a maximum of 21 animals experiencing auditory injury (0.11% of reference population) using the density estimate from the ObSERVE surveys.

11.9.1.50 For seals, the maximum instantaneous PTS-onset impact range was 60 m for the installation of either an 11 m monopile at the SW location (Table 11.23), or the installation of a 7 m or 14 m monopile at the S-OSP location (Table 11.25). As a result, no seals are expected to be impacted. Using the cumulative PTS-onset thresholds, the maximum impact range was 500 m for the installation of an 11 m monopile at the C WTG location (Table 11.23). As such, no seals are expected to be impacted.

11.9.1.51 The impact is restricted to active piling days during the construction phase and is reasonably expected to occur. It is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. As part of an expert elicitation workshop, experts in the relevant fields of marine mammal science discussed the nature, extent, and consequence of hearing threshold shifts on marine mammal arising from repeated exposures to low-frequency impulsive noise (Booth and Heinis, 2018). It was acknowledged that energy from piling noise primarily concentrates between about 30 and 500 Hz, and peaks between 100 and 300 Hz with extension to above 2 kHz (Kastelein *et al.*, 2015a, Kastelein *et al.*, 2016). The experts agreed that PTS and TTS as a result of piling would occur between the frequency range of 2 to 10 kHz (Kastelein *et al.*, 2017), with PTS of 6 to 18 dB within this narrow range. They concluded that such change is not likely to adversely and significantly impact the survival and reproductive rates of marine mammals, including minke whales, which have a hearing range in the lower frequencies (paragraphs 11.9.1.19 and 11.9.1.20).Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise and minke whale. For dolphin and seal species, no animals are predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible adverse.

Table 11.21: PTS-onset from pile driving at the NW WTG location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km^2)	Piling location							
		NW WTG location – 7 m monopile				NW WTG location – 11 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	0.70	490	<1	<0.01	0.73	500	<1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	<0.01	<50	0	0.00	0.01	<50	0	0.00
Harbour seal	0.0003	<0.01	<50	0	0.00	0.01	<50	0	0.00

Species	Density (animals/km²)	Piling location							
		NW WTG location – 7 m monopile				NW WTG location – 11 m monopile			
		Area (km²)	Maximum range (m)	Number of animals	% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	31	4,600	12	0.02	31	4,600	12	0.02
	0.2803			9	0.01			9	0.01
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	56	7,500	3	0.01	58	7,600	3	0.01
	0.017			1	<0.01			1	<0.01
Grey seal	0.08	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Harbour seal	0.0003	<0.1	<100	0	0.00	<0.1	<100	0	0.00

Table 11.22: PTS-onset from pile driving at the C WTG location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km²)	Piling location							
		C WTG location – 7 m monopile				C WTG location – 11 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.5	690	1	<0.01	1.5	700	1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	<50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	50	0	0.00	0.01	50	0	0.00
Harbour seal	0.0003	0.01	50	0	0.00	0.01	50	0	0.00

Species	Density (animals/km²)	Piling location							
		C WTG location – 7 m monopile				C WTG location – 11 m monopile			
		Area (km²)	Maximum range (m)	Number of animals	% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	150	9,100	57	0.09	150	9,100	57	0.09
	0.2803			42	0.07			42	0.07
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	400	17,000	18	0.09	400	17,000	18	0.09
	0.017			7	0.03			7	0.03
Grey seal	0.08	0.3	400	0	0.00	0.3	500	0	0.00
Harbour seal	0.0003	0.3	400	0	0.00	0.3	500	0	0.00

Table 11.23: PTS-onset from pile driving at the SW WTG location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km^2)	Piling location							
		SW WTG location – 7 m monopile				SW WTG location – 11 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.6	740	1	<0.01	1.6	750	1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	<50	0	0.00	0.01	60	0	0.00
Harbour seal	0.0003	0.01	<50	0	0.00	0.01	60	0	0.00

Species	Density (animals/km²)	Piling location							
		SW WTG location – 7 m monopile				SW WTG location – 11 m monopile			
		Area (km²)	Maximum range (m)	Number of animals	% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	180	10,000	68	0.11	180	10,000	68	0.11
	0.2803			50	0.08			50	0.08
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	460	18,000	21	0.10	470	19,000	21	0.11
	0.017			8	0.04			8	0.04
Grey seal	0.08	0.1	380	0	0.00	0.2	400	0	0.00
Harbour seal	0.0003	0.1	380	0	0.00	0.2	400	0	0.00

Table 11.24: PTS-onset from pile driving at the N-OSP location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km²)	Piling location							
		N-OSP location – 7 m monopile				N-OSP location – 14 m monopile			
		Area (km²)	Maximum range (m)	Number of animals	% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.0	570	<1	<0.01	1.0	580	<1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	<50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	<50	0	0.00	0.01	<50	0	0.00
Harbour seal	0.0003	0.01	<50	0	0.00	0.01	<50	0	0.00

Species	Density (animals/km²)	Piling location							
		N-OSP location – 7 m monopile				N-OSP location – 14 m monopile			
		Area (km²)	Maximum range (m)	Number of animals	% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	49	5,400	19	0.03	49	5,400	19	0.03
	0.2803			14	0.02			14	0.02
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	100	9,400	5	0.02	100	9,500	5	0.02
	0.017			2	0.01			2	0.01
Grey seal	0.08	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Harbour seal	0.0003	<0.1	<100	0	0.00	<0.1	<100	0	0.00

Table 11.25: PTS-onset from pile driving at the S-OSP location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km^2)	Piling location							
		S-OSP location – 7 m monopile				S-OSP location – 14 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.4	670	1	<0.01	1.4	680	1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	<50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	60	0	0.00	0.01	60	0	0.00
Harbour seal	0.0003	0.01	60	0	0.00	0.01	60	0	0.00

Species	Density (animals/km²)	Piling location							
		S-OSP location – 7 m monopile				S-OSP location – 14 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	170	10,000	65	0.10	170	10,000	65	0.10
	0.2803			48	0.08			48	0.08
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	440	18,000	20	0.10	450	18,000	20	0.10
	0.017			7	0.04			8	0.04
Grey seal	0.08	<0.1	200	0	0.00	<0.1	200	0	0.00
Harbour seal	0.0003	<0.1	200	0	0.00	<0.1	200	0	0.00

TTS

11.9.1.52 The following section provides the qualitative assessment of the impact of TTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for TTS-onset from pile driving at each of the five modelling locations are presented in Table 11.26. As outlined in section 11.7.4, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given because there are no thresholds to determine a biologically significant effect from TTS-onset.

11.9.1.53 For harbour porpoises, the maximum instantaneous TTS-onset impact range was 1,900 m for the installation of a 11-m monopile at the SW WTG location (Table 11.26). Using the cumulative TTS-onset thresholds, the maximum impact range for harbour porpoise was 63,000 m (63 km) for the installation of a monopile at the SW WTG location (Table 11.26).

11.9.1.54 For dolphin species, the maximum instantaneous TTS-onset impact range was <50 m (Table 11.26). Using the cumulative TTS-onset thresholds, the maximum impact range for dolphin species was <100 m (Table 11.26).

11.9.1.55 For minke whale, the maximum instantaneous TTS-onset impact range was 130 m for the installation of a monopile at the SW WTG location (Table 11.26). Using the cumulative TTS-onset thresholds, the maximum impact range for minke whale was 98,000 m (98 km) for the installation of a monopile at the SW WTG location (Table 11.26).

11.9.1.56 For seals, the maximum instantaneous TTS-onset impact range was 150 m for the installation of a monopile at the SW WTG location (Table 11.26). Using the cumulative TTS-onset thresholds, the maximum impact range for seals was 35,000 m (35 km) for the installation of a monopile at the SW WTG location (Table 11.26).

Table 11.26: TTS-onset impact ranges from pile driving

Species	Impact	Piling location									
		NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
Instantaneous TTS-onset (unweighted SPL_{peak})											
Harbour porpoise (VHF cetacean)	Area (km^2)	4.2	4.3	9.4	9.5	10	10	5.9	5.9	8.8	8.9
	Maximum range (m)	1,200	1,200	1,800	1,800	1,900	1,900	1,400	1,400	1,700	1,700
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Area (km^2)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum range (m)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Minke whale (LF cetacean)	Area (km^2)	0.03	0.03	0.04	0.04	0.05	0.05	0.03	0.03	0.04	0.05
	Maximum range (m)	90	90	120	120	130	130	110	110	120	120
Grey seal, harbour seal (PCW)	Area (km^2)	0.03	0.04	0.06	0.06	0.07	0.07	0.05	0.05	0.06	0.06
	Maximum range (m)	110	110	140	140	150	150	120	120	140	140
Cumulative TTS-Onset (weighted SEL_{cum})											
Harbour porpoise (VHF cetacean)	Area (km^2)	2,000	2,000	4,500	4,500	5,500	5,500	2,500	2,500	5,500	5,500
	Maximum range (m)	42,000	42,000	56,000	56,000	63,000	63,000	45,000	45,000	62,000	62,000
Bottlenose dolphin, Risso's dolphin, common	Area (km^2)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
	Maximum range (m)	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100

Species	Impact	Piling location									
		NW WTG 7 m	**NW WTG 11 m**	**C WTG 7 m**	**C WTG 11 m**	**SW WTG 7 m**	**SW WTG 11 m**	**N-OSP 7 m**	**N-OSP 14 m**	**S-OSP 7 m**	**S-OSP 14 m**
dolphin (HF cetacean)											
Minke whale (LF cetacean)	Area (km^2)	4,500	4,500	8,500	8,500	9,200	9,200	5,300	5,400	9,000	9,100
	Maximum range (m)	63,000	63,000	86,000	86,000	98,000	98,000	67,000	67,000	94,000	95,000
Grey seal, harbour seal (PCW)	Area (km^2)	380	380	1,500	1,500	1,800	1,800	570	570	1,700	1,700
	Maximum range (m)	18,000	18,000	32,000	32,000	35,000	35,000	21,000	21,000	34,000	34,000

BEHAVIOURAL DISTURBANCE

11.9.1.57 The number of each marine mammal species predicted to experience behavioural disturbance as a result of pile driving is presented in Table 11.27 and Table 11.28 and assessed as the proportion of the respective reference population (as presented in Table 11.7). For dolphin species and minke whale, numbers of animals predicted to experience behavioural disturbance have been calculated using both the dose response method (Graham *et al.,* 2017b) (see Table 11.27) and Level B harassment thresholds (NMFS, 2005) (see Table 11.28). The predictions for the C WTG, NW WTG, SW WTG, N-OSP, and S-OSP modelling locations are presented separately. Disturbance from concurrent piling has not been assessed as piling is limited to one installation per day for Project Design Option 1 (see Table 11.9). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.9.1.58 iPCoD modelling was conducted to determine whether the level of disturbance is expected to result in population level impacts. The results of the iPCoD modelling show that there is no significant effect of disturbance resulting from pile driving at the Proposed Development to harbour porpoise, bottlenose dolphin, minke whale, grey seal, and harbour seal. Furthermore, for minke whale, grey seal, and harbour seal, impacted population is predicted to continue at a stable trajectory at exactly the same size as the un-impacted population.

Table 11.27: Predicted impact of disturbance to marine mammals from pile driving using dose response curves; # = number of animals disturbed; % = the percentage of the reference population. For Further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Impact	Piling location									
			NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
Harbour porpoise	0.38	#	1,933	1,951	3,117	3,111	3,363	3,380	2,174	2,190	3,335	3,355
		%	3.09	3.12	4.99	4.98	5.38	5.41	3.48	3.50	5.33	5.37
	0.2803	#	1,426	1,439	2,299	2,295	2,481	2,493	1,604	1,615	2,460	2,475
		%	2.28	2.30	3.68	3.67	3.97	3.99	2.57	2.58	3.93	3.96
	Grid-cell specific	#	1,084	1,093	1,701	1,688	1,778	1,797	1,238	1,226	1,846	1,801
		%	1.73	1.75	2.72	2.70	2.84	2.87	1.98	1.96	2.95	2.88
Bottlenose dolphin	0.0201	#	102	103	165	165	178	179	115	116	176	177
		%	34.90	35.22	56.28	56.16	60.72	61.01	39.25	39.53	60.20	60.57
	0.2352	#	1,197	1,207	1,929	1,925	2,082	2,092	1,346	1,355	2,064	2,077
		%	408.41	412.07	658.52	657.13	710.52	713.96	459.29	462.59	704.44	708.81
	Grid-cell specific	#	122	123	181	179	183	186	137	137	186	187
		%	41.66	41.98	61.65	61.19	62.44	63.43	46.79	46.82	63.52	63.79
Risso's dolphin	0.031	#	158	159	254	254	274	276	177	179	272	274
		%	1.29	1.30	2.07	2.07	2.24	2.25	1.45	1.46	2.22	2.23
Common dolphin	0.0272	#	138	140	223	223	241	242	156	157	239	240
		%	0.13	0.14	0.22	0.22	0.23	0.24	0.15	0.15	0.23	0.23
	Grid-cell specific	#	208	209	358	357	427	429	237	237	419	422

Species	Density (animals/km²)	Impact	Piling location									
			NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
		%	0.20	0.20	0.35	0.35	0.42	0.42	0.23	0.23	0.41	0.41
Minke whale	0.045	#	229	231	369	368	398	400	257	259	395	397
		%	1.14	1.15	1.83	1.83	1.98	1.99	1.28	1.29	1.96	1.98
	0.017	#	86	87	139	139	150	151	97	98	149	150
		%	0.43	0.43	0.69	0.69	0.75	0.75	0.48	0.49	0.74	0.75
	Grid-cell specific	#	69	69	103	104	106	107	78	78	107	108
		%	0.34	0.34	0.51	0.51	0.53	0.53	0.39	0.39	0.53	0.54
Grey seal	0.08	#	130	132	269	271	297	299	155	157	297	300
		%	7.83	7.95	16.21	16.32	17.86	18.00	9.31	9.42	17.89	18.07
Harbour seal	0.0003	#	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		%	0.23	0.24	0.48	0.48	0.53	0.53	0.28	0.28	0.53	0.54

Table 11.28: Predicted impact of disturbance to marine mammals from pile driving using level B harassment threshold; # = number of animals disturbed; % = the percentage of the reference population. For Further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Impact	Piling location									
			NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
Bottlenose dolphin	0.0201	#	20	20	46	47	53	53	24	25	52	53
		%	6.77	6.78	15.78	15.89	17.95	18.11	8.30	8.42	17.76	17.97
	0.2352	#	229	233	541	545	616	621	285	289	609	616
		%	78.03	79.39	184.63	185.99	210.07	211.92	97.13	98.50	207.83	210.24
	Grid-cell specific	#	23	23	64	64	72	72	35	35	73	75
		%	7.97	7.97	21.93	21.93	24.72	24.72	12.08	12.08	24.76	25.54
Risso's dolphin	0.031	#	30	31	71	72	81	82	38	38	80	81
		%	0.25	0.25	0.58	0.59	0.66	0.67	0.31	0.31	0.65	0.66
Common dolphin	0.0272	#	26	27	63	63	71	72	33	33	70	71
		%	0.03	0.03	0.06	0.06	0.07	0.07	0.03	0.03	0.07	0.07
	Grid-cell specific	#	38	38	115	115	143	143	59	59	140	144
		%	0.04	0.04	0.11	0.11	0.14	0.14	0.06	0.06	0.14	0.14
Minke whale	0.045	#	44	45	104	104	118	119	54	55	117	118
		%	0.22	0.22	0.51	0.51	0.59	0.59	0.27	0.27	0.58	0.59
	0.017	#	17	17	39	39	44	45	21	21	44	45
		%	0.08	0.08	0.19	0.20	0.22	0.22	0.10	0.10	0.22	0.22
	Grid-cell specific	#	12	12	31	31	32	32	18	18	33	34

Species	Density (animals/km²)	Impact	Piling location									
			NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
		%	0.06	0.06	0.15	0.15	0.16	0.16	0.09	0.09	0.16	0.17

HARBOUR PORPOISE

11.9.1.59 Using the site-specific density estimate of 0.38 animals/km^2 from the DAS, it was estimated that a maximum of 3,380 animals (5.41% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). This is considered to be highly conservative because it assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea of which the noise contours extend across. As a result, alternative estimates have also been presented.

11.9.1.60 Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 2,493 animals (3.99% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). While this is considered to be a more realistic estimate of density across the wider disturbance area compared to the estimated density from the site-specific DAS, it assumes a uniform density of animals across the Irish Sea which is not realistic.

11.9.1.61 In order to account for the non-uniform density of harbour porpoise across the Irish Sea, the number of animals disturbed was also presented using the modelled density surfaces derived from SCANS-III. Using this approach, it was estimated that a maximum of 1,846 animals (2.95% of the reference population) will experience behavioural disturbance as a result of pile driving at the S-OSP location (Table 11.27).

11.9.1.62 At its furthest point from the source, the 120 SELss dB re 1μPa^2$_s$ disturbance contour reaches the Welsh coastline, extending northwards to approximately 4 km from the Isle of Man, and southwards to approximately 25 km to the coast of north Cornwall (Figure 11.3). This suggests that behavioural response from harbour porpoise may not be localised and could extend across the Irish Sea, although extremely low numbers (33 animals from pile driving of the 11 m monopile at the SW WTG location) of harbour porpoise are expected to respond at this received level (Table 11.27).

11.9.1.63 The impact on harbour porpoises is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoises.

BOTTLENOSE DOLPHIN

11.9.1.64 Using the uniform density estimate of 0.0201 animals/km^2 from the ObSERVE surveys, it was estimated that a maximum of 179 animals (61.01% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). This is considered to be conservative because it assumes that the density within stratum 5 (western Irish Sea) is the same across the wider extent of the Irish Sea of which the noise contours extend across.

11.9.1.65 Using the uniform density estimate of 0.2352 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 2,092 animals (713.96% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). This is not considered to be realistic as it assumes a uniform density and does not capture the variability in coastal and offshore population densities and distributions within the Irish Sea.

11.9.1.66 In order to account for the non-uniform density of bottlenose dolphin across the Irish Sea, modelled density surfaces derived from SCANS-III were also used to calculate the number of animals disturbed. Using this approach, it was estimated that a maximum of 187 animals (63.79% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP (Table 11.27). Both of these approaches are over-predicting the number of animals available in the area that could be disturbed by pile driving as the number of animals calculated exceeds the reference population size of 293. Therefore, these calculations are not considered to be robust.

11.9.1.67 The noise contours extend to cover the majority of the Irish Sea MU (Figure 11.4), which is used as the reference population for bottlenose dolphin (Table 11.7). Therefore, it is anticipated that the majority of the reference population of 293 dolphins will be within the disturbance contours.

11.9.1.68 However, the number and proportion of bottlenose dolphin disturbed during pile driving was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b), as there is no corresponding species-specific data available for bottlenose dolphin. However, studies suggest that bottlenose dolphins are typically less sensitive to behavioural disturbance than harbour porpoise (e.g. Culloch *et al.*, 2016; Kastelein *et al.*, 2006; Stone *et al.*, 2017). Therefore, it is expected that the probability of response to underwater noise from pile driving would be lower. To demonstrate this, the number and proportion of bottlenose dolphin disturbed during pile diving have also been calculated using the Level B harassment threshold and presented in Table 11.28. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, for example, a maximum of 621 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location and using the uniform density estimate of 0.2352 animals/km^2 from the wider SCANS-IV surveys (Table 11.28) compared to 2,092 animals estimated using the dose-response curve (Table 11.27). This suggests that the dose response method results in a very conservative calculation of the number and proportion of bottlenose dolphins disturbed.

11.9.1.69 Furthermore, the reference population does not take into account the connectivity of the reference population with other areas. Studies have shown large scale movement of bottlenose dolphins around Ireland and indicated connectivity with the population on the west coast of the RoI (O'Brien *et al.*, 2009). Long distance movements from the Atlantic to the North Sea between populations in the UK and Ireland have also been reported by Robinson *et al.* (2012). Therefore, the size of the reference population used from the Irish Sea MU is likely to be an under-representation of the number of bottlenose dolphins that may be present in the MU Study Area. Equally, the most recent abundance estimates from the semi-resident population at Cardigan Bay in West Wales (which is within the Irish Sea MU) alone were 147 individuals (95% CI: 127 to 194; NRW, 2018). The design of broad scale surveys, such as SCANS, used to derive MU population estimates are not able to capture localised, coastal populations such as that of Cardigan Bay, providing further evidence to suggest that the reference population size has been under-estimated.

11.9.1.70 Furthermore, it is important to highlight the significant difference between the SCANS-III and SCANS-IV abundance estimates of bottlenose dolphins in the Irish Sea. The SCANS-IV abundance estimate for the Irish Sea (blocks CS-D and CS-E) is 8,326 animals (Gilles *et al.,* 2023) whereas the MU population is derived from the lower SCANS-III abundance estimates, resulting in a population size of 293 (IAMMWG, 2023). As a result, the number of animals predicted to be disturbed using the density estimate from SCANS-IV is not compatible with the MU population size, resulting in a highly unrealistic proportion of the MU population estimated as impacted given that the population size is under-estimated. If the population size is taken to be 8,326 animals, the percentage of the population predicted to be disturbed reduces to 25.13%, when assuming 2,092 animals are disturbed using the dose-response curve, and 7.46% when using the Level B harassment threshold.

11.9.1.71 The impact on bottlenose dolphins is considered to result in a temporary change to most individuals, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is unlikely to have long-term consequences that would affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for bottlenose dolphins.

RISSO'S DOLPHIN

11.9.1.72 Using the uniform density estimate of 0.031 animals/km^2 from the wider SCANS-III surveys as the most conservative density estimate available, it was estimated that a maximum of 276 animals (2.25% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). While it is it unrealistic to assume a uniform density of animals across the Irish Sea, modelled density surfaces could not be derived for Risso's dolphin due to insufficient data (Lacey *et al.*, 2022).

11.9.1.73 Limited information on the response of Risso's dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of Risso's dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b) and is therefore likely to be an over-estimate (section 11.9.1). Due to the lack of species-specific data to apply to the dose-response curve for Risso's dolphin, the number and proportion of Risso's dolphin disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.28. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 82 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.28) compared to 276 animals estimated using the dose-response curve (Table 11.27). This suggests that the dose response method results in a very conservative calculation of the number and proportion of Risso's dolphins disturbed.

11.9.1.74 The impact on Risso's dolphins is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for Risso's dolphins.

COMMON DOLPHIN

11.9.1.75 Using the uniform density estimate of 0.0272 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 242 animals (0.24% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27).

11.9.1.76 Using the modelled density surfaces derived from SCANS-III, it was estimated that a maximum of 429 animals (0.42% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27).

11.9.1.77 Limited information on the response of common dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of common dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b) and is therefore likely to be an over-estimate (section 11.9.1). Due to the lack of species-specific data to apply to the dose-response curve for common dolphin, the number and proportion of common dolphin disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.28. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 144 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the S-OSP location (Table 11.28) compared to 429 animals estimated using the dose-response curve (Table 11.27). This suggests that the dose response method results in a very conservative calculation of the number and proportion of common dolphins disturbed.

11.9.1.78 The impact on common dolphins is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for common dolphins.

MINKE WHALE

11.9.1.79 Using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys, it was estimated that a maximum of 400 animals (1.99% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location.

11.9.1.80 Using the wider SCANS-III density estimate of 0.017 animals/km^2, it was estimated that a maximum of 151 animals (0.75% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). Using the modelled density surfaces derived from SCANS-III, it was estimated that a maximum of 108 animals (0.54% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP location (Table 11.27).

11.9.1.81 Limited information on the response of minke whale to behavioural disturbance to pile driving is available. Therefore, the number and proportion of minke whale disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b) and is therefore likely to be an over-estimate (section 11.9.1). Due to the lack of species-specific data to apply to the dose-response curve for minke whale, the number and proportion of minke whale disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.28. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 119 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.28) compared to 400 animals estimated using the dose-response curve (Table 11.27). This suggests that the dose response method results in a very conservative calculation of the number and proportion of minke whales disturbed.

11.9.1.82 It is also important to note that minke whales are expected to be mostly if not entirely absent in autumn and winter, and therefore any pile driving that occurs within these months is expected to have negligible impact on minke whales.

11.9.1.83 The impact on minke whale is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory and is only applicable to spring and summer months due to the seasonal presence of minke whales. Therefore, the magnitude of impact is assessed as Low adverse for minke whale.

GREY SEAL

11.9.1.84 Using the averaged grid-cell specific densities derived from Carter *et al.* (2020), it was estimated that a maximum of 300 animals (18.07% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP location (Table 11.27).

11.9.1.85 The impact on grey seal is considered to result in a small to medium proportion of the population affected with change expected to be recoverable, occur frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low to Medium adverse for grey seal.

HARBOUR SEAL

11.9.1.86 Using the averaged grid-cell specific densities derived from Carter *et al.* (2020), it was estimated that <1 animal (0.54% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP location (Table 11.27).

11.9.1.87 The impact on harbour seal is considered to result in a very small number and proportion of the population affected with change expected to be recoverable, occur frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour seal.

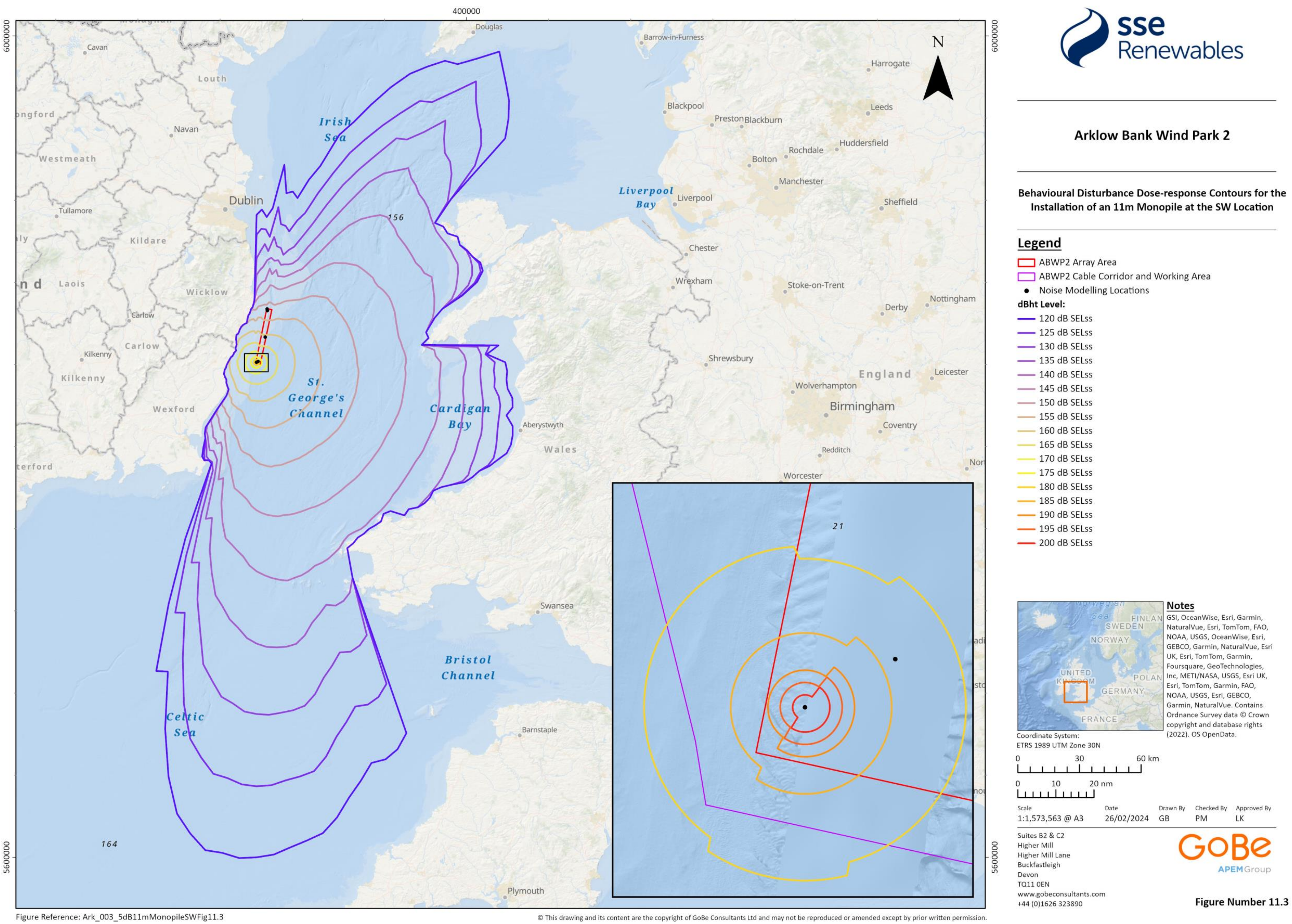

Figure 11.3: Behavioural Disturbance Dose Response Contours for the installation of an 11 m Monopile at the SW WTG Location

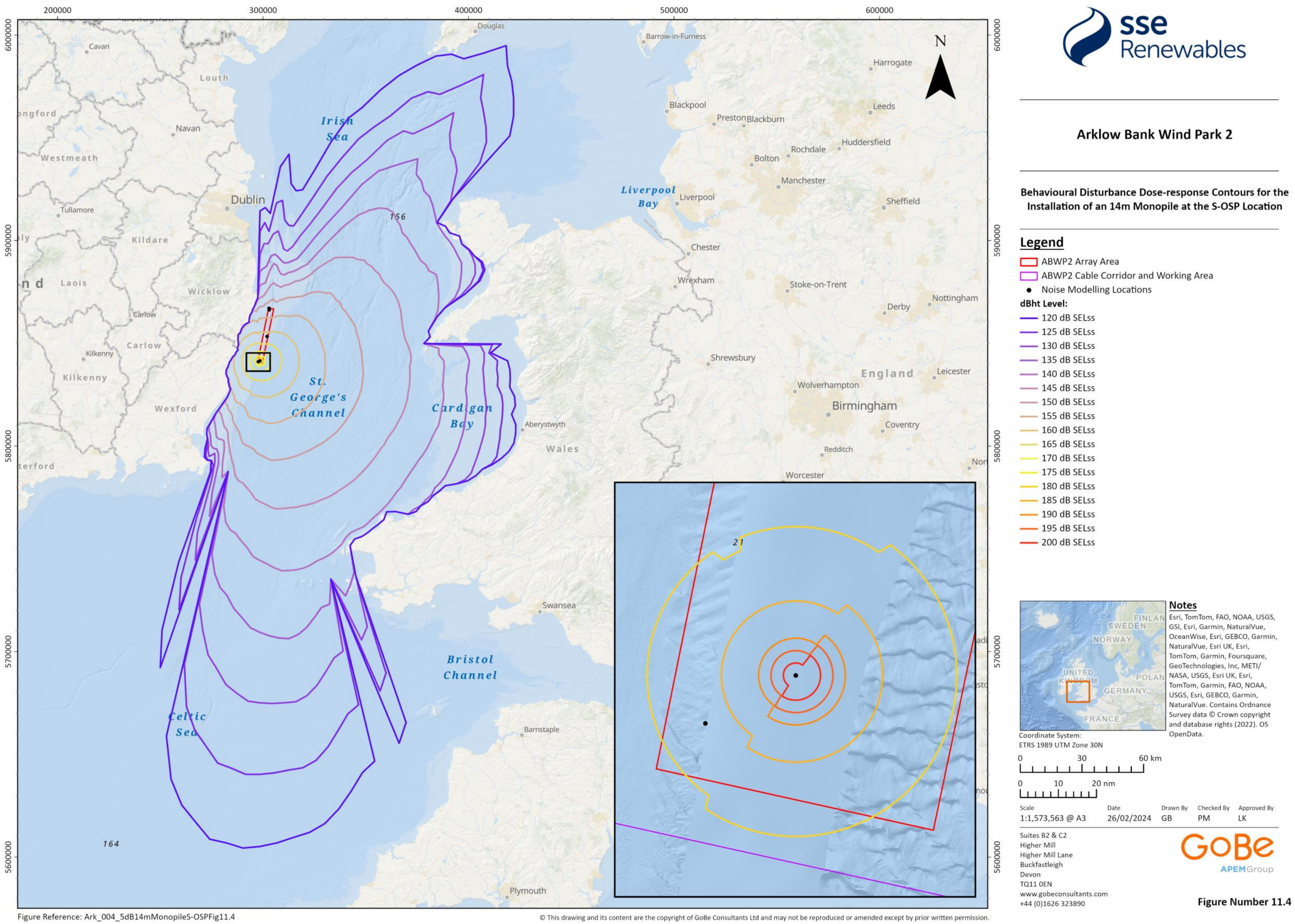

Figure 11.4: Behavioural Disturbance Dose Response Contours for the installation of an 14 m Monopile at the S-OSP Location

SIGNIFICANCE OF EFFECT

AUDITORY INJURY - PTS

11.9.1.88 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during pile driving **is Slight adverse**, which is **not significant** in EIA terms.

11.9.1.89 For bottlenose dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to bottlenose dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.9.1.90 For Risso's dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to Risso's dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.9.1.91 For common dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to common dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.9.1.92 For minke whale, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to minke whale from underwater noise during pile driving **is Slight adverse**, which is **not significant** in EIA terms.

11.9.1.93 For grey and harbour seal, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to grey and harbour seal from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.1.94 For harbour porpoise, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to harbour porpoise from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.9.1.95 For bottlenose dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Medium adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to bottlenose dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.9.1.96 For Risso's dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to Risso's dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.9.1.97 For common dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to common dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.9.1.98 For minke whale, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to minke whale from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.9.1.99 For grey seal, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low to Medium adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from disturbance to grey seal from underwater noise during pile driving is **Imperceptible**, which is **not significant** in EIA terms.

11.9.1.100 For harbour seal, magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to grey seal from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.1.101 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during pile driving is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.1.102 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, the Developer has committed to a piling MMMP (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan.) to further reduce the risk of PTS-onset, which also applies to both harbour and grey seals (which are not EPS).

11.9.2 Impact 2 – Injury and/or disturbance to marine mammals from vessel activities

11.9.2.1 Increased vessel movement during the construction, operational and maintenance, and decommissioning phases of the Proposed Development has the potential to result in a range of impacts on marine mammal receptors. These include injury or death due to collision with vessels, avoidance behaviour or displacement, and masking of vocalisations or changes in vocalisation rate.

11.9.2.2 The area surrounding the Proposed Development experiences a relatively low level of vessel traffic due to the presence of the shallow Arklow Bank sandbank, with higher traffic in the coastal areas and immediate surrounding waters (see Volume II, Chapter 15: Shipping and Navigation).

11.9.2.3 The shipping and navigation baseline study (Volume III, Appendix 15.1: Navigational Risk Assessment) recorded 29 days of vessel traffic data between 7th July and 14th August 2023. There was an average of 36 to 37 unique vessels per day recorded within the shipping and navigation Study Area (which is defined as Array Area and a 10 nm buffer).The busiest day recorded 59 unique vessels within the shipping and navigation Study Area. The main vessel types within the shipping and navigation Study Area were cargo vessels (40%), recreational vessels (31%) and fishing vessels (10%).

SENSITIVTY OF THE RECEPTOR

INJURY FROM VESSEL ACTIVITIES: COLLISION RISK

11.9.2.4 During construction of the windfarm, a potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship. In general, three consequences of vessel collision are defined: direct (injuries to the animals that are the immediate result of collision), long-term (a decrease in the fitness of the animal over time), and population consequences (Schoeman *et al.*, 2020). With regards to injuries, both fatal and non-fatal injuries between marine mammals and vessels have been documented (Laist *et al.*, 2001; Vanderlaan *et al.*, 2008; Cates *et al.*, 2017). Fatal collisions have been evidenced via carcasses washing up on beaches (Laist *et al.*, 2001; Peltier *et al.*, 2019); carcasses caught on vessel bows (Laist *et al.*, 2001; Peltier *et al.*, 2019); and floating carcasses which have strong evidence of ship strike, such as propeller cuts, significant bruising, oedema, internal bleeding radiating from a specific impact site, fractures and ship paint marks (Jensen and Silber, 2003; Douglas *et al.*, 2008). Fatalities from ship strikes, however, often go unreported (Authier *et al.*, 2014). For non-fatal injuries, evidence of animals which have survived ship strikes with non-fatal injuries from propellers has been widely documented (Wells *et al.*, 2008; Luksenburg, 2014).

11.9.2.5 Although many species of marine mammals are able to detect and avoid vessels, it is unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al.*, 2020), although it has been suggested that behaviours such as resting, foraging, nursing, and socialising could distract animals from detecting the risk posed by vessels (Dukas, 2002). It is also possible that animals do not hear vessels when they are near the surface. Collisions between cetaceans and vessels, however, are not necessarily lethal on all occasions (Wells *et al.*, 2008; Luksenburg, 2014).

11.9.2.6 Harbour porpoises, dolphins, and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. For example, several studies have shown that harbour porpoise typically avoid vessels (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018; Heinänen and Skov, 2015).

11.9.2.7 The risk of collision between marine mammals and vessels is directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al.*, 2001), and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in. There is currently a lack of information on the frequency of occurrence of vessel collisions with marine mammals in Irish waters, and there is little evidence from marine mammals stranded in the Irish Sea to suggest that injury from vessel collisions is a significant cause of marine mammal mortality. In the UK, the Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. According to the most recent CSIP report, post-mortems were conducted on 69 out of the 532 reported harbour porpoise strandings in 2018. A cause of death was established in 60 examined individuals and, of these, one individual died from physical trauma due to vessel strike and two individuals had died from physical trauma of an unknown cause, which could have been due to vessel strike (CSIP, 2019). For bottlenose dolphin, post-mortems were conducted on one out of the nine reported strandings in 2018; the cause of death was not associated with vessel collision (CSIP, 2019). For Risso's dolphin, post-mortems were conducted on two out of the 15 reported strandings in 2018; the cause of death was not associated with vessel collision (CSIP, 2019). For common dolphin, post-mortems were conducted on 45 out of the 191 reported strandings in 2018 and a cause of death was established for 43 individuals. Of these, two individuals had died from physical trauma of an unknown cause, which could have been due to vessel strike (CSIP, 2019). For minke whale, post-mortems were conducted on three out of the 28 reported strandings in 2018. Of these, one individual had died due to vessel strike (CSIP, 2019). Overall, the CSIP data shows that very few strandings have been attributed to vessel collisions, therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a significant cause of mortality in RoI and UK waters.

11.9.2.8 Collision risk for seals is less understood than for cetaceans, however trauma ascribed to collisions with vessels has been identified in a small proportion of both live stranded (Goldstein *et al.*, 1999) and dead stranded seals in the US (Swails, 2005). In these cases, however, less than 2% of all dead necropsied seals had vessel collision attributed to cause of death. A study in the Moray Firth showed that seals use the same areas as vessels during trips between haul-outs and foraging sites but that seals tended to remain beyond 20 m from vessels (only three instances over 2,241 days of seal activity resulted in passes at less than 20 m) (Onoufriou *et al.*, 2016), suggesting that the possibility of a risk of collision is very low.

11.9.2.9 Overall, these studies suggest that there is a high likelihood that marine mammals will avoid vessels and therefore, collision, suggesting a low vulnerability. It is important to note that not all collisions that do occur are lethal, and there is a potential for recovery from injury. Furthermore, vessel collision is not considered to be a significant cause of marine mammal mortality (CSIP, 2019), but does have the potential to kill animals. As a result, all marine mammal species within this assessment are considered to be of reasonable adaptability, limited to no tolerance, have medium-term to no recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a High sensitivity to injury from vessel activities.

DISTURBANCE FROM VESSEL ACTIVITIES

HARBOUR PORPOISE

11.9.2.10 Harbour porpoises are particularly sensitive to high frequency noise and it is well documented that they typically avoid vessels (e.g. Culloch *et al.*, 2016; Benhemma-Le Gall *et al.*, 2021). During the construction of Beatrice and Moray East offshore windfarms in the Moray Firth, harbour porpoise occurrence decreased with increasing vessel presence, with the magnitude of decrease depending on the distance to the vessel (Benhemma-Le Gall *et al.*, 2021). As such, the probability of harbour porpoise occurrence at a mean vessel distance of 2 km decreased by up to 95% to 0.02 for the highest vessel intensity (Benhemma-Le Gall *et al.*, 2021). At a mean vessel distance of 3 km, the probability decreased by up to 57% to 0.16 for the highest vessel intensity, and no apparent response was observed at 4 km (Benhemma-Le Gall *et al.*, 2021).

11.9.2.11 Additional studies conducted during offshore windfarm construction demonstrated that harbour porpoise detections in the vicinity of the pile driving location decline prior to a piling event (Benhemma-Le Gall *et al.* 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). For example, during a study conducted at seven offshore windfarms in the German Bight, a decline in harbour porpoise detections was observed within 2 km of the construction site and continued to be reduced for one to two days after (Brandt *et al.*, 2018). This was attributed to the increased vessel activity and traffic associated with construction-related activities (Brandt *et al.*, 2018).

11.9.2.12 In a large-scale study of harbour porpoise density in UK waters, increased vessel activity was generally associated with lower harbour porpoise densities (Heinänen and Skov, 2015). Furthermore, Wisniewska *et al.*, (2018) collected telemetry data to study the change in foraging rates of harbour porpoise in response to vessel noise in highly trafficked coastal waters in the inner Danish waters and Belt seas. The results show that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 μPa (16 kHz third-octave) (Wisniewska *et al.*, 2018).

11.9.2.13 Land-based surveys were conducted to examine the surfacing behaviour of harbour porpoise in relation to vessel traffic in Swansea Bay (Oakley *et al.*, 2017). The study found a significant correlation between harbour porpoise sightings and the number of vessels present, with 26% of interactions observed considered to be negative (animals moving away or prolonged diving) when vessels were up to 1 km away (Oakley *et al.*, 2017). The proximity of the vessel was found to be an important factor, with the greatest response occurring at 200 m from the vessel (Oakley *et al.*, 2017). Smaller motorised vessels (jet ski, speed boat, small fishing vessels) were associated with more negative behaviours than large cargo ships, although larger ships were less common in the area (Oakley *et al.*, 2017).

11.9.2.14 Behavioural responses of harbour porpoises to vessel noise have also been observed in more controlled conditions. For example, behavioural responses of four harbour porpoise in a semi-natural net pen were observed during exposure to low levels of medium to high frequency vessel noise (Dyndo *et al.*, 2015). 'Porpoising' (a stereotypical disturbance behaviour) was observed during 27.5% of recordings of boat noise (Dyndo *et al.*, 2015).

11.9.2.15 These studies discussed above evidence some changes in harbour porpoise behaviour and presence as a result of disturbance from vessel activity. Behavioural responses include increased fluking, interrupted foraging, change to vocalisations, prolonged dives and directed movement away from the sound source (Oakley *et al.*, 2017; Wisniewska *et al.*, 2018). Several studies have also evidenced an increase in vessel presence correlates with a decrease in harbour porpoise presence (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). However, harbour porpoises occur widely throughout the Irish Sea (Berrow *et al.*, 2010; Rogan *et al.*, 2018a; Wall *et al.*, 2013) and therefore it is assumed (since they have a requirement to feed regularly) that there is suitable foraging habitat across their range. Therefore, relatively short-term localised disturbance within the vicinity of the Proposed Development is unlikely to lead to any population-level effects on harbour porpoise. As a result, harbour porpoises are considered to be of reasonable adaptability, limited tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

BOTTLENOSE DOLPHIN

11.9.2.16 Studies on the interactions of bottlenose dolphins with vessels have shown various responses. In the Moray Firth, a passive acoustic monitoring study showed that the presence of vessels resulted in a short-term reduction in foraging activity by 49%, with animals resuming foraging after the vessel had travelled through the area, suggesting that disturbance was limited to the time the vessel was physically present (Pirotta *et al.*, 2015). As a result, the study concluded that the physical presence of vessels plays a larger role in disturbance, as vessel noise was not taken into consideration (Pirotta *et al.*, 2015).

11.9.2.17 In a modelling study by Lusseau *et al.* (2011), it was predicted that increased vessels movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphins, although it did note that foraging may be disrupted by disturbance from vessels. Mathematical modelling was also conducted by New *et al.* (2013) to simulate the complex interactions of the bottlenose dolphin population in the Moray Firth and determine whether an increased rate of disturbance from vessel traffic from proposed offshore developments was biologically significant. The study statistically modelled an increase in vessel traffic from 70 to 470 vessels per year and found that an increase in commercial vessel traffic alone will not result in a biologically significant increase in disturbance, because dolphins have the ability to compensate for their immediate behavioural response. Therefore, their health and vital rates were predicted to be unaffected (New *et al.*, 2013).

11.9.2.18 Bottlenose dolphins have also been observed tolerating vessel disturbance, particularly in areas where vessel traffic has always been high (Pirotta *et al.* 2013). Similarly, the presence of bottlenose dolphin was positively correlated with overall vessel number during the construction works of an oil pipeline in Broadhaven Bay, northwest Ireland (Anderwald *et al.*, 2013). However, it was unclear whether the bottlenose dolphins were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.*, 2013).

11.9.2.19 A study of Indo-Pacific bottlenose dolphin habitat occupancy along the coast of Western Australia found dolphin density to be negatively affected by vessels at one site, but no significant impact at the other (Marley *et al.*, 2017a). It is hypothesised that the quality of the habitat impacts the behavioural response to disturbance as the latter habitat is a known foraging area. Other studies along the coast of Western Australia have found that increased vessel presence was associated with significantly increased swim speeds for individuals when resting or socialising (Marley *et al.*, 2017b). Animals exposed to high levels of shipping traffic were also found to spend more time travelling and less time resting or socialising. The study also found that the whistle characteristics changed with increased broadband exposure, with the greatest variation occurring in the presence of low frequency noise (Marley *et al.*, 2017b). Other studies have reported similar findings, for example, common bottlenose dolphins in Galveston Ship Channel, US, found that the presence of vessels was associated with significantly less foraging and socialising activity (Piwetz, 2019). For this population, a significant increase in swimming speeds was observed during the presence of recreational and tourism vessels, and shrimp trawlers (Piwetz, 2019).

11.9.2.20 Bottlenose dolphins have also been known to exhibit different behavioural responses to different vessel types. A study conducted in New Zealand showed that bottlenose dolphin resting behaviour decreased as the number of dolphin-watching tour boats increased (Constantine *et al.*, 2004). In a study conducted in Italy, dolphins exhibited an avoidance response to motorboats, but changed their acoustic behaviour in response to trawler vessels, presumably to compensate for masking (La Manna *et al.*, 2013). This study also found that bottlenose dolphins would tolerate vessel presence within certain levels and were more likely to leave an area if disturbance was persistent (La Manna *et al.*, 2013). Therefore, the degree to which an individual is disturbed is likely linked to their baseline level of tolerance (Bejder *et al.*, 2009).

11.9.2.21 These studies show that vessel disturbance can result in a variety of responses in bottlenose dolphins including changes to foraging behaviour, swim speed, behavioural state, and acoustic behaviour, and can cause avoidance responses (Constantine *et al.*, 2004; La Manna *et al.*, 2013; Marley *et al.*, 2017a; Marley *et al.*, 2017b; Pirotta *et al.*, 2015). However, where behavioural changes in bottlenose dolphins occur, predictive modelling of high levels of vessel disturbance has concluded that this is not biologically significant to a small population of bottlenose dolphins in the Moray Firth (New *et al.*, 2013). As a result, bottlenose dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

RISSO'S DOLPHIN

11.9.2.22 Limited information is available on the behavioural responses of Risso's dolphins to vessel disturbance. However, several studies have shown that vessel traffic can affect the behaviour, activity, energy budgets, habitat use, and reproductive success of dolphin species (Bejder *et al.*, 2006; Lusseau, 2003; 2004). A study on the behavioural responses of Risso's dolphins to vessel traffic in Pico, Azores suggested a disruption of resting behaviour by cetacean watching vessels (Oudejans *et al.*, 2007; Visser *et al.*, 2006). In the Ionian Sea, a study on the impacts of cetacean watching vessels on behavioural activities of Risso's dolphins observed a neutral response to the presence of the vessel during 81.3% of sightings (Bellomo *et al.*, 2021).

11.9.2.23 As limited information exists on the behavioural response of Risso's dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on Risso's dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction and O&M vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, Risso's dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, Risso's dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

COMMON DOLPHIN

11.9.2.24 Limited information is available on the behavioural responses of common dolphins to vessel disturbance. Marine mammal monitoring in Broadhaven Bay, northwest Ireland showed that an increase in vessel numbers resulted in a reduction in common dolphin presence (Culloch *et al.*, 2016).

11.9.2.25 Studies on disturbance effects from cetacean watching vessels reports that common dolphins spent significantly less time foraging when interacting vessels were present (Meissner *et al.*, 2015). Once disrupted, dolphins took at least twice as long to return to foraging when compared to control conditions (vessels >300 m away from dolphins) (Meissner *et al.*, 2015). The study also found that the probability of common dolphins starting to forage while engaged in travelling in the presence of cetacean watching vessels decreased by two thirds (Meissner *et al.*, 2015). Common dolphin foraging tactics include cooperative herding of prey (Neumann and Orams, 2003), therefore it is possible that the behavioural changes of some individuals within a group, as a result of approaching vessels, could compromise the success of the overall foraging event (Meissner *et al.*, 2015).

11.9.2.26 As limited information exists on the behavioural response of common dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on common dolphin behaviour have also been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction, O&M, and decommissioning vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, common dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

MINKE WHALE

11.9.2.27 Limited information is available on the behavioural responses of minke whales to vessel disturbance. A study into the response of minke whales to construction-related vessel traffic in Broadhaven Bay, northwest Ireland found a significant negative correlation between the presence of minke whale and both the number of overall vessels and the number of utility vessels (those emitting lower frequency noise but moving around more than construction vessels), suggesting that minke whale were displaced from the area, most likely due to vessel presence and/or disturbance (Anderwald *et al.*, 2013).

11.9.2.28 A study by Christiansen *et al.* (2013) showed that minke whales change their diving patterns and behaviour in response to disturbance from whale watching vessels. Analysis of respiration rates found that energy expenditure of minke whales was 28% higher during vessel interactions (regardless of swim speed) and swim speed was found to increase with vessel presence (Christiansen *et al.*, 2013). These combined physiological and behavioural changes are considered to represent a stress response. The study also suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success (Christiansen *et al.*, 2013). It is important to note that noise levels were not measured in this study, therefore behavioural responses are considered to be related to vessel presence.

11.9.2.29 Christiansen *et al.* (2015) considered the spatial and temporal rates of minke whale exposure of the entire whale watching season and found no potential for a population-level effect as a result of disturbance.

11.9.2.30 The bioenergetic effects of disturbance from whale watching vessels on foetal growth were examined by Christiansen and Lusseau (2015) using a mechanistic model and found that the presence of whale watching vessels resulted in an immediate reduction in net energy intake by 63.5%. However, the impact of disturbance was negligible because it was considered below the threshold value for which whale watching vessels would have a significant impact on foetal growth, as the number of interactions with vessels was low during the foraging season (Christiansen and Lusseau, 2015).

11.9.2.31 It is expected that minke whales are more sensitive to low frequency sounds (Nowacek *et al.*, 2007) such as those produced by slow moving vessels, although limited information exists on the behavioural response of minke whales to construction-related vessels. Studies on the impact of whale watching vessels on minke whale behaviour have therefore been presented as a proxy to inform this assessment, although it is important to note that disturbance effects from whale watching vessels are direct, whilst those from construction and O&M vessels would be indirect. As a result, minke whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whale are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

GREY SEAL

11.9.2.32 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to grey seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Terhune and Almon, 1983; Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for grey seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.9.2.33 Britton (2012) recorded a significant correlation between boat speed and the distance at which hauled-out grey seals on the Isle of Man showed alert behaviour. A similar association was also observed between boat speed and movement and flushing response (entering the water) although this was not tested. The duration of the boat interaction was, however, found to be important, with flushing occurring in all vessel interactions lasting four minutes or longer (Britton, 2012).

11.9.2.34 A study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (using the Southall *et al.* (2019) thresholds (Trigg *et al.*, 2020).A study of vessel traffic and marine mammal presence at Broadhaven Bay, northwest Ireland found grey seals sightings decreased with increased vessel activity in the surrounding area, though the effect size was small, and the relationships between sightings and vessel numbers were weaker than those with environmental variables such as sea state (Anderwald *et al.*, 2013).

11.9.2.35 Grey seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

HARBOUR SEAL

11.9.2.36 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to harbour seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for harbour seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.9.2.37 Avoidance behaviour or alert reactions have been reported in harbour seal when vessels approach within 100 m of a haul-out (Richardson *et al.*, 1995). A study in which 37 harbour seals were telemetry tagged on the east coast of Scotland did not show any apparent response of seals at sea to close passing vessels (they neither moved towards nor away from them) (Onoufriou *et al.*, 2016).

11.9.2.38 Another telemetry study that included the tagging of 28 harbour seals in the UK found high exposure levels of harbour seals to shipping noise, and as a result 20 individuals may have experienced a TTS due to cumulative SELs exceeded the TTS-threshold for pinnipeds exposed to continuous underwater noise (183dB re 1 $\mu Pa^2{}_s$) (Jones *et al.*, 2017). The overlap between seals and vessel activity most frequently occurred within 50 km of the coast and in proximity to seal haul-outs. The study concluded that there was no evidence of reduced harbour seal presence as a result of vessel traffic, despite the spatial overlap and cumulative SELs (Jones *et al.*, 2017).

11.9.2.39 Harbour seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

Construction phase

MAGNITUDE OF IMPACT

11.9.2.40 During the construction phase, a maximum of 66 installation vessels will be present within the Array Area at any one time, resulting in a maximum of 4,150 vessel return trips over the five-year construction period, and a maximum of 1,797 vessel return trips per year (Table 11.9). Vessels that will be used during the construction phase include jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels, and other support vessels (Table 11.9).

INJURY FROM VESSEL ACTIVITIES

11.9.2.41 Vessel traffic associated with the Proposed Development has the potential to lead to an increase in vessel movements within the Marine Mammal Study Area. This increase in vessel movement could lead to an increase in interactions between marine mammals and vessels during offshore construction. Whilst a broad range of vessel types have been involved in collisions with marine mammals (Laist *et al.*, 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger strike impact (Schoeman *et al.*, 2020). For example, a study by Laist *et al.* (2001) found that in 89% of collisions in which the whale was killed or seriously injured vessels were travelling at speeds of 14 kn (7 m/s) or more, and the vessel exceeded a length of 80 m. Therefore, larger vessels travelling at 7 m/s or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al.*, 2001). The majority of vessels used during the construction phase are likely to be large vessels that will either be travelling considerably slower than 7 m/s or will be stationary for significant periods of time. Therefore, the actual increase in vessel traffic moving within the Proposed Development and to/from port will occur over short periods of the offshore construction activity. Smaller vessels involved in construction activities (i.e. tug/anchor handlers, guard vessels, survey vessels, and crew transfer vessels) are able to move to avoid marine mammals (when detected), even when an animal is close and the vessel is going at high speed, due to better manoeuvrability compared to larger vessels (Schoeman *et al.*, 2020). In contrast, large vessels, such as jack-up vessels, have low manoeuvrability and may require larger distances to avoid an animal, but travel at slower speeds. In addition, the Factored In Measures (see Table 11.15) which include an Environmental VMP, will advise that vessel traffic will move along predictable routes, which is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.*, 2001; Lusseau 2003; 2006). The Environmental VMP will also provide best practice guidance to minimise interactions with marine mammals and define how vessels should behave in the presence of them.

11.9.2.42 It is also likely that the noise emissions from vessels involved in the construction phase will be detectable by marine mammals and therefore will deter animals from the areas of potential impact. Whilst construction of the Proposed Development will lead to an uplift in vessel activity, vessel movements will be largely restricted to within the Array Area or along the Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Due to the volume of vessel traffic around the Marine Mammal Study Area already, the introduction of additional vessels during the construction phase of the Proposed Development will not be a novel impact for marine mammals present in the area. Therefore, it is not expected that vessel activities during the construction phase would increase the risk of injury due to vessel collision.

11.9.2.43 The impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the construction phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.44 Disturbance to marine mammals by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (Pirotta *et al.*, 2015). It is not simple to disentangle these drivers, therefore, disturbance from vessels is assessed within this chapter in general terms, covering disturbance driven by both vessel presence and underwater noise.

11.9.2.45 Noise levels from construction vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, and various rotating machinery (e.g., power generation, pumps) in the vicinity of the Proposed Development. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed and ambient noise levels (Wilson *et al.*, 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the construction of the Proposed Development exceeds the background ambient noise level.

11.9.2.46 Vessel noise levels are typically in the range of 10 to 100 Hz (Erbe *et al.*, 2019) with an estimated source level of 168 SEL_{cum} dB re 1 µPa @ 1 m (Root Mean Square (RMS)) for large construction vessels and 161 SEL_{cum} dB re 1 µPa @ 1 m (RMS) for medium construction vessels, travelling at a speed of 10 knots (see Volume III, Appendix 11.1: Underwater Noise Assessment). In general, support and supply vessels (50-100 m) are expected to have broadband source levels in the range 165-180 dB re 1µPa, with the majority of energy below 1 kHz (OSPAR, 2009). Large commercial vessels (>100 m) produce relatively loud and predominately low frequency sounds, with the strongest energy concentrated below several hundred Hz (OSPAR, 2009).

11.9.2.47 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.9.2.48 Thomsen *et al.* (2006) estimated that harbour porpoises will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. In addition, a study on the impacts of construction-related activities at Beatrice and Moray East offshore windfarms showed that harbour porpoises are displaced by offshore windfarm construction vessels (Benhemma-Le Gall *et al.*, 2021). Types of construction-related vessels that were assessed in this study included offshore service vessels for pile driving and jacket/turbine installation, guard vessels, crew-transfer vessels, and port service craft (Benhemma-Le Gall *et al.*, 2021). The median construction-related vessel density across the Moray Firth during the study period was 1.4 vessels/km^2. PAM data recorded at the site showed that the hourly occurrence of porpoise detections declined within 2 km of construction vessels, but that no response was observed out to 4 km, suggesting that responses declined within increasing distance to vessels (Benhemma-Le Gall *et al.*, 2021).

11.9.2.49 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation and Volume III, Appendix 15.1: Navigational Risk Assessment).

11.9.2.50 Throughout the construction of the Proposed Development, the Environmental VMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals.

11.9.2.51 For seals, Jones *et al.* (2017) analysed the predicted co-occurrence of ships and seals at sea which demonstrated that there is a large degree of predicted co-occurrence UK-wide, particularly within 50 km of the coast close to seal haul-outs. However, there is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and seals. In areas where seal populations are showing high levels of growth, such as southeast England, ship co-occurrences are highest (Jones *et al.*, 2017).

11.9.2.52 Although co-occurrence of vessels and seals is well documented through telemetry studies (e.g. Jones *et al.*, 2017), Thomsen *et al.* (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. Where seals may respond, it is expected that any impact on behaviour would be short-term and localised and would return to baseline once the vessel disturbance has ended.

11.9.2.53 The proposed implementation of an Environmental VMP (Table 11.15) will reduce the risk of vessel disturbance by providing guidance regarding the speed and movement of vessels, resulting in slower moving vessels travelling more predictable routes which are less likely to cause disturbance. This is supported by vessel simulation modelling by Findlay *et al.* (2023) which predicted that, when animals were exposed to vessels at a given distance with both a 20% and a 50% reduction in speed, all potential noise impacts were reduced. At a 20% reduction in speed, the vessel noise swath halved, reducing the average number of animals exposed by 50% and therefore reducing the number of animals that are likely to be disturbed (Findlay *et al.*, 2023). In addition, the study demonstrated that moderate slowdowns strongly reduce vessel source levels, with a 20% reduction in speed decreasing mean source levels by 6 dB and a 50% speed reduction by 18 dB (Findlay *et al.*, 2023).

11.9.2.54 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.9.2.55 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.56 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.2.57 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.9.2.58 During the operational and maintenance phase, a maximum of 30 vessels will be present within the Array Area at any one time, resulting in a maximum of 1,359 vessel return trips per year (Table 11.9). Vessels that will be used during the operational and maintenance phase include crew transfer vessels, jack-up vessels, cable repair vessels (Table 11.9).

INJURY FROM VESSEL ACTIVITIES

11.9.2.59 Baseline information on vessel traffic during the operational and maintenance phase is outlined in paragraph 11.9.2.58 and Table 11.9. The operational and maintenance phase may last for up to 36.5 years.

11.9.2.60 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the operational and maintenance phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the operational and maintenance phase would increase the risk of injury due to vessel collision.

11.9.2.61 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.9.2.41 and Table 11.15, the implementation of the Factored In Measures, including an Environmental VMP, will advise that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout O&M activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.9.2.62 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality, as highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.9.2.63 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the operational and maintenance phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.64 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity during the operational and maintenance phase is not considered a novel impact for marine mammals present in the area.

11.9.2.65 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 ships/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation and Volume III, Appendix 15.1: Navigational Risk Assessment). Considering a maximum of 22 O&M vessels will be present within the Array Area at any one time, vessel traffic in the area around the Proposed Development is not likely to exceed the value presented by Heinänen and Skov (2015) even with the addition of vessels involved in the O&M phase.

11.9.2.66 As discussed in paragraph 11.9.2.41 and Table 11.15, the implementation of the Factored In Measures, including an Environmental VMP, advises that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals, which will minimise the magnitude of any impact. Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the operational and maintenance phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.9.2.67 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the operational and maintenance phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.68 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the operational and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the operational and maintenance phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.2.69 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.9.2.70 Vessel traffic during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase (Table 11.9).

INJURY FROM VESSEL ACTIVITIES

11.9.2.71 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the decommissioning phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the decommissioning phase would increase the risk of injury from collision.

11.9.2.72 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.9.2.41 and Table 11.15, the implementation of the Factored In Measures, including an Environmental VMP, will advise that vessels movements follow predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout decommissioning activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.9.2.73 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.9.2.74 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the decommissioning phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.75 The potential impacts during the decommissioning phase are anticipated to be similar to or less than the construction phase as the Rehabilitation Schedule confirms that no piling will be undertaken (Table 11.15).

11.9.2.76 As stated in paragraphs 11.9.2.2 and 11.9.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.9.2.77 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation and Volume III, Appendix 15.1: Navigational Risk Assessment).The Environmental VMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact.

11.9.2.78 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the decommissioning phase, the effect is reasonably expected to occur, have short-term and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.9.2.79 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.9.2.80 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.2.81 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.3 Impact 3 – Changes in fish and shellfish community affecting prey resources

11.9.3.1 Marine mammals are dependent on fish and shellfish species as prey resources, therefore there is potential for indirect effects on marine mammals to occur as a result of direct impacts on fish and shellfish and/or their supporting habitat.

11.9.3.2 The key prey species for marine mammals within this assessment are presented in Table 11.29.

Table 11.29: Key prey species for marine mammals, where region outlines where the study took place

Species	Key prey species	Region	Reference
Harbour porpoise	Whiting (*Merlangius merlangus*), herring (*Clupea harengus*), poor cod (*Trisopterus* spp)	Ireland	Hernandez-Milian *et al.* (2011)

Species	Key prey species	Region	Reference
Bottlenose dolphin	Whiting, blue whiting (*Micromesistius poutassou*), pollock (*Pollachius*), saithe (*Pollachius virens*), haddock (*Melanogrammus aeglefinus*), poor cod, European hake (*Merluccius merluccius*), horse mackerel (*Trachurus trachurus*), flatfish (*Pleuronectiformes*), pelagic squid (*Loligo spp.*), octopus (*Octopus spp.*).	Ireland	Hernandez-Milian *et al.* (2011; 2015)
Risso's dolphin	Octopus species, squid species, cuttlefish species (*Sepiida*), crustaceans (*Crustacea*), poor cod, haddock, whiting	Scotland	MacLeod *et al.* (2014)
Common dolphin	Poor cod, goby (*Caragobius urolepis*), blue whiting, whiting, cephalopods (*Cephalopoda*), Atlantic herring, European sprat (*Sprattus sprattus*), haddock	Ireland	Brophy *et al.* (2009)
Minke whale	Sandeel, herring, sprat, mackerel, poor cod, gobies	UK	Pierce *et al.* (2004); Whooley (2016); Robinson *et al.* (2023)
Grey seal	Poor cod, salmonids (*Salmonidae*), sandeel, dragonet (*Callionymidae*), whiting, bib (*Trisopterus luscus*), blue whiting, haddock, pollock, saithe, herring, rockling (*Ciliata Mustela* and *Gaidropsarus vulgaris*), Norway pout (*Trisopterus esmarkii*), mackerel, hake, eels (Anguilliformes), wrasse (*Labridae*), perch (*Perca fluviatili*), sole (*Solea*), halibut (*Hippoglossus hippoglossus*), dab (*Limanda limanda*), flatfish species, squid species, octopus species	Ireland	Gosch *et al.* (2014); Wilson and Hammond (2019)
Harbour seal	Sandeel, sole, poor cod, dragonet, whiting, rockling, Atlantic horse mackerel, crustaceans, squid species, octopus species	Ireland	Kavangah *et al.* (2010)

SENSITIVITY OF THE RECEPTOR

11.9.3.3 Impacts to prey resources will be largely restricted to the boundaries of the Proposed Development and, therefore, marine mammals occurring within this area also have the potential to be affected. However, the fish and shellfish species identified in Volume II: Chapter 10: Fish, Shellfish, and Sea Turtle Ecology are typical of those present within the western Irish Sea, and as marine mammals are highly mobile, it is reasonable to assume that they will be able to feed on sufficient, similar prey resource that is available in the wider area.

11.9.3.4 While there may be particular prey species that comprise a high proportion of their diet, all marine mammals within this assessment are considered as generalist feeders, therefore they can exploit a variety of prey resources and are not reliant on a single prey species (Table 11.29). As a result, all marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Low sensitivity to changes in fish and shellfish community affecting prey resources.

Construction phase

MAGNITUDE OF IMPACT

11.9.3.5 Potential impacts on fish and shellfish during the construction phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Injury and/or disturbance as a result of underwater noise and vibration during pile driving and cable installation activities; and
- Accidental pollution.

11.9.3.6 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology, which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the construction phase providing that Factored In Measures are implemented.

11.9.3.7 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the construction phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the construction phase.

SIGNIFICANCE OF EFFECT

11.9.3.8 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the construction phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.3.9 The significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.9.3.10 Potential impacts on fish and shellfish during the operational and maintenance phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Accidental pollution;
- Long-term habitat loss;
- Alteration of seabed habitats arising from changes in physical processes; and
- Changes in EMF from subsea electrical cabling.

11.9.3.11 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology, which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the operational and maintenance phase.

11.9.3.12 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur continuously throughout the operational and maintenance phase, have very short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the operational and maintenance phase.

SIGNIFICANCE OF EFFECT

11.9.3.13 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the operational and maintenance phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the operational and maintenance phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.3.14 The significance of effect from changes in fish and shellfish community affecting prey resources during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.9.3.15 Potential impacts on fish and shellfish during the decommissioning phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition; and
- Accidental pollution.

11.9.3.16 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology, which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the decommissioning phase.

11.9.3.17 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the decommissioning phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the decommissioning phase.

SIGNIFICANCE OF EFFECT

11.9.3.18 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.3.19 The significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.4 Impact 4 – Accidental pollution

11.9.4.1 There is the potential for an accidental release of pollutants to occur from vessels and equipment associated with the construction, operational and maintenance and decommissioning phases of the Proposed Development, which may result in adverse effects on marine mammals. Pollutants may include diesel fuel, bentonite (from drilling activities), lubricants, grease and oils, anti-fouling biocides, and grout.

SENSITIVITY OF THE RECEPTOR

11.9.4.2 In the event of an accidental spill, given the density and distribution of marine mammals in the Marine Mammal Study Area, it is possible that individuals could come into contact with contaminants.

11.9.4.3 Direct impacts include ingestion, inhalation, and absorption. All of which may result in physiological responses with health and long-term survival and/or reproduction consequences, the most serious of which could be damage to the respiratory system (Helm *et al.*, 2015).

11.9.4.4 Indirect impacts include short- and long-term reductions in food availability, disruption to social bonds, reduced reproduction, and/or cumulative effects on individuals, populations, and the ecosystem (Helm *et al.*, 2015).

11.9.4.5 Cetaceans are at risk from oil pollution in the marine environment because they lack the ability to leave the water to avoid oil. Cetaceans are however highly mobile and wide ranging, therefore any contact with a spill would be expected to be brief. They are also capable of detecting surface slicks, for example, experiments with captive bottlenose dolphins have shown that they can visually discriminate between oil and uncontaminated water and avoid oil on the surface of the water (Geraci and St. Aubin, 1984). Dolphins appear to rely on tactile clues to detect and avoid oil and it is unlikely that they would be unknowingly subjected to prolonged or repeated exposure to oil in the wild (Helm *et al.*, 2015).

11.9.4.6 Cetaceans must surface periodically to breathe, potentially bringing them into contact with floating oil and volatile toxic components. The more extensive the slick, the more likely that an animal will surface within it (Geraci and St. Aubin, 1980). While oil does not readily penetrate cetacean skin, exposure could affect mucus membranes, eyes, and other external soft tissue areas, potentially resulting in mortality (Helm *et al.*, 2015).

11.9.4.7 In the event of an accidental spill, prey species may also become oiled. Ingestion of oil through consumption of contaminated prey may cause damage to internal organs and have long-term consequences for individuals (Helm *et al.*, 2015).

11.9.4.8 Unlike cetaceans, seals are reliant on terrestrial haul-out sites for resting, moulting, and breeding which makes them particularly vulnerable to the effects of pollution. Information on key haul-outs for grey seals and harbour seals in the vicinity of the Proposed Development is presented in section 11.5.2. Seals have been shown to develop conjunctivitis, corneal abrasion, and swollen eyelid membranes in response to exposure to crude oil (Geraci and St. Aubin, 1980). While external oiling is not expected to significantly impact the ability of adult seals to maintain their core body temperature as they rely on blubber for insulation, seal pups entering the water could be vulnerable as oil residues can reduce the thermal properties of neonate animals, increasing their susceptibility to hypothermia (Helm *et al.*, 2015).

11.9.4.9 All marine mammal species within this assessment are considered to be of reasonable adaptability, reasonable tolerance, have medium recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Medium sensitivity to accidental pollution.

Construction phase

MAGNITUDE OF IMPACT

11.9.4.10 The installation of the offshore infrastructure for the Proposed Development may lead to the accidental release of pollutants through spills and leaks from vessels and equipment. The project design parameters for Project Design Option 1 during the construction phase are outlined in Table 11.9 and include the installation of 56 WTGs, two OSPs, between 110 and 122 km of inter-array cables, between 25 and 28 km of interconnector cables, and between 35 and 40 km offshore export cables. There will also be up to 4,150 vessel round trips and 294 helicopter round trips during the construction phase (including activities at the landfall site).

11.9.4.11 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by construction vessels and within equipment. The release of a large inventory of fuel oil from a construction vessel is, however, considered to represent the greatest potential accidental pollution event from installation activities. In the event of an accidental spill from vessels, equipment or from construction activities, the spill would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022).

11.9.4.12 Given the Factored In Measures (see Table 11.15), the likelihood of accidental release is considered extremely low. The measures in the EMP include storage of chemicals in secure designated areas on vessels in line with appropriate regulations and guidelines, and double skinning of any tanks and pipes containing hazardous substances. All chemicals used will be subject to a chemical risk assessment to ensure risks are understood and minimised. The EMP also includes a MPCP which will contain key emergency contact details and response procedures in the event of a spill of any magnitude (TIER I, II or III) to ensure minimal impact. Compliance with these procedures will also reduce the magnitude of any spill. Adherence to the Factored In Measures outlined in Table 11.15, including the EMP and MPCP will significantly reduce the likelihood of an accidental pollution incident occurring, and the magnitude of its impact.

11.9.4.13 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the construction phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.4.14 For all marine mammal species, the magnitude of the impact of accidental pollution during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.4.15 The significance of effect from accidental pollution during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in

Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.9.4.16 There is the potential for the accidental release of pollutants during the operational and maintenance phase of the Proposed Development as a result of the presence of offshore infrastructure, associated equipment, and vessel movements. The project design parameters for Project Design Option 1 during the operational and maintenance phase are outlined in Table 11.9. This includes synthetic compound, for example from antifouling biocides, heavy metal, and hydrocarbon contamination as a result of the presence of 56 WTGs and two OSPs as well as from maintenance activities. There will also be up to 1,359 vessel round trips and 485 helicopter round trips per year during the operational and maintenance phase.

11.9.4.17 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by operational and maintenance vessels and within equipment. Any accidental spill from vessels or equipment or from maintenance activities would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022). As discussed in paragraph 11.9.4.12 and Table 11.15, the implementation of the Factored In Measures, including an EMP and MPCP, will ensure that the likelihood of accidental release occurring is extremely low and, in the event that an accidental release does occur, will limit the magnitude of the impact.

11.9.4.18 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the operational and maintenance phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.4.19 For all marine mammal species, the magnitude of the impact of accidental pollution during the operational and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the operational and maintenance phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.4.20 The significance of effect from accidental pollution during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.9.4.21 The magnitude of the potential impact to marine mammals from accidental pollution during the decommissioning phase is expected to be the same as described previously for the construction phase (see paragraphs 11.9.4.10 *et seq.*).

11.9.4.22 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the decommissioning phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.4.23 For all marine mammal species, the magnitude of the impact of accidental pollution during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the decommissioning phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.4.24 The significance of effect from accidental pollution during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.5 Impact 5 – Changes in Electromagnetic Fields (EMF) from subsea electrical cabling

11.9.5.1 The conduction of electricity through subsea power cables has the potential to emit a localised EMF which could potentially affect the sensory mechanisms of marine mammal species (CMACS, 2003; Copping, 2018; Normandeau *et al.*, 2011).

11.9.5.2 There are no thresholds for assessing impacts to marine life from EMFs, therefore by necessity, this impact assessment is qualitative by nature, based on the available evidence base (a combination of laboratory experiments and field studies). An overview of the expected levels of EMF and the potential impacts associated are presented below.

SENSITIVITY OF THE RECEPTOR

11.9.5.3 The effects of EMF on marine mammals are not well understood and, more broadly, there has been a lack of studies investigating the effects of EMFs on the behaviour of magneto- and electrosensitive animals.

11.9.5.4 There is no evidence that seals can detect or respond to EMF, however there is evidence to suggest that some species of cetacean may be able to detect variations in magnetic fields, therefore it is plausible that they are magneto-sensitive (Normandeau *et al.*, 2011). Kirschvink *et al.* (1986) suggested that species that were sensitive to changes in the Earth's magnetic field and that are likely to be present within the Proposed Development include harbour porpoise, Risso's dolphin, and common dolphin. However, the majority of these have had a theoretical evidence base, coming to differing conclusions regarding species' sensitivity to changes in electric and magnetic fields (Normandeau *et al.*, 2011). The only evidence of electro-sensitivity in marine mammals to date is reported in Guiana dolphin (*Sotalia guianensis*) as they have been shown to possess an electroreceptive system which is used to detect electrical stimuli (Czech-Damal *et al.*, 2013).

11.9.5.5 Potential responses of cetaceans from EMF could include avoidance behaviour, disruption in orientation, and effects on feeding or social interaction (Normandeau *et al.*, 2011), although it is important to note that these responses are all currently hypothetical. Whilst subsea cables could create a very localised change in the geomagnetic field (Taormina *et al.*, 2018), modelling studies of EMF from cables suggests that the likelihood of such a change affecting a large enough area to elicit a significant course alteration would be low (Normandeau *et al.*, 2011).

11.9.5.6 Theoretically, there is the potential for some very localised behavioural effects, although no evidence exists at present that marine mammal species within this assessment are magneto sensitive. All marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Negligible sensitivity to changes in EMF from subsea electrical cabling.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.9.5.7 EMFs are a combination of an electrical field and a magnetic field, with the electrical field generated by static charges and the magnetic field generated by moving currents.

11.9.5.8 Anthropogenic sources of EMF are primarily subsea cables used for power generation and telecommunications or submarine communications (Normandeau *et al.*, 2011; Tasker *et al.*, 2010). Therefore, the presence and operation of between 110 and 122 km of 66 kV inter-array cables, between 35 and 40 km of 220 kV offshore export cables, and between 25 and 28 km of 220 kV OSP interconnector cables during the lifetime of the Proposed Development (see Table 11.9) may lead to localised EMF effects on marine mammals.

11.9.5.9 Submarine cables can cause three different types of EMFs: electrical (E) fields, magnetic (B) fields, and induced electric (iE) fields. E-fields are measured in volts per metre (V/m) and are generated by the voltage of the cable. B-fields are measured in microtesla (μT) or milligauss (mG) where 1 μT = 10 mG and are generated by the current of the power through the cable. They attenuate both horizontally and vertically away from the cable, with field strength directly related to the power of the current passing through the cable, rather than being specifically related to the voltage. iE-fields are measured in V/m and are generated by the fluctuation of the B-fields (in AC transmission) or by the motion of the seawater (or an organism) through the B-field. Therefore, they are dependent on the strength of the B-field, thus the strength of the iE-field is directly related to the B-field, which is strongest closest to the cable, attenuating horizontally and vertically away from it.

11.9.5.10 EMFs also occur naturally in the marine environment from a variety of sources including background levels from the Earth's magnetic field, and very small fields generated by electrical currents moving through organisms (Tricas and Gill, 2011). The Earth's static B-field is present in both terrestrial and aquatic environments and lies in the range 25 to 65 μT (Hutchison *et al.*, 2018). The B-field strength of the Irish Sea is approximately 49 μT (National Oceanic and Atmospheric Administration (NOAA), 2020).

11.9.5.11 Measurements of EMF for subsea cables associated with offshore windfarms vary, with the strength of the B-field generated generally related to the wind speed captured by the turbines. A variety of design and installation factors affect EMF levels in the vicinity of the cables such as current flow, distance between cables, cable insulation, number of conductors, configuration of cable and burial depth. For example, EMFs produced by inter-array cables are smaller than those of export and OSP interconnector cables as they are lower powered in comparison. Furthermore, the B-fields generated by High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC) cables are significantly different, with HVDC cables typically generating much larger EMFs than HVAC cables (Tricas and Gill, 2011). The transmission system used for the Proposed Development will only comprise HVAC.

11.9.5.12 CMACS (2003) reported that for a 132 kV three-phase AC cable with perfect shielding, the predicted B-field in close proximity to the cable was 1.6 μT and the respective iE-field was 91.25 μV/m above the cable if buried to 1 m depth, which reduced to 10 μV m-1 8 m from the cable. Gill *et al.* (2009) measured iE-fields of 30 μV/m and 110 μV/m at two different offshore windfarm cables (both three-phase AC, 36 kV, 100 A) close to the cables and B-fields of 0.23 μT and 6.5

μT, respectively. Continental Shelf Associates (CSA, 2019) compared offshore windfarm subsea cables and found EMF levels directly over live AC undersea power cables associated with offshore wind energy projects ranged between 5 to 15 mG (0.5 to 1.5 μT) for inter-array cables and 10 to 40 mG (1 to 4 μT) for export cables, at heights of 1 m above the seabed. At lateral distances of between 3 m and 7.5 m from the cable, B-fields greatly reduced to <0.1 to 7 mG (<0.01 to 0.7 μT) for inter-array cables, and <0.1 to 12 mG (<0.01 to 1.2 μT) for export cables, at heights of 1 m above the seabed. Measurements of the iE-fields directly over live AC undersea power cables in the same study ranged between 0.1 to 1.2 mV/m for the inter-array cables and 0.2 to 2.0 mV/m for export cables, at heights of 1 m above the seabed (CSA, 2019). At lateral distances of between 3 m and 7.5 m, iE-fields reduced to between 0.01 to 0.9 m V/m for inter-array cables and 0.02 to 1.1 mV/m for export cables at heights of 1 m above the seabed.

11.9.5.13 The strength of the B-field (and consequently, iE-fields) decreases rapidly horizontally and vertically with distance from source (Normandeau *et al.*, 2011). Burial of cables, in particular, can therefore reduce the strength of the B- and iE-fields. However, it is unlikely that cables can be buried to sufficient depths that will reduce the magnitude of the B-field, and hence the sediment-seawater interface iE-field, to the extent that these fields could not be detected by certain marine organisms on or close to the seabed (Gill *et al.*, 2005). A study conducted by CSA (2019) found that inter-array and export cables buried between depths of 1 m to 2 m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

11.9.5.14 While there may be some change to EMFs in the vicinity of inter-array, export, and OSP interconnector cables, the studies presented above indicate that these would likely be highly localised, with the strength of EMFs dissipating quickly with increased distance from the buried cables. The impact of EMFs on marine mammals is considered to occur throughout the operational and maintenance phase, is reasonably expected to occur, and have intermittent and recoverable consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.9.5.15 For all marine mammal species, the magnitude of the impact of changes in EMFs from subsea electrical cabling has been assessed as **Low adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from changes in EMFs from subsea electrical cabling during the operational and maintenance phase for all marine mammal species is **Imperceptible**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.5.16 The significance of effect from changes in EMFs from subsea electrical cabling during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.6 Impact 6 – Injury and/or disturbance to marine mammals from underwater noise during UXO clearance

11.9.6.1 It is possible that UXO items with a range of charge weights (or quantity of contained explosive) are present within the boundaries of the Proposed Development, therefore there is potential for UXO clearance to be required prior to construction. While it may be possible for identified UXO to be either avoided, removed, or relocated, there is potential that underwater detonation could be required where it is deemed necessary and unsafe to remove the UXO.

11.9.6.2 Methods of UXO clearance considered for the Proposed Development may include high order and low order detonation. It is important to note that while high-order detonation represents the worst-case scenario for UXO clearance, high order detonation may be avoided, and low-order clearance methods (deflagration) used instead.

11.9.6.3 The number of UXO that may require clearance and duration of UXO clearance operations are currently unknown. Therefore, it is important to note that the assessments for UXO clearance presented within this chapter are, at this stage, illustrative.

11.9.6.4 The severity of the consequences of UXO detonation will depend on several variables, including, but not limited to, the charge weight and its proximity to the receptor. Potential effects of underwater detonation of UXOs on marine mammals include auditory injury from exposure to the acoustic wave, resulting in permanent auditory injury or loss in hearing sensitivity (PTS), or temporary loss in hearing sensitivity (TTS); and behavioural disturbance which could impact on feeding, mating, breeding, and/or resting (Ketten, 2004; Richardson *et al.,* 1995; von Benda-Beckmann *et al.,* 2015).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.9.6.5 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.9.6.6 The primary acoustic energy produced by a high order detonation is below the region of greatest sensitivity for most marine mammal species (harbour porpoise, dolphin species, seals) considered within this assessment (Southall *et al.,* 2019), with most acoustic energy produced below a few hundred Hz, and decreasing by SEL ~10 dB per decade above 100 Hz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). There is also a pronounced reduction in energy levels above ~5-10 kHz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). Furthermore, recent evidence shows that the sound produced during UXO detonation has lower frequency components (<100 Hz) than was previously assumed (Robinson *et al.,* 2022), therefore this assessment is likely to be overly precautionary for species, such as minke whale, whose hearing sensitivity was previously assumed to overlap with the primary acoustic energy produced by a high order detonation.

11.9.6.7 If PTS were to occur within this low frequency range, it is unlikely that it would result in a significant impact on the vital rates of harbour porpoise, dolphin species, and seals. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoise, dolphin species, and seal species are assessed as having a Low sensitivity to PTS from underwater noise during UXO clearance. Minke whales are assessed as having a Medium sensitivity to PTS from underwater noise during UXO clearance, although as discussed in paragraph 11.9.6.6, this is precautionary.

BEHAVIOURAL DISTURBANCE

11.9.6.8 JNCC (2020) states that 'a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement'. Each donation will be of short-term duration; therefore, it is not expected that behavioural disturbance from a single UXO detonation would cause a significant impact.

11.9.6.9 As a result, all marine mammal species are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, they are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during UXO clearance.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY – PTS

11.9.6.10 The following section provides the quantitative assessment of the impact of PTS from UXO clearance on marine mammals. A UXO detonation is defined as a single pulse, therefore both the weighted SEL_{cum} criteria and the unweighted SPL_{peak} criteria from Southall *et al.* (2019) have been presented in Table 11.18 and the source levels (unweighted SPL_{peak} and SEL_{ss}) for each charge weight are presented in Table 11.19, whereby SEL_{cum} is equivalent to SEL_{ss}. As a result, animal fleeing assumptions do not apply to the values presented. The predicted impact ranges for auditory injury (PTS-onset) from UXO clearance for each FHG are presented in Table 11.30 and the number of animals predicted to experience PTS-onset from UXO clearance are presented in Table 11.31.

11.9.6.11 Generally, the estimated auditory injury (PTS-onset) impact ranges increased with the size of the charge for all FHGs (Table 11.30). For harbour porpoise, the maximum PTS-onset impact range was 14 km (SPL_{peak}) (Table 11.30). This equates to a maximum of 234 individuals experiencing auditory injury (0.37% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) using the site-specific DAS density estimate (Table 11.31).

11.9.6.12 At all charge sizes, HF cetaceans (dolphin species) have the smallest predicted impact range of up to 840 m (SPL_{peak}) (Table 11.30). For bottlenose dolphin, Risso's dolphin, and common dolphin, the maximum PTS-onset impact range was 840 m (SPL_{peak}), which equates to <1 individual experiencing auditory injury from UXO clearance (Table 11.31).

11.9.6.13 For all FHGs, the unweighted SPL_{peak} impact ranges are higher than the weighted SEL_{ss} impact ranges with the exception of LF cetaceans, such as minke whale, due to the sensitivity of their hearing (Table 11.30). For minke whale, the maximum PTS-onset impact range was 11 km (SEL_{ss}) (Table 11.30). This equates to a maximum of 17 individuals experiencing auditory injury (0.09% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) (Table 11.31).

11.9.6.14 For seals, the maximum PTS-onset impact range was 2.8 km (SPL_{peak}) (Table 11.30). This equates to two grey seals (0.12% of the reference population) and <1 harbour seal (<0.01% of the reference population) experiencing auditory injury from a high order UXO clearance using the greatest charge weight (Table 11.31).

11.9.6.15 For all FHGs, the auditory injury (PTS-onset) impact range for low order clearance is small, with a maximum range of <1.2 km (Table 11.30).

11.9.6.16 For all marine mammal species, the impact is considered to result in a very small proportion of the population affected and very unlikely to affect the population trajectory, although auditory injury (PTS) is expected to have a permanent change to the receptor. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise, minke whale, and grey seal. For dolphin species and harbour seal, <1 animal is predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible.

Table 11.30: Summary of auditory injury (PTS-onset) impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals

Charge weight (kg)	PTS-onset (unweighted SPL_{peak})				PTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	1.2 km	70 m	220 m	240 m	110 m	<50 m	320 m	60 m
25 + donor	4.6 km	260 m	820 m	910 m	570 m	<50 m	2.2 km	390 m
55 + donor	6.0 km	340 m	1.0 km	1.1 km	740 m	<50 m	3.2 km	570 m
120 + donor	7.8 km	450 m	1.3 km	1.5 km	950 m	<50 m	4.7 km	830 m
240 + donor	9.8 km	560 m	1.7 km	1.9 km	1.1 km	<50 m	6.5 km	1.1 km
525 + donor	12.0 km	730 m	2.2 km	2.5 km	1.4 km	50 m	9.5 km	1.6 km
700 + donor	14.0 km	810 m	2.4 km	2.7 km	1.5 km	60 m	10.0 km	1.9 km
800 + donor	14.0 km	840 m	2.6 km	2.8 km	1.6 km	60 m	11.0 km	2.0 km

Table 11.31: Predicted impact of PTS-onset for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population. For further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor	0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor
Harbour porpoise	0.38	#	2	25	43	73	115	172	234	234	<1	<1	1	1	1	2	3	3
		%	<0.01	0.04	0.07	0.12	0.18	0.27	0.37	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.2803	#	1	19	32	54	85	127	173	173	<1	<1	<1	1	1	2	2	2
		%	<0.01	0.03	0.05	0.09	0.14	0.20	0.28	0.28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bottlenose dolphin	0.0201	#	0	0	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	<0.01	<0.01	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.2352	#	0	<1	<1	<1	<1	<1	<1	1	0	0	0	0	0	0	0	0
		%	0.00	0.02	0.03	0.05	0.08	0.13	0.17	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Risso's dolphin	0.031	#	0	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Common dolphin	0.0272	#	0	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Minke whale	0.045	#	<1	<1	<1	<1	<1	1	1	1	<1	1	1	3	6	13	14	17
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.03	0.06	0.07	0.09
	0.017	#	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	2	5	5	6
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.03	0.03
Grey seal	0.08	#	<1	<1	<1	1	1	2	2	2	0	<1	<1	<1	<1	1	1	1
		%	<0.01	0.01	0.02	0.03	0.05	0.09	0.11	0.12	0.00	<0.01	<0.01	0.01	0.02	0.04	0.05	0.06
Harbour seal	0.0003	#	0	0	0	0	0	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TTS

11.9.6.17 The following section provides the qualitative assessment of the impact of TTS from UXO clearance on marine mammals. The predicted impact ranges for TTS-onset from UXO clearance for each FHG are presented in Table 11.32. As outlined in paragraph 11.7.5.6, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given.

11.9.6.18 Generally, the estimated TTS-onset impact ranges increased with the size of the charge for all FHGs. For harbour porpoises (VHF cetaceans), the maximum TTS-onset impact range was 26 km (SPL_{peak}) for a high order detonation using the greatest charge weight (800 kg plus donor) (Table 11.32).

11.9.6.19 For dolphin species (HF cetaceans), the maximum TTS-onset impact range was 1.5 km (SPL_{peak}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.32).

11.9.6.20 For minke whale, the maximum TTS-onset impact range was 120 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.32).

11.9.6.21 For seals, the maximum TTS-onset impact range was 23 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.32).

11.9.6.22 For all FHGs, the TTS-onset impact range for low order clearance is small, with a range of <4.5 km.

Table 11.32: Summary of TTS-onset impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals.

Charge weight (kg)	**TTS-onset (unweighted SPL_{peak})**				**TTS-onset (weighted SEL_{ss})**			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	2.3 km	130 m	410 m	450 m	930 m	<50 m	4.5 km	800 m
25 + donor	8.5 km	490 m	1.5 km	1.6 km	2.4 km	150 m	29 km	5.2 km
55 + donor	11 km	640 m	1.9 km	2.1 km	2.8 km	210 m	41 km	7.5 km
120 + donor	14 km	830 m	2.5 km	2.8 km	3.2 km	300 m	57 km	10 km
240 + donor	18 km	1.0 km	3.2 km	3.5 km	3.5 km	390 m	76 km	14 km
525 + donor	23 km	1.3 km	4.1 km	4.6 km	4.0 km	530 m	100 km	19 km
700 + donor	25 km	1.4 km	4.5 km	5.0 km	4.1 km	590 m	110 km	22 km
800 + donor	26 km	1.5 km	4.7 km	5.3 km	4.2 km	620 m	120 km	23 km

BEHAVIOURAL DISTURBANCE

11.9.6.23 This section presents the quantitative assessment for behavioural disturbance during UXO clearance using high order and low order methodologies as described in section 11.7.5.

26 KM EDR FOR HIGH ORDER CLEARANCE

11.9.6.24 The number of each marine mammal species predicted to experience behavioural disturbance as a result of high order UXO detonation using a 26 km EDR is quantified by multiplying the area of impact (assuming a 26 km EDR results in an impact area of 2,123.72 km^2) by the respective species-specific density estimate. The results are presented in Table 11.33 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.33: Predicted impact of disturbance to marine mammals from UXO assuming a 26 km EDR. For further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	807	1.29
	0.2803	595	0.95
Bottlenose dolphin	0.0201	43	14.57
	0.2352	499	170
Risso's dolphin	0.031	66	0.54
Common dolphin	0.0272	58	0.06
Minke whale	0.045	96	0.48
	0.017	36	0.18
Grey seal	0.08	170	10.22
Harbour seal	0.0003	1	0.35

11.9.6.25 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 807 harbour porpoises, 499 bottlenose dolphins, and 170 grey seals are predicted to be disturbed (Table 11.33).

11.9.6.26 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.33). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative. Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that 499 animals will experience behavioural disturbance as a result of UXO detonation, using the 26 km EDR (Table 11.33), which is considerably lower.

11.9.6.27 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys (Table 11.33). However, the percentage of the reference population impacted is not considered to be realistic as it does not account for the variability in coastal and offshore population densities and distributions within the Irish Sea. Furthermore, the design of broad scale surveys, such as SCANS, used to derive MU population estimates are not designed to capture localised, coastal populations such as that of Cardigan Bay; therefore, the reference population size has been under-estimated.

11.9.6.28 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.33).

11.9.6.29 While it is expected that a high order UXO detonation would elicit a startle response and therefore, only a very short-term duration behavioural response is expected (JNCC, 2020); however, there is no empirical evidence of any marine mammal species' response to these events. The impact is considered to result in a small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as **Low** adverse for all marine mammal species.

5 KM EDR FOR LOW ORDER CLEARANCE

11.9.6.30 The 5 km EDR has been used in this assessment for illustrative purposes and should be viewed with caution as there is no evidence to support this impact range. The number of each marine mammal species predicted to experience behavioural disturbance as a result of low order UXO detonation using a 5 km EDR is quantified by multiplying the area of impact (78.54 km^2) by the respective species-specific density estimate. The results are presented in Table 11.34 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.34: Predicted impact of disturbance to marine mammals from UXO assuming a 5 km EDR. For further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	30	0.05
	0.2803	22	0.04
Bottlenose dolphin	0.0201	2	0.54
	0.2352	18	6.30
Risso's dolphin	0.031	2	0.02
Common dolphin	0.0272	2	<0.01
Minke whale	0.045	4	0.02
	0.017	1	0.01
Grey seal	0.08	10	0.38
Harbour seal	0.0003	<1	0.01

11.9.6.31 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 30 harbour porpoises, 18 bottlenose dolphins, and 10 grey seals are predicted to be disturbed (Table 11.34).

11.9.6.32 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.34). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative.

11.9.6.33 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys and is therefore considered to be the most conservative estimate (Table 11.34).

11.9.6.34 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.34).

11.9.6.35 The impact of low order detonation is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT.

AUDITORY INJURY - PTS

11.9.6.36 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during UXO clearance **is Slight adverse**, which is **not significant** in EIA terms.

11.9.6.37 For bottlenose dolphin, Risso's dolphin, and common dolphin, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin, Risso's dolphin, and common dolphin from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

11.9.6.38 For minke whale, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium.** Therefore, the significance of effect from PTS to minke whale from underwater noise during UXO clearance **is Slight adverse**, which is **not significant** in EIA terms.

11.9.6.39 For grey seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to grey seal from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.9.6.40 For harbour seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour seal from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.6.41 For all marine mammal species, the impact of behavioural disturbance from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during UXO clearance **is Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.6.42 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during UXO clearance is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.6.43 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, the Developer has committed to a UXO MMMP to further reduce the risk of PTS-onset, which also applies to both harbour and grey seals (which are not EPS).

11.9.7 Impact 7 – Injury and/or disturbance from underwater noise during site surveys

11.9.7.1 In 2023, the Developer submitted a Foreshore Licence Application (FLA) to carry out site surveys at the site of the Proposed Development. The details provided within this assessment are aligned with the Arklow Bank Wind Park – Foreshore Licence Application for Site Surveys – Annex IV Species Risk Assessment (RPS, 2023), and the accompanying Schedule of Works. Surveys will be carried out before the construction phase, prior to the installation of the offshore infrastructure, and routinely during the operational and maintenance phase.

11.9.7.2 The key parameters for assessment of Project Design Option 1 considers underwater noise from site surveys (Table 11.9). Site surveys of relevance to this chapter are those that produce underwater noise and include geophysical and geotechnical surveys. Geophysical surveys such as multibeam EchoSounder (MBES) and side scan sonar (SSS) typically produce sound sources that are sonar-based or impulsive. Geotechnical surveys such as vibrocoring, typically produce non-impulsive sound sources, whilst some geotechnical surveys, such as grab sampling will not result in any measurable noise (Table 11.35; Table 11.36). The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of the different survey equipment and expected source levels are presented in Table 11.35 for geophysical equipment, and Table 11.36 for geotechnical survey equipment.

Table 11.35: Expected geophysical surveys and equipment, with indicative source levels.

Survey type	Equipment type	SEL (unweighted) (dB re 1µPa²s @1 m)	SPL $_{rms}$ T90 (dB re 1µPa @1 m)	SPL $_{pk}$ (dB re 1µPa @ 1 m)
Non-impulsive sonar-based surveys / equipment				
Multibeam EchoSounder (MBES)	Konsberg EM2040 or Seabat 7125	N/A	213	N/A
Side scan sonar (SSS)	Edgetech FS4200 or Klein 5000	N/A	210	N/A
Sub-bottom profiler (SBP)	Innomar SES Standard / Medium or Applied Acoustics AA251 or Egdetech 6205S	N/A	245	N/A
Impulsive surveys / equipment				

Seismic refraction	TI sleeve 10CU	195	214	224
Sparker (2DUHRS and 3DUHRS)	Geosource 200 – 400	182	214	219

Table 11.36: Expected geotechnical surveys and source levels.

Survey type	Source level (dB re 1µPa re 1 m (peak)	Source SEL (dB re 1 µPa^{2}s re 1 m) (unweighted)	SPL rms T90
Seismic Cone Penetration Test (CPT)[1]	220	189	203
Vibrocore	190	223[2]	187
Grab sample	N/A	N/A	N/A

[1]Equipment is pushed into the seabed and therefore would not result in a measurable noise source.

[2]Based on one hour of operation for a single core sample.

11.9.7.3 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.18) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.20; Southall *et al.*, 2019). Noise levels generated from site surveys (geophysical and geotechnical) were predicted by Seiche Ltd. Full details of the underwater noise modelling methodology, assumptions, and resulting impact ranges are detailed in Seiche Ltd. (2022).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY

11.9.7.4 Very limited information exists on the impacts of site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns. However, all species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.9.7.5 A study by Lucke *et al.* (2009) indicated that TTS could be induced in harbour porpoise at 350 m when exposed to an airgun impulse at a peak pressure of 200 $dB_{pk\text{-}pk}$ re 1 µPa with corresponding SEL of 164.5 dB re µ$Pa^2{}_s$) in shallow waters (~4 m), however this study is highly conservative as it assumes that the animal would remain stationary throughout the exposure. Evidence from other studies suggests that harbour porpoises exposed to such noise sources would likely move away from the source, and therefore leave the impact range of PTS-onset (Hermannsen *et al.,* 2015). Furthermore, it is expected that vessel presence will act as a deterrent to harbour porpoise, reducing the risk of auditory injury (Benhemma-Le Gall *et al*., 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any survey activity.

11.9.7.6 While PTS is a permanent effect which cannot be recovered from, the most likely response of a marine mammal to noise levels that could induce TTS is to flee the area (Southall *et al.,* 2007). Therefore, animals exposed to these noise levels that could induce TTS are likely to actively avoid hearing damage by moving away from the source.

11.9.7.7 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. However, it is unlikely that PTS and TTS from site surveys would significantly impact the survival of reproductive rates of marine mammal species in this assessment. As a result, they are considered to be of high adaptability, reasonable tolerance, have between no and full recoverability, and are of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to auditory injury from underwater noise during site surveys.

BEHAVIOURAL DISTURBANCE

11.9.7.8 Limited information exists on the impacts of behavioural disturbance from site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns.

11.9.7.9 An analysis of MMO reports found that small cetaceans (including harbour porpoise) have a tendency to swim away from seismic airguns at speed or tend to avoid survey vessels when airguns are firing up to a distance of ~1 km away (Moulton and Miller, 2005; Pirotta *et al.,* 2014; Stone, 2003). Acoustic data collected by Pirotta *et al.* (2013) showed that harbour porpoise that remained in the seismic survey impact area reduced their echolocation activity by 15% during the survey, which could be indicative of changes to foraging or social behaviour (van Beest *et al.,* 2018). Although, Thomspon *et al.* (2013) found that short-term disturbance by a seismic survey in the North Sea did not lead to long-term displacement of harbour porpoises as animals were typically detected again within a few hours following the survey works. Similarly, Hoekendijk *et al.* (2018) concluded that short-term, irregular disturbance events are unlikely to significantly affect the energetic status of harbour porpoise, particularly where surveys are conducted in shallow waters as sound cannot propagate as far.

11.9.7.10 For common dolphins, evidence suggests that there is no change in occurrence or sighting densities of common dolphin during active seismic surveys (Kavanagh *et al*., 2019; Stone *et al.*, 2017). Similarly, Risso's dolphin showed no response to seismic airguns (Stone *et al.,* 2017) or simulated military sonar (Southall *et al*., 2011). Whereas a study on minke whale investigating the impacts of exposure to naval sonar (with acoustic characteristics of 1.3 – 2 kHz to a maximum SL of 214dB re 1µPa @ 1 m) found that whales increased their swimming speeds to avoid the sound source (Kvadsheim *et al.,* 2017). Increases in metabolic rates associated with avoidance behaviour could have implications on energy expenditure and survival for individuals (Kvadsheim *et al.,* 2017).

11.9.7.11 Very limited studies on the effects of seismic airguns on seals, however other studies on the behavioural effects of impulsive noise sources to seals have shown varying responses of grey seals. During pile driving, grey seals were most commonly recorded changing behaviour from foraging to horizontal movement; although changes in swim speed, surfacing and diving behaviour and no response were also observed (Aarts *et al.,* 2018). A telemetry study during piling in southeast England showed that harbour seals within the area returned to usage levels similar to that of non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term (Russell *et al.,* 2016). Seals are generally considered to be relatively adaptable due to their generalist diets, wide foraging ranges, and adequate fat stores which enable them to compensate for lost foraging opportunities as a result of disturbance (Booth *et al.,* 2019; Smout *et al.,* 2014; Stansbury *et al.,* 2015).

11.9.7.12 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. Based on evidence available, all marine mammal species within this assessment are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during site surveys.

Construction phase

MAGNITUDE OF IMPACT

PTS

11.9.7.13 The following section provides the assessment of the impact of PTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the PTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.9.7.14 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP) injury in the form of cumulative PTS could occur up to 517 m from the sound source, depending on the survey equipment and the functional hearing group being assessed. For the MBES, the greatest predicted impact range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (VHF and HF cetaceans) (Seiche Ltd., 2022). The threshold for cumulative PTS is not predicted to be exceeded for minke whale (LF cetaceans) (Seiche Ltd., 2022). For the SSS, the greatest predicted range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative PTS is 517 m, for harbour porpoise (Seiche Ltd., 2022).

11.9.7.15 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker) injury in the form of instantaneous PTS could occur up to 22 m from the source and cumulative PTS could occur up to 130 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous PTS is 22 m and for cumulative PTS is 130 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for cumulative PTS is 14 m, for harbour porpoise (Seiche Ltd., 2022) The instantaneous PTS thresholds are not exceeded for any of the FHGs for the sparker surveys.

11.9.7.16 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling) injury in the form of instantaneous PTS could occur up to 15 m from the source and cumulative PTS could occur up to 62 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for cumulative PTS is 62 m, for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, cumulative PTS only occurs for VHF cetaceans (harbour porpoise) and is predicted to occur within 2 m of the source (Seiche Ltd., 2022).

11.9.7.17 In addition, the Factored In Measures (see Table 11.15 and RPS (2023)) which includes the implementation of a project-specific mitigation protocol during the geophysical surveys will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance.

11.9.7.18 The impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.9.7.19 The following section provides the qualitative assessment of the impact of TTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the TTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.9.7.20 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP), cumulative TTS could occur up to 3,150 m from the sound source. For the MBES, the greatest predicted range for cumulative TTS is 33 m for harbour porpoise (VHF cetaceans). For the SSS, the greatest predicted range for cumulative TTS is 97 m, for harbour porpoise (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative TTS is 3,150 m for harbour porpoise (Seiche Ltd., 2022).

11.9.7.21 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker), instantaneous TTS could occur up to 40 m from the source and cumulative TTS could occur up to 1,524 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous TTS is 40 m and for cumulative TTS is 1,524 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for instantaneous TTS is 32 m and for cumulative TTS is 68 m, for harbour porpoise (Seiche Ltd., 2022).

11.9.7.22 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling), instantaneous TTS could occur up to 33 m from the sound source and cumulative TTS could occur up to 856 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for instantaneous TTS is 33 m and for cumulative TTS is 856 m for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, the greatest predicted impact range for cumulative TTS is 607 m for harbour porpoise (Seiche Ltd., 2022).

11.9.7.23 It is important to note that the Factored In Measures (see Table 11.15 and RPS (2023)) which will include the implementation of a project-specific mitigation protocol during the geophysical surveys, will reduce the risk of marine mammal experiencing TTS although the focus of this will be to minimise the risk of PTS. As a minimum it will adhere to international best practice, including DAHG (2014) guidance.

BEHAVIOURAL DISTUBANCE

11.9.7.24 The following section provides the assessment of the impact of behavioural disturbance from site surveys (geophysical and geotechnical) on marine mammals. For impulsive noise sources, the threshold for mild disturbance is 140 dB re 1 μPa (rms) and the threshold for strong disturbance is 160 dB re 1 μPa (rms). For continuous/non-impulsive noise the threshold for disturbance is 120 dB re 1 μPa (rms). Further detail with regard to the thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.9.7.25 The Subsea Noise Assessment (Seiche Ltd., 2022) concluded that for non-impulsive geophysical survey sound sources, disturbance could occur for all FHGs up to 4,950 m from the sound source.

11.9.7.26 For impulsive sound sources, disturbance could occur out to 700 m for a sparker and out to 1,324 m for seismic refraction for all FHGs (Seiche Ltd., 2022).

11.9.7.27 The Subsea Noise Assessment concluded that for geotechnical surveys, disturbance could occur for all FHGs out to 10 km for vibrocore surveys and 1.5 km for seismic CPT surveys for strong disturbance (Seiche Ltd., 2022).

11.9.7.28 Therefore, the impact of disturbance to all marine mammal species from site surveys is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

PTS

11.9.7.29 For all marine mammal species, the impact of PTS-onset from underwater noise during site surveys has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise during site surveys is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.7.30 For all marine mammal species, the impact of behavioural disturbance from underwater noise during site surveys has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.7.31 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during site surveys is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.7.32 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). The Developer has conducted an Annex IV Species Risk Assessment (RPS, 2023) for species listed under Annex IV of the Habitats Directive and EPS to determine if the proposed surveys could have the potential risk of auditory injury or disturbance to these species and outlines proposed mitigation within the risk assessment report to further reduce the risk of injury and disturbance. Within this document, the Developer has committed to a project-specific mitigation protocol during the geophysical surveys that will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance (see RPS, 2023).

Operational and maintenance phase

11.9.7.33 Routine geophysical surveys will be undertaken of the inter-array cables, inter-connector cables, and export cables throughout the operational and maintenance phase. Surveys will occur every six months during the first two years and annually thereafter (Table 11.9).

11.9.7.34 The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore an illustrative assessment has been conducted by assuming that equipment will be the same as that proposed in the FLA. The conclusions of this assessment should be interpreted with a high level of precaution given the lack of information regarding the equipment types that will be used.

MAGNITUDE OF IMPACT

PTS

11.9.7.35 Based on the results of the Subsea Noise Assessment (Seiche Ltd., 2022) conducted for site surveys during the construction phase as part of the FLA, it is assumed that the magnitude of impact of PTS-onset from surveys during the operational and maintenance phase will be similar, assuming the same equipment is used.

11.9.7.36 Therefore, the impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.9.7.37 The impact ranges for TTS-onset from site surveys on marine mammals are expected to be similar to those presented in Seiche Ltd. (2022), assuming the same equipment is used in both the construction and operational and maintenance phases (see paragraphs 11.9.7.20 to 11.9.7.22).

11.9.7.38 It is important to note that the Factored In Measures (see Table 11.15) which will include the implementation of a project-specific mitigation protocol during the geophysical surveys, will reduce the risk of marine mammal experiencing TTS although the focus of this will be to minimise the risk of PTS. As a minimum it will adhere to international best practice, including DAHG (2014) guidance.

BEHAVIOURAL DISTURBANCE

11.9.7.39 Based on the results of the Subsea Noise Assessment (Seiche Ltd., 2022) conducted for site surveys during the construction phase as part of the FLA, it is assumed that the magnitude of impact of behavioural disturbance from surveys during the operational and maintenance phase will be similar, assuming the same equipment is used.

11.9.7.40 Therefore, the impact of disturbance to all marine mammal species from site surveys is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

PTS

11.9.7.41 For all marine mammal species, the impact of PTS-onset from underwater noise during site surveys has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise during site surveys is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.9.7.42 For all marine mammal species, the impact of behavioural disturbance from underwater noise during site surveys has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.9.7.43 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during site surveys is not significant in EIA terms. Therefore, no additional mitigation to the

Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.9.7.44 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, an Annex IV Species Risk Assessment for species listed under Annex IV of the Habitats Directive and EPS should be conducted once survey equipment is known to determine if the proposed surveys could have the potential risk of auditory injury or disturbance to these species and outlines proposed mitigation within the risk assessment report to further reduce the risk of injury and disturbance. Within this document, the Developer has committed to a project-specific mitigation protocol during the geophysical surveys that will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance.

11.10 Assessment of Project Design Option 2

11.10.1 Impact 1 – Injury and/or disturbance to marine mammals from underwater noise during pile driving

11.10.1.1 This impact assessment focusses on elevations in underwater noise and vibration as a result of pile driving during construction, as this activity has the greatest potential for impact on marine mammals.

11.10.1.2 The potential impacts of subsea noise arising during non-percussive noise-generating activities such as dredging and trenching during the construction, operational and maintenance, and decommissioning phases have been scoped out of this assessment. Whilst there is potential for elevations in subsea noise during other construction activities, these activities are considered to result in very localised, short-term effects on marine mammals and therefore has been scoped out of the assessment. In addition, noise generated during wind turbine operation has also been scoped out (Table 11.11).

11.10.1.3 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.37) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised (Table 11.18; Southall *et al.*, 2019).

Table 11.37: Marine mammal hearing ranges (Southall *et al.*, 2019)

Functional hearing group (FHG)	Relevant species	Generalised hearing range
Very High Frequency (VHF) cetacean	Harbour porpoise	275 Hz to 160 kHz
High Frequency (HF) cetacean	Bottlenose dolphin, Risso's dolphin, common dolphin	150 Hz to 160 kHz
Low Frequency (LF) cetacean	Minke whale	7 Hz to 35 kHz
Phocid (in water) (PCW)	Grey seal, harbour seal	50 Hz to 86 KHz

11.10.1.4 Impacts to marine mammals from underwater noise range from changes in behaviour and masking that affect communication and listening space, and/or locating prey (Basran *et al.*, 2020;

Dunlop, 2016; Erbe *et al.*, 2016; Heiler *et al.*, 2016; Pine *et al.*, 2019; Pirotta *et al.*, 2012; Wisniewska *et al.*, 2018), displacement and disturbance (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Graham *et al.*, 2019; Pirotta *et al.*, 2014; Stone *et al.*, 2017), injury and mortality (Reichmuth *et al.*, 2019; Schaffeld *et al.*, 2019).

11.10.1.5 The potential for auditory injury is related to the level of the underwater sound, its frequency relative to the hearing bandwidth of the animals, and by the duration of exposure. Exposure to loud, underwater noise can lead to a reduction in hearing sensitivity (a shift in hearing threshold) which may be temporary (TTS) or permanent (PTS).

11.10.1.6 TTS has been included in the assessment as a precautionary measure because it has the potential to have negative effects on an animal's ability to use natural sounds, including communication, navigation, and prey location, and consequently, could lead to a reduction in the fitness of the animal.

11.10.1.7 This impact assessment will be divided into an assessment of auditory injury (PTS), TTS and behavioural disturbance to underwater noise during pile driving.

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.10.1.8 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS (a permanent and irreversible hearing impairment) are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.10.1.9 At a Department of Business, Energy, and Industrial Strategy (BEIS)-funded expert elicitation workshop in 2018, experts discussed the nature, extent, and potentially consequences of PTS to marine mammal species in the UK (Booth and Heinis, 2018). Using the best and most recent data available on the effects of PTS on marine mammals, the experts concluded that PTS did not mean animals were deaf, and the magnitude and frequency band in which PTS occurs is critical to assessing the effect on vital rates.

11.10.1.10 The onset of PTS was defined by Southall *et al.* (2007) as a non-recoverable elevation of the hearing threshold of 6 dB. It has been assumed that PTS-onset occurs after TTS has grown to 40 dB, based on TTS growth rates obtained from scientific literature. Studies of auditory injury in relation to a typical piling sequence have suggested that hearing impairment caused by exposure to piling noise is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum (Kastelein *et al.*, 2013a). For piling noise, most energy is between ~30 – 500 Hz, with a peak between 100-300 Hz and energy extending above 2 kHz (Kastelein *et al.*, 2015; Kastelein *et al.*, 2016). Studies have shown that exposure to impulsive pile driving noise induces TTS in a relatively narrow frequency band in both harbour porpoise and harbour seals (Finneran, 2015), with statistically significant TTS occurring at 4 and 8 kHz, respectively (Kastelein *et al.*, 2016) and centred at 4 kHz (Kastelein *et al.*, 2012a; Kastelein *et al.*, 2012b; Kastelein *et al.*, 2013b; Kastelein *et al.*, 2017). As a result, at an expert elicitation workshop, it was agreed that any threshold shifts to hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al.*, 2017). It was also agreed that a PTS of 6 – 18 dB in a narrow frequency band in the 2 – 10 kHz region is unlikely to significantly affect the ability of individuals to survive and reproduce (Kastelein *et al.*, 2017).

HARBOUR PORPOISE (VERY HIGH FREQUENCY CETACEANS)

11.10.1.11 During an expert elicitation workshop, experts discussed the nature, extent, and potentially consequences of PTS to harbour porpoises; concluding that the probability of PTS significantly affecting the survival and reproduction of harbour porpoises was very low (Booth and Heins, 2018).

11.10.1.12 Furthermore, data collected during the construction of offshore windfarms have shown that harbour porpoise detections around the pile driving area decline for several hours prior to the commencement of pile driving (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018; Graham *et al.*, 2019). For example, during the installation campaigns of both Beatric and Moray East offshore windfarms, harbour porpoise acoustic detections gradually declined by up to 33% during the 48-hour period prior to piling (Benhemma-Le Gall *et al.*, 2023). It is assumed that this is due to an increase in other construction-related activities and the presence of vessels in advance of pile driving which act as a deterrent to harbour porpoise, therefore reducing the risk of auditory injury (Benhemma-Le Gall *et al.*, 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity of the pile driving at the start of the activity. Consequently, the assessment of underwater noise in relation to pile driving, which assumes harbour porpoises will be present in the immediate vicinity during pile driving, is extremely precautionary.

11.10.1.13 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of harbour porpoise. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

DOLPHIN SPECIES (HIGH FREQUENCY CETACEANS)

11.10.1.14 The ecological consequences of PTS for bottlenose dolphin, Risso's dolphin, and common dolphin are uncertain but could result in effects that influence survival and reproductivity, as discussed in paragraph 11.10.1.8.

11.10.1.15 As described for harbour porpoise, studies have shown that there are frequency-specific differences in the onset and growth of noise-induced threshold shifts in relation to the characteristics of the noise source and hearing sensitivity of the receiving species. At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of bottlenose dolphins was very low, assuming an impact a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.10.1.16 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of dolphin species. As a result, bottlenose dolphins, Risso's dolphins, and common dolphins are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, bottlenose dolphins, Risso's dolphins, and common dolphins are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

MINKE WHALE (LOW FREQUENCY CETACEANS)

11.10.1.17 The low frequency noise produced during pile driving may be more likely to overlap with the hearing range of low frequency cetacean species such as minke whales. Although very little is known about minke whale hearing, it is likely that they use sound for communication and are thought to be capable of hearing sounds through their skull bones (Cranford and Krysl, 2015).

11.10.1.18 As for other FHGs above, it is assumed that animals experiencing PTS would suffer a biological effect that could impact on the health and vital rates of the animal (Erbe *et al.*, 2018) and could ultimately lead to reduced birth rate in females or mortality of individuals.

11.10.1.19 Tubeli *et al.* (2012) estimated the most sensitive hearing range for minke whales to extend from 30 to 100 Hz up to 7.5 to 25 kHz. This suggests that a 6 dB PTS in the 2 – 10 kHz range would only affect a small region of their hearing. Furthermore, several studies have demonstrated that minke whale communication signals are below 2 kHz (Edds-Walton, 2000; Gedamke *et al.*, 2001; Mellinger *et al.*, 2006; Risch *et al.*, 2013; 2014).

11.10.1.20 PTS is a permanent effect which cannot be recovered from, although evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of minke whale as only a small region of their hearing would be potentially affected. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, minke whales are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

GREY AND HARBOUR SEAL (PHOCIDS IN WATER)

11.10.1.21 Seals use sound both in air and water for communication, predator avoidance, and reproductive interactions, and are less dependent on hearing for foraging than cetaceans (Deecke *et al.*, 2002). Seals have very well developed tactile sensory systems that are used for foraging, but in certain conditions they may also listen to sounds produced by vocalising fish whilst hunting for prey (Dehnhardt *et al.*, 2001; Shulte-Pelkum *et al.*, 2007).

11.10.1.22 Any threshold shifts in hearing caused by pile driving would manifest in the range of 2 – 10 kHz (Kastelein *et al.*, 2017). At a BEIS-funded export elicitation workshop in 2018, experts concluded that the probability of PTS significantly affecting the survival and reproduction of grey and harbour seals was very low, assuming a 6 dB PTS in the 2 – 10 kHz range (Booth and Heinis, 2018).

11.10.1.23 Calculations of SELs of tagged seals during the construction of the Lincs offshore windfarm (Southern North Sea, UK) estimated that at least 50% of tagged seals would have received a dose of sound greater than published thresholds for PTS (Hastie *et al.*, 2015), although it is important to note that published thresholds have since been updated in Southall *et al.* (2019) and therefore this estimate is now expected to be lower. For example, Whyte *et al.* (2020) found that the percentage of tagged seals predicted to experience PTS-onset varied from 0 to 17% depending on the onset threshold applied. The extent of offshore windfarm construction within the Wash over the last decade and the degree of overlap with foraging ranges of harbour seals in this region would suggest that a large number of individuals within the Wash population may have experienced levels of sound that have the potential to cause PTS (Russell *et al.*, 2016). However, the increase in the Wash harbour seal population during this period suggests that either the survival and fitness of individuals is not affected or that seals are not developing PTS despite predictions of exposure that indicate that they should be.

11.10.1.24 PTS is a permanent effect which cannot be recovered from, although, seals do not generally use hearing as the primary sensory function for locating prey and evidence does not suggest that PTS from piling will significantly impact the survival or reproductive rates of seals. As a result, they are considered highly adaptable, reasonably tolerant, have no recoverability, and are of high value. Therefore, grey and harbour seals are assessed as having a Low sensitivity to PTS from underwater noise during pile driving.

BEHAVIOURAL DISTURBANCE

HARBOUR PORPOISE

11.10.1.25 Harbour porpoises are particularly vulnerable to disturbance because they are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently in order to maintain a high metabolic rate with little energy remaining for fat storage

(Rojano-Doñate *et al.*, 2018; Wisniewska *et al.*, 2016). Therefore, there is a risk of changes to their overall fitness if they are displaced from high-quality foraging grounds or if their foraging efficiency is disturbed, and they are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. However, results from studies using Digital Acoustic Recording Tags (DTAGs) suggest that harbour porpoises are able to respond to short-term reductions in food intake and may have some resilience to disturbance (Wisniewska *et al.*, 2016).

11.10.1.26 Several studies have shown that harbour porpoises are displaced during periods of pile driving (e.g. Benhemma-Le Gall *et al.*, 2021; Brandt *et al.*, 2016; Graham *et al.*, 2019;). For example, monitoring of harbour porpoise during piling at Beatrice offshore windfarm in northeast Scotland indicated that porpoises were displaced from the immediate vicinity of the piling activity with a 50% probability of response occurring at approximately 7 km at the first piled location (Graham *et al.*, 2019). However, the 50% probability of response reduced to 1.3 km by the final piling location, suggesting that the response of harbour porpoise diminished over the construction period (Graham *et al.*, 2019).

11.10.1.27 This is further supported by studies at eight offshore windfarms in the German North Sea where declines in porpoise detection of >90% were recorded at noise levels above 170 dB compared to a baseline period of 24 to 48 hours (Brandt *et al.*, 2016). A decline in detections of 25% at noise levels between 145 and 150 dB showed a decrease in effect with increase in distance from the piling location (Brandt *et al.*, 2016). Furthermore, the detection rates showed that animals were only displaced from the area for a short period (one to three days) (Brandt *et al.*, 2011; Brandt *et al.*, 2016; Brandt *et al.*, 2018; Dähne *et al.*, 2013).

11.10.1.28 Recent studies at two offshore windfarms in Scotland showed that detections of clicks, associated with echolocation, and buzzing, associated with prey capture, in the short range (2 km) did not cease in response to piling, suggesting that porpoises were not completely displaced from the piling area (Benhemma-Le Gall *et al.*, 2021). Furthermore, the study suggests that animals that experience displacement may be able to compensate for missed foraging opportunities and increased energy expenditure of fleeing the piling area as detections of both clicks and buzzing were positively related to the distance from the piling activity (Benhemma-Le Gall *et al.*, 2021) which could be due to an increase in foraging activities beyond the piling impact range.

11.10.1.29 At an expert elicitation workshop in 2019, experts agreed that juvenile and adult survival were unlikely to be significantly affected by missed foraging opportunities as a result of disturbance from piling (Booth *et al.*, 2019). As a result, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

BOTTLENOSE DOLPHIN

11.10.1.30 A study of bottlenose dolphin response to impulsive noise (including the piling campaigns of Beatrice offshore windfarm and Moray East offshore windfarm, northeast Scotland), suggest that these activities did not cause displacement of the species from the southern coast of the Moray Firth (Fernandez-Betelu *et al.*, 2021). At the small temporal scale, dolphin detections increased, and the species remained within the predicted impacted area close to the offshore activities, for a median of two hours per day, on days with impulsive noise. This could be due to modifications in group size and/or behaviour, or changes in vocalisation rate or amplitude in response to impulsive noise generated by offshore activities. It is also important to note that bottlenose dolphin occurrence is largely influenced by various natural drivers, such as prey abundance, which could be deemed of higher importance in affecting their occurrence. Other studies in the Cromarty Firth, northeast Scotland have suggested small spatial and temporal scale disturbance of bottlenose dolphins from piling activities have occurred previously, as evidenced by a slight reduction of the presence, detection positive hours, and the encounter duration in the vicinity of construction works, although dolphins were not excluded entirely from the area (Graham *et al*., 2017a).

11.10.1.31 There is potential for behavioural disturbance due to underwater noise to result in disruption in foraging and resting activities and an increase in travel and energetic costs (Marley *et al*., 2017; Pirotta *et al*., 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that while there is potential for disturbance to affect bottlenose dolphin behaviour and health, which will then impact vital rates and population dynamics, individuals are able to compensate for immediate behavioural responses to disturbances caused by vessel activity. This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. As a result, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

RISSO'S DOLPHIN

11.10.1.32 Limited information on the response of Risso's dolphin to pile driving exists and there are few studies to investigate the effects of other impulsive noise sources, such as seismic surveys. The frequency range of seismic airguns may be similar to that of low-frequency noise produced by pile driving, although its duration and cumulative acoustic energy levels will differ. A study on the effects of seismic operations in UK waters showed no response by Risso's dolphin to seismic airguns (Stone *et al*., 2017). During controlled experiments where Risso's dolphin were exposed to simulated military sonar (SPLs of 135 dB re 1µPa), no clear behavioural response was recorded (Southall *et al*., 2011).

11.10.1.33 The limited information available for the impacts of pile driving, construction-related activity and seismic surveys on Risso's dolphins make it challenging to assess the risk for this species. Based on evidence available, Risso's dolphin are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, Risso's dolphin are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

COMMON DOLPHIN

11.10.1.34 Limited information on the response of common dolphins to pile driving exists, with few studies investigating impacts of any impulsive sound source on this species. The majority of evidence for the response of common dolphins to seismic surveys (an impulsive sound source) shows no change in occurrence or sighting densities of common dolphin during active surveys (Kavanagh *et al*., 2019; Stone *et al*., 2017). Similarly, a monitoring study in northwest Ireland investigating the effects of construction-related activity, including but not limited to seismic surveys, multi-beam surveys, remotely operated vehicle (ROV) surveys, dredging, back filling, rock trenching, rock placement, rock breaking, pipe laying and umbilical laying, during the construction of a gas pipeline found no changes in occurrence of common dolphin as a result of these construction -related activities in the area (Culloch *et al*., 2016).

11.10.1.35 The limited information available for the impacts of pile driving, construction-related activity and seismic surveys on common dolphins make it challenging to assess the risk to this species. However, there is evidence to suggest that common dolphins are able to adjust their whistle characteristics to account for masking as a result of anthropogenic noise (Papale *et al*., 2015), suggesting some tolerance and adaptability. As a result, common dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value.

Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during pile driving.

MINKE WHALE

11.10.1.36 Limited information on the behavioural responses of minke whales to underwater noise is available. A study on the behavioural sensitivity of minke whale reactions to sonar signals showed that they displayed prolonged avoidance, increase in swim speed directly away from the source, and cessation of feeding for a received SPL of 146dB re 1µPa and long-term (6 hour) avoidance of the area for a received SPL of 158dB re 1µPa (Sivle *et al.*, 2015). A study detailing minke whale responses to the Lofitech 'seal scarer' ADD showed minke whales within 500 m and 1,000 m of the source (source level of 204dB re 1 µPa @1 m) exhibiting responses of increased swim speeds and movement away from the source (McGarry *et al.*, 2017). Marine mammal monitoring showed that fine-scale temporal occurrence of minke whales was reduced by the presence of construction related activity (which did not include pile driving but did assess vessel presence as a proxy for other activities, including seismic surveys and multi-beam surveys) in Broadhaven Bay, northwest Ireland (Culloch *et al.*, 2016).

11.10.1.37 Minke whale are seasonal migrants to Irish (and UK) waters, where they forage on pelagic schooling fish during the summer months (Whooley, 2016). While information on the behavioural responses of minke whales to underwater noise is limited, it is anticipated that minke whales will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage. As a result, minke whales are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whales are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

GREY SEAL

11.10.1.38 Limited information on the behavioural responses of grey seals to underwater noise is available. Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the during the construction of the Luchterduinen windfarm and from 16 grey seals in 2015 during the construction of the Gemini windfarm (Aarts *et al.*, 2018). The most common response suggested a change in behaviour from foraging to horizontal movement, although various other responses were recorded including, altered surfacing and diving behaviour, changes in swim direction, and no response (Aarts *et al.*, 2018). Data from this study also showed that seals returned to the area on subsequent trips, despite receiving multiple exposures.

11.10.1.39 During an expert elicitation workshop in 2018, it was concluded that grey seals were considered to have a reasonable ability to compensate for missed foraging opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al.*, 2019). In general, experts agreed that grey seals would be more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet and more adaptable in their foraging strategies (Booth *et al.*, 2019). Experts also agreed that moderate-high levels of repeated disturbance would be required for any effect on grey seal fertility rates (Booth *et al.*, 2019).

11.10.1.40 Grey seals are highly adaptable to a changing environment. They can adjust their metabolic rate and foraging strategies and can compensate for lost opportunities due to their generalist diet, mobility, and adequate fat stores (Smout *et al.*, 2014; Stansbury *et al.*, 2015). They are also able to tolerate periods of fasting as part of their life history because of their large body size and thick layer of blubber (i.e. more energy reserve) (Pomeroy *et al.*, 1999). In addition, they are wide ranging and can travel large distances (up to 488 km) between different haul out and foraging regions, although on average, distances tend to be approximately 65 km (McConnell *et al.*, 1999). As a result, grey seals are considered to be of high adaptability, reasonable to high tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Negligible sensitivity to behavioural disturbance from underwater noise during piling driving.

HARBOUR SEAL

11.10.1.41 Behavioural disturbance of harbour seals as a result of underwater noise during pile driving could have an effect on both survival if it results in the separation of a pup from its mother, and reproduction via body condition if it results in the animal spending less time feeding or conserving energy by resting (Booth *et al.*, 2019).

11.10.1.42 A study of telemetry tagged harbour seals in the Wash, showed displacement during piling with a 19 to 83% reduction in abundance compared to during piling breaks (Russell *et al.*, 2016). The study shows that abundance was significantly reduced up to 25 km from the piling activity (Russell *et al.*, 2016). However, seals within the area returned to usage levels similar to non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term.

11.10.1.43 It is possible that displacement of harbour seals could result in an increase energetic cost if they are required to travel greater distances to compensate for missed foraging opportunities, which could potentially affect the reproductive success of a small number of individuals. However, during an expert elicitation workshop in 2018, the experts considered it unlikely that an individual would repeatedly return to an area where it had been previously displaced, and therefore unlikely to result in reduced foraging opportunities over a number of days that would be required to reduce body condition or fertility (Booth *et al.*, 2019).

11.10.1.44 Harbour seals have been reported to travel up to 273 kilometres from a haul-out whilst foraging, although they tend to remain within 50 km of their haul-out site and show high site fidelity (Carter *et al.*, 2022). The identified harbour seal haul-outs at Wexford Harbour, north Bull Island and Lambay island are situated approximately 50 km, 55 km and 62 km away from the Proposed Development, respectively, which suggests there is a low likelihood of harbour seals from these haul-outs using waters within the Proposed Development.

11.10.1.45 During the expert elicitation workshop in 2018, the experts also agreed that harbour seals have a reasonable ability to compensate for missed foraging opportunities from disturbance (from exposure to low frequency broadband pulsed noise such as piling driving) due to their generalist diet, adequate fat stores, mobility, and life-history traits (Booth *et al.*, 2019), for example, they have a thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods. Therefore, they are likely to have capacity to tolerate short-term displacement from foraging grounds during piling activity. As a result, harbour seals are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during piling driving.

Construction phase

MAGNITUDE OF IMPACT

PTS

11.10.1.46 The following section provides the quantitative assessment of the impact of PTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for auditory injury (PTS-onset) from pile driving for each marine mammal species are also presented in Table 11.38, Table 11.39, Table 11.40, Table 11.41, and Table 11.42.This includes the prediction of impact for each of the five modelling locations. A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.10.1.47 For harbour porpoise, the maximum instantaneous PTS-onset impact range was 750 m for the installation of an 11 m monopile at the SW WTG location (Table 11.40). This equates to a maximum of one animal experiencing auditory injury (<0.01% of the reference population) using the site-specific DAS density estimate. Using the cumulative PTS-onset thresholds, the maximum impact range was 10,000 m (10 km) for the installation of either an 11 m monopile at the SW WTG location, or the installation of a 14 monopile at the S-OSP location (Table 11.42). This equates to a maximum of 68 animals experiencing auditory injury (0.11% of the reference population) using the site-specific DAS density estimate. Using the density estimate from SCANS-IV, which covers a larger spatial scale, this would be <1 animal (<0.01% of the reference population) that would experience auditory injury due to instantaneous PTS-onset, and 50 animals (0.08% of the reference population) that would experience auditory injury due to cumulative PTS-onset (Table 11.42).

11.10.1.48 For dolphin species, the maximum instantaneous PTS-onset impact range was <50 m, therefore, no dolphins are expected to be impacted (Table 11.38; Table 11.39; Table 11.40; Table 11.41; Table 11.42). Using the cumulative PTS-onset thresholds, the maximum impact range for dolphin species was <100 m, and as such, no dolphins are expected to be impacted (Table 11.38; Table 11.39; Table 11.40; Table 11.41; Table 11.42).

11.10.1.49 For minke whale, the maximum instantaneous PTS-onset impact range was 50 m for the installation of an 11 m monopile at the SW WTG location, therefore no whales are expected to be impacted (Table 11.40). Using the cumulative PTS-onset thresholds, the maximum impact range was 19,000 m (19 km) for the installation of an 11 m monopile at the SW WTG location (Table 11.40). This equates to a maximum of 21 animals experiencing auditory injury (0.11% of reference population) using the density estimate from the ObSERVE surveys.

11.10.1.50 For seals, the maximum instantaneous PTS-onset impact range was 60 m for the installation of either an 11 m monopile at the SW WTG location (Table 11.40), or the installation of a 7 m or 14 m monopile at the S-OSP location (Table 11.42). As a result, no seals are expected to be impacted. Using the cumulative PTS-onset thresholds, the maximum impact range was 400 m for the installation of an 11 m monopile at the C WTG location (Table 11.40). As such, no seals are expected to be impacted.

11.10.1.51 The impact is restricted to active piling days during the construction phase and is reasonably expected to occur. It is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. As part of an expert elicitation workshop, experts in the relevant fields of marine mammal science discussed the nature, extent, and consequence of hearing threshold shifts on marine mammal arising from repeated exposures to low-frequency impulsive noise (Booth and Heinis, 2018). It was acknowledged that energy from piling noise primarily concentrates between about 30 and 500 Hz, and peaks between 100 and 300 Hz with extension to above 2 kHz (Kastelein *et al.*, 2015a, Kastelein *et al.*, 2016). The experts agreed that PTS and TTS as a result of piling would occur between the frequency range of 2 to 10 kHz (Kastelein *et al.*, 2017), with PTS of 6 to 18 dB within this narrow range. They concluded that such change is not likely to adversely and significantly impact the survival and reproductive rates of marine mammals, including minke whales, which have a hearing range in the lower frequencies (paragraphs 11.10.1.19 and 11.10.1.20).Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise and minke whale. For dolphin and seal species, no animals are predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible adverse.

Table 11.38: PTS-onset from pile driving at the NW WTG location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km2)	Piling location									
		NW WTG location – 7 m monopile				NW WTG location – 11 m monopile					
	Area (km2)	Maximum range (m)	Number of animals			% of reference population	Area (km2)	Maximum range (m)		Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})											
Harbour porpoise	0.38	0.70	490	<1	<0.01	0.73	500	<1		<0.01	
	0.2803			<1	<0.01			<1		<0.01	
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0		0.00	
	0.2352			0	0.00			0		0.00	
Risso's dolphin	0.031	<0.01	<50			0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50			0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	<0.01	<50	0	0.00	<0.01	<50	0		0.00	
	0.017			0	0.00			0		0.00	
Grey seal	0.08	<0.01	<50			0	0.00	0.01	<50	0	0.00
Harbour seal	0.0003	<0.01	<50			0	0.00	0.01	<50	0	0.00

Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	31	4,600	12	0.02	31	4,600	12	0.02
	0.2803			9	0.01			9	0.01
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	56	7,500	3	0.01	58	7,600	3	0.01
	0.017			1	<0.01			1	<0.01
Grey seal	0.08	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Harbour seal	0.0003	<0.1	<100	0	0.00	<0.1	<100	0	0.00

Table 11.39: PTS-onset from pile driving at the C WTG location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km²)	Piling location								
		C WTG location – 7 m monopile					C WTG location – 11 m monopile			
	Area (km²)	Maximum range (m)	Number of animals			% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})										
Harbour porpoise	0.38	1.5	690	1	<0.01	1.5	700	1		<0.01
	0.2803			<1	<0.01			<1		<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0		0.00
	0.2352			0	0.00			0		0.00
Risso's dolphin	0.031	<0.01	<50	0		0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0		0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	<50	0		0.00
	0.017			0	0.00			0		0.00
Grey seal	0.08	0.01	50	0		0.00	0.01	50	0	0.00
Harbour seal	0.0003	0.01	50	0		0.00	0.01	50	0	0.00

Cumulative PTS-onset (weighted SEL_{cum})											
Harbour porpoise	0.38	150	9,100	57	0.09	150		9,100	57	0.09	
	0.2803			42	0.07				42	0.07	
Bottlenose dolphin	0.0201	<0.1	0			0.00	<0.1	<100		0	0.00
	0.2352	<100		0		0.00				0	0.00
Risso's dolphin	0.031	<0.1	<100	0		0.00		<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0		0.00		<0.1	<100	0	0.00
Minke whale	0.045	400	17,000	18	0.09	400		17,000	18	0.09	
	0.017			7	0.03				7	0.03	
Grey seal	0.08	0.3	400	0		0.00		0.3	500	0	0.00
Harbour seal	0.0003	0.3	400	0		0.00		0.3	500	0	0.00

Table 11.40: PTS-onset from pile driving at the SW WTG location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km^2)	Piling location							
		SW WTG location – 7 m monopile				SW WTG location – 11 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.6	740	1	<0.01	1.6	750	1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso’s dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	<50	0	0.00	0.01	60	0	0.00

Species	Density (animals/km²)	Piling location							
		SW WTG location – 7 m monopile				SW WTG location – 11 m monopile			
		Area (km²)	Maximum range (m)	Number of animals	% of reference population	Area (km²)	Maximum range (m)	Number of animals	% of reference population
Harbour seal	0.0003	0.01	<50	0	0.00	0.01	60	0	0.00
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	180	10,000	68	0.11	180	10,000	68	0.11
	0.2803			50	0.08			50	0.08
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	460	18,000	21	0.10	470	19,000	21	0.11
	0.017			8	0.04			8	0.04
Grey seal	0.08	0.1	380	0	0.00	0.2	400	0	0.00
Harbour seal	0.0003	0.1	380	0	0.00	0.2	400	0	0.00

Table 11.41: PTS-onset from pile driving at the N-OSP location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km^2)	Piling location							
		N-OSP location – 7 m monopile				N-OSP location – 14 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.0	570	<1	<0.01	1.0	580	<1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	<50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	<50	0	0.00	0.01	<50	0	0.00
Harbour seal	0.0003	0.01	<50	0	0.00	0.01	<50	0	0.00

Species	Density (animals/km^2)	Piling location							
		N-OSP location – 7 m monopile				N-OSP location – 14 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	49	5,400	19	0.03	49	5,400	19	0.03
	0.2803			14	0.02			14	0.02
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	100	9,400	5	0.02	100	9,500	5	0.02
	0.017			2	0.01			2	0.01
Grey seal	0.08	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Harbour seal	0.0003	<0.1	<100	0	0.00	<0.1	<100	0	0.00

Table 11.42: PTS-onset from pile driving at the S-OSP location; further information on the density estimates presented here can be found in Table 11.7

Species	Density (animals/km^2)	Piling location							
		S-OSP location – 7 m monopile				S-OSP location – 14 m monopile			
		Area (km^2)	Maximum range (m)	Number of animals	% of reference population	Area (km^2)	Maximum range (m)	Number of animals	% of reference population
Instantaneous PTS-onset (unweighted SPL_{peak})									
Harbour porpoise	0.38	1.4	670	1	<0.01	1.4	680	1	<0.01
	0.2803			<1	<0.01			<1	<0.01
Bottlenose dolphin	0.0201	<0.01	<50	0	0.00	<0.01	<50	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Common dolphin	0.0272	<0.01	<50	0	0.00	<0.01	<50	0	0.00
Minke whale	0.045	0.01	<50	0	0.00	0.01	<50	0	0.00
	0.017			0	0.00			0	0.00
Grey seal	0.08	0.01	60	0	0.00	0.01	60	0	0.00
Harbour seal	0.0003	0.01	60	0	0.00	0.01	60	0	0.00

Species	Density (animals/km²)	S-OSP location – 7 m monopile: Area (km²)	Maximum range (m)	Number of animals	% of reference population	S-OSP location – 14 m monopile: Area (km²)	Maximum range (m)	Number of animals	% of reference population
Cumulative PTS-onset (weighted SEL_{cum})									
Harbour porpoise	0.38	170	10,000	65	0.10	170	10,000	65	0.10
	0.2803			48	0.08			48	0.08
Bottlenose dolphin	0.0201	<0.1	<100	0	0.00	<0.1	<100	0	0.00
	0.2352			0	0.00			0	0.00
Risso's dolphin	0.031	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Common dolphin	0.0272	<0.1	<100	0	0.00	<0.1	<100	0	0.00
Minke whale	0.045	440	18,000	20	0.10	450	18,000	20	0.10
	0.017			7	0.04			8	0.04
Grey seal	0.08	<0.1	200	0	0.00	<0.1	200	0	0.00
Harbour seal	0.0003	<0.1	200	0	0.00	<0.1	200	0	0.00

TTS

11.10.1.52 The following section provides the qualitative assessment of the impact of TTS from pile driving on marine mammals. The predicted areas and maximum impact ranges for TTS-onset from pile driving at each of the five modelling locations are presented in Table 11.43. As outlined in section 11.7.4, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given because there are no thresholds to determine a biologically significant effect from TTS-onset.

11.10.1.53 For harbour porpoises, the maximum instantaneous TTS-onset impact range was 1,900 m for the installation of a 11-m monopile at the SW WTG location (Table 11.43). Using the cumulative TTS-onset thresholds, the maximum impact range for harbour porpoise was 63,000 m (63 km) for the installation of a monopile at the SW WTG location (Table 11.43).

11.10.1.54 For dolphin species, the maximum instantaneous TTS-onset impact range was <50 m (Table 11.43). Using the cumulative TTS-onset thresholds, the maximum impact range for dolphin species was <100 m (Table 11.43).

11.10.1.55 For minke whale, the maximum instantaneous TTS-onset impact range was 130 m for the installation of a monopile at the SW WTG location (Table 11.43). Using the cumulative TTS-onset thresholds, the maximum impact range for minke whale was 98,000 m (98 km) for the installation of a monopile at the SW WTG location (Table 11.43).

11.10.1.56 For seals, the maximum instantaneous TTS-onset impact range was 150 m for the installation of a monopile at the SW WTG location (Table 11.43). Using the cumulative TTS-onset thresholds, the maximum impact range for seals was 35,000 m (35 km) for the installation of a monopile at the SW WTG location (Table 11.43).

Table 11.43: TTS-onset impact ranges from pile driving

Species	Impact	Piling location									
		NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
Instantaneous TTS-onset (unweighted SPL_{peak})											
Harbour porpoise (VHF cetacean)	Area (km^2)	4.2	4.3	9.4	9.5	10	10	5.9	5.9	8.8	8.9
	Maximum range (m)	1,200	1,200	1,800	1,800	1,900	1,900	1,400	1,400	1,700	1,700
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Area (km^2)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	Maximum range (m)	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
Minke whale (LF cetacean)	Area (km^2)	0.03	0.03	0.04	0.04	0.05	0.05	0.03	0.03	0.04	0.05
	Maximum range (m)	90	90	120	120	130	130	110	110	120	120
Grey seal, harbour seal (PCW)	Area (km^2)	0.03	0.04	0.06	0.06	0.07	0.07	0.05	0.05	0.06	0.06
	Maximum range (m)	110	110	140	140	150	150	120	120	140	140
Cumulative TTS-Onset (weighted SEL_{cum})											
Harbour porpoise (VHF cetacean)	Area (km^2)	2,000	2,000	4,500	4,500	5,500	5,500	2,500	2,500	5,500	5,500
	Maximum range (m)	42,000	42,000	56,000	56,000	63,000	63,000	45,000	45,000	62,000	62,000
	Area (km^2)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1

Species	Impact	Piling location									
		NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
Bottlenose dolphin, Risso's dolphin, common dolphin (HF cetacean)	Maximum range (m)	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100
Minke whale (LF cetacean)	Area (km^2)	4,500	4,500	8,500	8,500	9,200	9,200	5,300	5,400	9,000	9,100
	Maximum range (m)	63,000	63,000	86,000	86,000	98,000	98,000	67,000	67,000	94,000	95,000
Grey seal, harbour seal (PCW)	Area (km^2)	380	380	1,500	1,500	1,800	1,800	570	570	1,700	1,700
	Maximum range (m)	18,000	18,000	32,000	32,000	35,000	35,000	21,000	21,000	34,000	34,000

BEHAVIOURAL DISTURBANCE

11.10.1.57 The number of each marine mammal species predicted to experience behavioural disturbance as a result of pile driving is presented in Table 11.44 and Table 11.45 and assessed as the proportion of the respective reference population (as presented in Table 11.7). For dolphin species and minke whale, numbers of animals predicted to experience behavioural disturbance have been calculated using both the dose response method (Graham *et al.,* 2017b) (see Table 11.44) and Level B harassment thresholds (NMFS, 2005) (see Table 11.45). The predictions for the C WTG, NW WTG, SW WTG, N-OSP, and S-OSP modelling locations are presented separately. Disturbance from concurrent piling has not been assessed as piling is limited to one installation per day for Project Design Option 2 (see Table 11.10). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

11.10.1.58 iPCoD modelling was conducted to determine whether the level of disturbance is expected to result in population level impacts. The results of the iPCoD modelling show that there is no significant effect of disturbance resulting from pile driving at the Proposed Development to harbour porpoise, bottlenose dolphin, minke whale, grey seal, and harbour seal. Furthermore, for minke whale, grey seal, and harbour seal, impacted population is predicted to continue at a stable trajectory at exactly the same size as the un-impacted population.

Table 11.44: Predicted impact of disturbance to marine mammals from pile driving using dose response curves; # = number of animals disturbed; % = the percentage of the reference population. For Further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Impact	Piling location									
			NW WTG 7 m	**NW WTG 11 m**	**C WTG 7 m**	**C WTG 11 m**	**SW WTG 7 m**	**SW WTG 11 m**	**N-OSP 7 m**	**N-OSP 14 m**	**S-OSP 7 m**	**S-OSP 14 m**
Harbour porpoise	0.38	#	1,933	1,951	3,117	3,111	3,363	3,380	2,174	2,190	3,335	3,355
		%	3.09	3.12	4.99	4.98	5.38	5.41	3.48	3.50	5.33	5.37
	0.2803	#	1,426	1,439	2,299	2,295	2,481	2,493	1,604	1,615	2,460	2,475
		%	2.28	2.30	3.68	3.67	3.97	3.99	2.57	2.58	3.93	3.96
	Grid-cell specific	#	1,084	1,093	1,701	1,688	1,778	1,797	1,238	1,226	1,846	1,801
		%	1.73	1.75	2.72	2.70	2.84	2.87	1.98	1.96	2.95	2.88
Bottlenose dolphin	0.0201	#	102	103	165	165	178	179	115	116	176	177
		%	34.90	35.22	56.28	56.16	60.72	61.01	39.25	39.53	60.20	60.57
	0.2352	#	1,197	1,207	1,929	1,925	2,082	2,092	1,346	1,355	2,064	2,077
		%	408.41	412.07	658.52	657.13	710.52	713.96	459.29	462.59	704.44	708.81
	Grid-cell specific	#	122	123	181	179	183	186	137	137	186	187
		%	41.66	41.98	61.65	61.19	62.44	63.43	46.79	46.82	63.52	63.79
Risso’s dolphin	0.031	#	158	159	254	254	274	276	177	179	272	274
		%	1.29	1.30	2.07	2.07	2.24	2.25	1.45	1.46	2.22	2.23
Common dolphin	0.0272	#	138	140	223	223	241	242	156	157	239	240
		%	0.13	0.14	0.22	0.22	0.23	0.24	0.15	0.15	0.23	0.23
	Grid-cell specific	#	208	209	358	357	427	429	237	237	419	422

Species	Density (animals/km²)	Impact	Piling location									
			NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
		%	0.20	0.20	0.35	0.35	0.42	0.42	0.23	0.23	0.41	0.41
Minke whale	0.045	#	229	231	369	368	398	400	257	259	395	397
		%	1.14	1.15	1.83	1.83	1.98	1.99	1.28	1.29	1.96	1.98
	0.017	#	86	87	139	139	150	151	97	98	149	150
		%	0.43	0.43	0.69	0.69	0.75	0.75	0.48	0.49	0.74	0.75
	Grid-cell specific	#	69	69	103	104	106	107	78	78	107	108
		%	0.34	0.34	0.51	0.51	0.53	0.53	0.39	0.39	0.53	0.54
Grey seal	0.08	#	130	132	269	271	297	299	155	157	297	300
		%	7.83	7,95	16.21	16.32	17.86	18.00	9.31	9.42	17.89	18.07
Harbour seal	0.0003	#	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		%	0.23	0.24	0.48	0.48	0.53	0.53	0.28	0.28	0.53	0.54

Table 11.45: Predicted impact of disturbance to marine mammals from pile driving using level B harassment threshold; # = number of animals disturbed; % = the percentage of the reference population. For Further information on the densities used, see Table 11.7

Species	Density (animals/km²)	Impact	Piling location									
			NW WTG 7 m	NW WTG 11 m	C WTG 7 m	C WTG 11 m	SW WTG 7 m	SW WTG 11 m	N-OSP 7 m	N-OSP 14 m	S-OSP 7 m	S-OSP 14 m
	0.0201	#	20	20	46	47	53	53	24	25	52	53

Species	Density (animals/km^2)	Impact	Piling location									
			NW WTG 7 m	**NW WTG 11 m**	**C WTG 7 m**	**C WTG 11 m**	**SW WTG 7 m**	**SW WTG 11 m**	**N-OSP 7 m**	**N-OSP 14 m**	**S-OSP 7 m**	**S-OSP 14 m**
Bottlenose dolphin		%	6.77	6.78	15.78	15.89	17.95	18.11	8.30	8.42	17.76	17.97
	0.2352	#	229	233	541	545	616	621	285	289	609	616
		%	78.03	79.39	184.63	185.99	210.07	211.92	97.13	98.50	207.83	210.24
	Grid-cell specific	#	23	23	64	64	72	72	35	35	73	75
		%	7.97	7.97	21.93	21.93	24.72	24.72	12.08	12.08	24.76	25.54
Risso's dolphin	0.031	#	30	31	71	72	81	82	38	38	80	81
		%	0.25	0.25	0.58	0.59	0.66	0.67	0.31	0.31	0.65	0.66
Common dolphin	0.0272	#	26	27	63	63	71	72	33	33	70	71
		%	0.03	0.03	0.06	0.06	0.07	0.07	0.03	0.03	0.07	0.07
	Grid-cell specific	#	38	38	115	115	143	143	59	59	140	144
		%	0.04	0.04	0.11	0.11	0.14	0.14	0.06	0.06	0.14	0.14
Minke whale	0.045	#	44	45	104	104	118	119	54	55	117	118
		%	0.22	0.22	0.51	0.51	0.59	0.59	0.27	0.27	0.58	0.59
	0.017	#	17	17	39	39	44	45	21	21	44	45
		%	0.08	0.08	0.19	0.20	0.22	0.22	0.10	0.10	0.22	0.22
	Grid-cell specific	#	12	12	31	31	32	32	18	18	33	34
		%	0.06	0.06	0.15	0.15	0.16	0.16	0.09	0.09	0.16	0.17

HARBOUR PORPOISE

11.10.1.59 Using the site-specific density estimate of 0.38 animals/km^2 from the DAS, it was estimated that a maximum of 3,380 animals (5.41% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.44). This is considered to be highly conservative because it assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea of which the noise contours extend across. As a result, alternative estimates have also been presented.

11.10.1.60 Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 2,493 animals (3.99% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.44). While this is considered to be a more realistic estimate of density across the wider disturbance area compared to the estimated density from the site-specific DAS, it assumes a uniform density of animals across the Irish Sea which is not realistic.

11.10.1.61 In order to account for the non-uniform density of harbour porpoise across the Irish Sea, the number of animals disturbed was also presented using the modelled density surfaces derived from SCANS-III. Using this approach, it was estimated that a maximum of 1,846 animals (2.95% of the reference population) will experience behavioural disturbance as a result of pile driving at the S-OSP location (Table 11.44).

11.10.1.62 At its furthest point from the source, the 120 SELss dB re 1μPa^2$_s$ disturbance contour reaches the Welsh coastline, extending northwards to approximately 4 km from the Isle of Man, and southwards to approximately 25 km to the coast of north Cornwall (Figure 11.3). This suggests that behavioural response from harbour porpoise may not be localised and could extend across the Irish Sea, although extremely low numbers (33 animals from pile driving of the 11 m monopile at the SW WTG location) of harbour porpoise are expected to respond at this received level (Table 11.44).

11.10.1.63 The impact on harbour porpoises is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoises.

BOTTLENOSE DOLPHIN

11.10.1.64 Using the uniform density estimate of 0.0201 animals/km^2 from the ObSERVE surveys, it was estimated that a maximum of 179 animals (61.01% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.44). This is considered to be conservative because it assumes that the density within stratum 5 (western Irish Sea) is the same across the wider extent of the Irish Sea of which the noise contours extend across.

11.10.1.65 Using the uniform density estimate of 0.2352 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 2,092 animals (713.96% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.44). This is not considered to be realistic as it assumes a uniform density and does not capture the variability in coastal and offshore population densities and distributions within the Irish Sea.

11.10.1.66 In order to account for the non-uniform density of bottlenose dolphin across the Irish Sea, modelled density surfaces derived from SCANS-III were also used to calculate the number of animals disturbed. Using this approach, it was estimated that a maximum of 187 animals (63.79% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP (Table 11.44). Both of these approaches are over-predicting the number of animals available in the area that could be disturbed by pile driving as the number of animals calculated exceeds the reference population size of 293. Therefore, these calculations are not considered to be robust.

11.10.1.67 The noise contours extend to cover the majority of the Irish Sea MU (Figure 11.4), which is used as the reference population for bottlenose dolphin (Table 11.7). Therefore, it is anticipated that the majority of the reference population of 293 dolphins will be within the disturbance contours.

11.10.1.68 However, the number and proportion of bottlenose dolphin disturbed during pile driving was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b), as there is no corresponding species-specific data available for bottlenose dolphin. However, studies suggest that bottlenose dolphins are typically less sensitive to behavioural disturbance than harbour porpoise (e.g. Culloch *et al.*, 2016; Kastelein *et al.*, 2006; Stone *et al.*, 2017). Therefore, it is expected that the probability of response to underwater noise from pile driving would be lower. To demonstrate this, the number and proportion of bottlenose dolphin disturbed during pile diving have also been calculated using the Level B harassment threshold and presented in Table 11.45. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, for example, a maximum of 621 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW location and using the uniform density estimate of 0.2352 animals/km^2 from the wider SCANS-IV surveys (Table 11.45) compared to 2,092 animals estimated using the dose-response curve (Table 11.27). This suggests that the dose response method results in a very conservative calculation of the number and proportion of bottlenose dolphins disturbed.

11.10.1.69 Furthermore, the reference population does not take into account the connectivity of the reference population with other areas. Studies have shown large scale movement of bottlenose dolphins around Ireland and indicated connectivity with the population on the west coast of the RoI (O'Brien *et al.*, 2009). Long distance movements from the Atlantic to the North Sea between populations in the UK and Ireland have also been reported by Robinson *et al.* (2012). Therefore, the size of the reference population used from the Irish Sea MU is likely to be an under-representation of the number of bottlenose dolphins that may be present in the MU Study Area. Equally, the most recent abundance estimates from the semi-resident population at Cardigan Bay in West Wales (which is within the Irish Sea MU) alone were 147 individuals (95% CI: 127 to 194; NRW, 2018). The design of broad scale surveys, such as SCANS, used to derive MU population estimates are not able to capture localised, coastal populations such as that of Cardigan Bay, providing further evidence to suggest that the reference population size has been under-estimated.

11.10.1.70 Furthermore, it is important to highlight the significant difference between the SCANS-III and SCANS-IV abundance estimates of bottlenose dolphins in the Irish Sea. The SCANS-IV abundance estimate for the Irish Sea (blocks CS-D and CS-E) is 8,326 animals (Gilles *et al.,* 2023) whereas the MU population is derived from the lower SCANS-III abundance estimates, resulting in a population size of 293 (IAMMWG, 2023). As a result, the number of animals predicted to be disturbed using the density estimate from SCANS-IV is not compatible with the MU population size, resulting in a highly unrealistic proportion of the MU population estimated as impacted given that the population size is under-estimated. If the population size is taken to be 8,326 animals, the percentage of the population predicted to be disturbed reduces to 25.13%, when assuming 2,092 animals are disturbed using the dose-response curve, and 7.46% when using the Level B harassment threshold.

11.10.1.71 The impact on bottlenose dolphins is considered to result in a temporary change to most individuals, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences, but the impact is unlikely to have long-term consequences that would affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for bottlenose dolphins.

RISSO'S DOLPHIN

11.10.1.72 Using the uniform density estimate of 0.031 animals/km^2 from the wider SCANS-III surveys as the most conservative density estimate available, it was estimated that a maximum of 276 animals (2.25% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.44). While it is it unrealistic to assume a uniform density of animals across the Irish Sea, modelled density surfaces could not be derived for Risso's dolphin due to insufficient data (Lacey *et al.*, 2022).

11.10.1.73 Limited information on the response of Risso's dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of Risso's dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b) and is therefore likely to be an over-estimate (section 11.10.1). Due to the lack of species-specific data to apply to the dose-response curve for Risso's dolphin, the number and proportion of Risso's dolphin disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.45. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 82 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.45) compared to 276 animals estimated using the dose-response curve (Table 11.44). This suggests that the dose response method results in a very conservative calculation of the number and proportion of Risso's dolphins disturbed.

11.10.1.74 The impact on Risso's dolphins is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for Risso's dolphins.

COMMON DOLPHIN

11.10.1.75 Using the uniform density estimate of 0.0272 animals/km^2 from the wider SCANS-IV surveys, it was estimated that a maximum of 242 animals (0.24% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW location (Table 11.44).

11.10.1.76 Using the modelled density surfaces derived from SCANS-III, it was estimated that a maximum of 429 animals (0.42% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.44).

11.10.1.77 Limited information on the response of common dolphin to behavioural disturbance to pile driving is available. Therefore, the number and proportion of common dolphin disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b) and is therefore likely to be an over-estimate (section 11.10.1). Due to the lack of species-specific data to apply to the dose-response curve for common dolphin, the number and proportion of common dolphin disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.45. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 144 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the S-OSP location (Table 11.45) compared to 429 animals estimated using the dose-response curve (Table 11.44). This suggests that the dose response method results in a very conservative calculation of the number and proportion of common dolphins disturbed.

11.10.1.78 The impact on common dolphins is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for common dolphins.

MINKE WHALE

11.10.1.79 Using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys, it was estimated that a maximum of 400 animals (1.99% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW location.

11.10.1.80 Using the wider SCANS-III density estimate of 0.017 animals/km^2, it was estimated that a maximum of 151 animals (0.75% of the reference population) will experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.27). Using the modelled density surfaces derived from SCANS-III, it was estimated that a maximum of 108 animals (0.54% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP location (Table 11.27).

11.10.1.81 Limited information on the response of minke whale to behavioural disturbance to pile driving is available. Therefore, the number and proportion of minke whale disturbed was calculated using the dose-response curve for harbour porpoise from Graham *et al.* (2017b) and is therefore likely to be an over-estimate (section 11.9.1). Due to the lack of species-specific data to apply to the dose-response curve for minke whale, the number and proportion of minke whale disturbed during piling was also calculated using the Level B harassment threshold and presented in Table 11.45. When comparing these numbers against those calculated using the dose-response curve, they are considerably lower, with a maximum of 119 animals are estimated to experience behavioural disturbance as a result of pile driving of the 11 m monopile at the SW WTG location (Table 11.45) compared to 400 animals estimated using the dose-response curve (Table 11.44). This suggests that the dose response method results in a very conservative calculation of the number and proportion of minke whales disturbed.

11.10.1.82 It is also important to note that minke whales are expected to be mostly if not entirely absent in autumn and winter, and therefore any pile driving that occurs within these months is expected to have negligible impact on minke whales.

11.10.1.83 The impact on minke whale is considered to result in a small proportion of the population affected with change expected to be recoverable, occur relatively frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory and is only applicable to spring and summer months due to the seasonal presence of minke whales. Therefore, the magnitude of impact is assessed as Low adverse for minke whale.

GREY SEAL

11.10.1.84 Using the averaged grid-cell specific densities derived from Carter *et al.* (2020), it was estimated that a maximum of 300 animals (18.07% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP location (Table 11.44).

11.10.1.85 The impact on grey seal is considered to result in a small to medium proportion of the population affected with change expected to be recoverable, occur frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low to Medium adverse for grey seal.

HARBOUR SEAL

11.10.1.86 Using the averaged grid-cell specific densities derived from Carter *et al.* (2020), it was estimated that <1 animal (0.54% of the reference population) will experience behavioural disturbance as a result of pile driving of the 14 m monopile at the S-OSP location (Table 11.44).

11.10.1.87 The impact on harbour seal is considered to result in a very small number and proportion of the population affected with change expected to be recoverable, occur frequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour seal.

SIGNIFICANCE OF EFFECT

AUDITORY INJURY

PTS

11.10.1.88 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during pile driving **is Slight adverse**, which is **not significant** in EIA terms.

11.10.1.89 For bottlenose dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.90 For Risso's dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to Risso's dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.91 For common dolphin, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to common dolphin from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

11.10.1.92 For minke whale, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to minke whale from underwater noise during pile driving **is Slight adverse**, which is **not significant** in EIA terms.

11.10.1.93 For grey and harbour seal, the magnitude of the impact of PTS from underwater noise during pile driving has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to grey and harbour seal from underwater noise during pile driving is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.10.1.94 For harbour porpoise, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to harbour porpoise from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.95 For bottlenose dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Medium adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to bottlenose dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.96 For Risso's dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to Risso's dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.97 For common dolphin, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to common dolphin from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.98 For minke whale, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to minke whale from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

11.10.1.99 For grey seal, the magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low to Medium adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from disturbance to grey seal from underwater noise during pile driving is **Imperceptible**, which is **not significant** in EIA terms.

11.10.1.100 For harbour seal, magnitude of the impact of disturbance from underwater noise during pile driving has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from disturbance to grey seal from underwater noise during pile driving is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.1.101 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during pile driving is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.1.102 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, the Developer has committed to a piling MMMP (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan.) to further reduce the risk of PTS-onset, which also applies to both harbour and grey seals (which are not EPS).

11.10.2 Impact 2 – Injury and/or disturbance to marine mammals from vessel activities

11.10.2.1 Increased vessel movement during the construction, operational and maintenance, and decommissioning phases of the Proposed Development has the potential to result in a range of impacts on marine mammal receptors. These include injury or death due to collision with vessels, avoidance behaviour or displacement, and masking of vocalisations or changes in vocalisation rate.

11.10.2.2 The area surrounding the Proposed Development experiences a relatively low level of vessel traffic due to the presence of the shallow Arklow Bank sandbank, with higher traffic in the coastal areas and immediate surrounding waters (see Volume II, Chapter 15: Shipping and Navigation).

11.10.2.3 The shipping and navigation baseline study (Volume III, Appendix 15.1: Navigational Risk Assessment) recorded 29 days of vessel traffic data between 7th July and 14th August 2023. There was an average of 36 to 37 unique vessels per day recorded within the shipping and navigation

Study Area (which is defined as Array Area and a 10 nm buffer).The busiest day recorded 59 unique vessels within the shipping and navigation Study Area. The main vessel types within the shipping and navigation Study Area were cargo vessels (40%), recreational vessels (31%) and fishing vessels (10%).

SENSITIVITY OF THE RECEPTOR

INJURY FROM VESSEL ACTIVITIES: COLLISION RISK

11.10.2.4 During construction of the windfarm, a potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship. In general, three consequences of vessel collision are defined: direct (injuries to the animals that are the immediate result of collision), long-term (a decrease in the fitness of the animal over time), and population consequences (Schoeman *et al.*, 2020). With regards to injuries, both fatal and non-fatal injuries between marine mammals and vessels have been documented (Laist *et al.*, 2001; Vanderlaan *et al.*, 2008; Cates *et al.*, 2017). Fatal collisions have been evidenced via carcasses washing up on beaches (Laist *et al.*, 2001; Peltier *et al.*, 2019); carcasses caught on vessel bows (Laist *et al.*, 2001; Peltier *et al.*, 2019); and floating carcasses which have strong evidence of ship strike, such as propeller cuts, significant bruising, oedema, internal bleeding radiating from a specific impact site, fractures and ship paint marks (Jensen and Silber, 2003; Douglas *et al.*, 2008). Fatalities from ship strikes, however, often go unreported (Authier *et al.*, 2014). For non-fatal injuries, evidence of animals which have survived ship strikes with non-fatal injuries from propellers has been widely documented (Wells *et al.*, 2008; Luksenburg, 2014).

11.10.2.5 Although many species of marine mammals are able to detect and avoid vessels, it is unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al.*, 2020), although it has been suggested that behaviours such as resting, foraging, nursing, and socialising could distract animals from detecting the risk posed by vessels (Dukas, 2002). It is also possible that animals do not hear vessels when they are near the surface. Collisions between cetaceans and vessels, however, are not necessarily lethal on all occasions (Wells *et al.*, 2008; Luksenburg, 2014).

11.10.2.6 Harbour porpoises, dolphins, and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. For example, several studies have shown that harbour porpoise typically avoid vessels (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018; Heinänen and Skov, 2015).

11.10.2.7 The risk of collision between marine mammals and vessels is directly influenced by the type of vessel and the speed with which it is travelling (Laist *et al.*, 2001), and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in There is currently a lack of information on the frequency of occurrence of vessel collisions with marine mammals in Irish waters, and there is little evidence from marine mammals stranded in the Irish Sea to suggest that injury from vessel collisions is a significant cause of marine mammal mortality. In the UK, the Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. According to the most recent CSIP report, post-mortems were conducted on 69 out of the 532 reported harbour porpoise strandings in 2018. A cause of death was established in 60 examined individuals and, of these, one individual died from physical trauma due to vessel strike and two individuals had died from physical trauma of an unknown cause, which could have been due to vessel strike (CSIP, 2019). For bottlenose dolphin, post-mortems were conducted on one out of the nine reported strandings in 2018; the cause of death was not associated with vessel collision (CSIP, 2019). For Risso's dolphin, post-mortems were conducted on two out of the 15 reported strandings in 2018; the cause of death was not associated with vessel collision (CSIP, 2019). For common dolphin, post-mortems were conducted on 45 out of the 191 reported strandings in 2018 and a cause of death was established for 43 individuals. Of these, two individuals had died from physical trauma of an unknown cause, which could have been due to vessel strike (CSIP, 2019). For minke whale, post-mortems were conducted on three out of the 28 reported strandings in 2018. Of these, one individual had died due to vessel strike (CSIP, 2019). Overall, the CSIP data shows that very few strandings have been attributed to vessel collisions, therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a significant cause of mortality in RoI and UK waters.

11.10.2.8 Collision risk for seals is less understood than for cetaceans. However, trauma ascribed to collisions with vessels has been identified in a small proportion of both live stranded (Goldstein *et al.*, 1999) and dead stranded seals in the US (Swails, 2005). In these cases, however, less than 2% of all dead necropsied seals had vessel collision attributed to cause of death. A study in the Moray Firth showed that seals use the same areas as vessels during trips between haul-outs and foraging sites but that seals tended to remain beyond 20 m from vessels (only three instances over 2,241 days of seal activity resulted in passes at less than 20 m) (Onoufriou *et al.*, 2016), suggesting that the possibility of a risk of collision is very low.

11.10.2.9 Overall, these studies suggest that there is a high likelihood that marine mammals will avoid vessels and therefore, collision suggesting a low vulnerability. It is important to note that not all collisions that do occur are lethal, and there is a potential for recovery from injury. Furthermore, vessel collision is not considered to be a significant cause of marine mammal mortality (CSIP, 2019), but does have the potential to kill animals. As a result, all marine mammal species within this assessment are considered to be of reasonable adaptability, limited to no tolerance, have medium-term to no recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a High sensitivity to injury from vessel activities.

DISTURBANCE FROM VESSEL ACTIVITIES

HARBOUR PORPOISE

11.10.2.10 Harbour porpoises are particularly sensitive to high frequency noise and it is well documented that they typically avoid vessels (e.g. Culloch *et al.*, 2016; Benhemma-Le Gall *et al.*, 2021). During the construction of Beatrice and Moray East offshore windfarms in the Moray Firth, harbour porpoise occurrence decreased with increasing vessel presence, with the magnitude of decrease depending on the distance to the vessel (Benhemma-Le Gall *et al.*, 2021). As such, the probability of harbour porpoise occurrence at a mean vessel distance of 2 km decreased by up to 95% to 0.02 for the highest vessel intensity (Benhemma-Le Gall *et al.*, 2021). At a mean vessel distance of 3 km, the probability decreased by up to 57% to 0.16 for the highest vessel intensity, and no apparent response was observed at 4 km (Benhemma-Le Gall *et al.*, 2021).

11.10.2.11 Additional studies conducted during offshore windfarm construction demonstrated that harbour porpoise detections in the vicinity of the pile driving location decline prior to a piling event (Benhemma-Le Gall *et al.* 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). For example, during a study conducted at seven offshore windfarms in the German Bight, a decline in harbour porpoise detections was observed within 2 km of the construction site and continued to be reduced for 1 to 2 days after (Brandt *et al.*, 2018). This was attributed to the increased vessel activity and traffic associated with construction-related activities (Brandt *et al.*, 2018).

11.10.2.12 In a large-scale study of harbour porpoise density in UK waters, increased vessel activity was generally associated with lower harbour porpoise densities (Heinänen and Skov, 2015). Furthermore, Wisniewska *et al.*, (2018) collected telemetry data to study the change in foraging rates of harbour porpoise in response to vessel noise in highly trafficked coastal waters in the inner Danish waters and Belt seas. The results show that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 µPa (16 kHz third-octave) (Wisniewska *et al.*, 2018).

11.10.2.13 Land-based surveys were conducted to examine the surfacing behaviour of harbour porpoise in relation to vessel traffic in Swansea Bay (Oakley *et al.*, 2017). The study found a significant correlation between harbour porpoise sightings and the number of vessels present, with 26% of interactions observed considered to be negative (animals moving away or prolonged diving) when vessels were up to 1 km away (Oakley *et al.*, 2017). The proximity of the vessel was found to be an important factor, with the greatest response occurring at 200 m from the vessel (Oakley *et al.*, 2017). Smaller motorised vessels (jet ski, speed boat, small fishing vessels) were associated with more negative behaviours than large cargo ships, although larger ships were less common in the area (Oakley *et al.*, 2017).

11.10.2.14 Behavioural responses of harbour porpoises to vessel noise have also been observed in more controlled conditions. For example, behavioural responses of four harbour porpoise in a semi-natural net pen were observed during exposure to low levels of medium to high frequency vessel noise (Dyndo *et al.*, 2015). 'Porpoising' (a stereotypical disturbance behaviour) was observed during 27.5% of recordings of boat noise (Dyndo *et al.*, 2015).

11.10.2.15 These studies discussed above evidence some changes in harbour porpoise behaviour and presence as a result of disturbance from vessel activity. Behavioural responses include increased fluking, interrupted foraging, change to vocalisations, prolonged dives and directed movement away from the sound source (Oakley *et al.*, 2017; Wisniewska *et al.*, 2018). Several studies have also evidenced an increase in vessel presence correlates with a decrease in harbour porpoise presence (Benhemma-Le Gall *et al.*, 2021; Benhemma-Le Gall *et al.*, 2023; Brandt *et al.*, 2018). However, harbour porpoises occur widely throughout the Irish Sea (Berrow *et al.*, 2010; Rogan *et al.*, 2018a; Wall *et al.*, 2013) and therefore it is assumed (since they have a requirement to feed regularly) that there is suitable foraging habitat across their range. Therefore, relatively short-term localised disturbance within the vicinity of the Proposed Development is unlikely to lead to any population-level effects on harbour porpoise. As a result, harbour porpoises are considered to be of reasonable adaptability, limited tolerance, have high recoverability, and are of high value. Therefore, harbour porpoises are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

BOTTLENOSE DOLPHIN

11.10.2.16 Studies on the interactions of bottlenose dolphins with vessels have shown various responses. In the Moray Firth, a passive acoustic monitoring study showed that the presence of vessels resulted in a short-term reduction in foraging activity by 49%, with animals resuming foraging after the vessel had travelled through the area, suggesting that disturbance was limited to the time the vessel was physically present (Pirotta *et al.*, 2015). As a result, the study concluded that the physical presence of vessels plays a larger role in disturbance, as vessel noise was not taken into consideration (Pirotta *et al.*, 2015).

11.10.2.17 In a modelling study by Lusseau *et al.* (2011), it was predicted that increased vessels movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphins, although it did note that foraging may be disrupted by disturbance from vessels. Mathematical modelling was also conducted by New *et al.* (2013) to simulate the complex interactions of the bottlenose dolphin population in the Moray Firth and determine whether an increased rate of disturbance from vessel traffic from proposed offshore developments was biologically significant. The study statistically modelled an increase in vessel traffic from 70 to 470 vessels per year and found that an increase in commercial vessel traffic alone will not result in a biologically significant increase in disturbance, because dolphins have the ability to compensate for their immediate behavioural response. Therefore, their health and vital rates were predicted to be unaffected (New *et al.*, 2013).

11.10.2.18 Bottlenose dolphins have also been observed tolerating vessel disturbance, particularly in areas where vessel traffic has always been high (Pirotta *et al.* 2013). Similarly, the presence of bottlenose dolphin was positively correlated with overall vessel number during the construction works of an oil pipeline in Broadhaven Bay, northwest Ireland (Anderwald *et al.*, 2013). However, it was unclear whether the bottlenose dolphins were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.*, 2013).

11.10.2.19 A study of Indo-Pacific bottlenose dolphin habitat occupancy along the coast of Western Australia found dolphin density to be negatively affected by vessels at one site, but no significant impact at the other (Marley *et al.*, 2017a). It is hypothesised that the quality of the habitat impacts the behavioural response to disturbance as the latter habitat is a known foraging area. Other studies along the coast of Western Australia have found that increased vessel presence was associated with significantly increased swim speeds for individuals when resting or socialising (Marley *et al.*, 2017b). Animals exposed to high levels of shipping traffic were also found to spend more time travelling and less time resting or socialising. The study also found that the whistle characteristics changed with increased broadband exposure, with the greatest variation occurring in the presence of low frequency noise (Marley *et al.*, 2017b). Other studies have reported similar findings, for example, common bottlenose dolphins in Galveston Ship Channel, US, found that the presence of vessels was associated with significantly less foraging and socialising activity (Piwetz, 2019). For this population, a significant increase in swimming speeds was observed during the presence of recreational and tourism vessels, and shrimp trawlers (Piwetz, 2019).

11.10.2.20 Bottlenose dolphins have also been known to exhibit different behavioural responses to different vessel types. A study conducted in New Zealand showed that bottlenose dolphin resting behaviour decreased as the number of dolphin-watching tour boats increased (Constantine *et al.*, 2004). In a study conducted in Italy, dolphins exhibited an avoidance response to motorboats, but changed their acoustic behaviour in response to trawler vessels, presumably to compensate for masking (La Manna *et al.*, 2013). This study also found that bottlenose dolphins would tolerate vessel presence within certain levels and were more likely to leave an area if disturbance was persistent (La Manna *et al.*, 2013). Therefore, the degree to which an individual is disturbed is likely linked to their baseline level of tolerance (Bejder *et al.*, 2009).

11.10.2.21 These studies show that vessel disturbance can result in a variety of responses in bottlenose dolphins including changes to foraging behaviour, swim speed, behavioural state, and acoustic behaviour, and can cause avoidance responses (Constantine *et al.*, 2004; La Manna *et al.*, 2013; Marley *et al.*, 2017a; Marley *et al.*, 2017b; Pirotta *et al.*, 2015). However, where behavioural changes in bottlenose dolphins occur, predictive modelling of high levels of vessel disturbance has concluded that this is not biologically significant to a small population of bottlenose dolphins in the Moray Firth (New *et al.*, 2013). As a result, bottlenose dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, bottlenose dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

RISSO'S DOLPHIN

11.10.2.22 Limited information is available on the behavioural responses of Risso's dolphins to vessel disturbance. However, several studies have shown that vessel traffic can affect the behaviour, activity, energy budgets, habitat use, and reproductive success of dolphin species (Bejder *et al.*, 2006; Lusseau, 2003; 2004). A study on the behavioural responses of Risso's dolphins to vessel traffic in Pico, Azores suggested a disruption of resting behaviour by cetacean watching vessels (Oudejans *et al.*, 2007; Visser *et al.*, 2006). In the Ionian Sea, a study on the impacts of cetacean watching vessels on behavioural activities of Risso's dolphins observed a neutral response to the presence of the vessel during 81.3% of sightings (Bellomo *et al.*, 2021).

11.10.2.23 As limited information exists on the behavioural response of Risso's dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on Risso's dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction and O&M vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, Risso's dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, Risso's dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

COMMON DOLPHIN

11.10.2.24 Limited information is available on the behavioural responses of common dolphins to vessel disturbance. Marine mammal monitoring in Broadhaven Bay, northwest Ireland showed that an increase in vessel numbers resulted in a reduction in common dolphin presence (Culloch *et al.*, 2016).

11.10.2.25 Studies on disturbance effects from cetacean watching vessels reports that common dolphins spent significantly less time foraging when interacting vessels were present (Meissner *et al.*, 2015). Once disrupted, dolphins took at least twice as long to return to foraging when compared to control conditions (vessels >300 m away from dolphins) (Meissner *et al.*, 2015). The study also found that the probability of common dolphins starting to forage while engaged in travelling in the presence of cetacean watching vessels decreased by two thirds (Meissner *et al.*, 2015). Common dolphin foraging tactics include cooperative herding of prey (Neumann and Orams, 2003), therefore it is possible that the behavioural changes of some individuals within a group, as a result of approaching vessels, could compromise the success of the overall foraging event (Meissner *et al.*, 2015).

11.10.2.26 As limited information exists on the behavioural response of common dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on common dolphin behaviour have also been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are direct, whilst those from construction, O&M and decommissioning vessels would be indirect as interactions are unlikely to be deliberate or targeted to dolphin groups. As a result, common dolphins are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, common dolphins are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

MINKE WHALE

11.10.2.27 Limited information is available on the behavioural responses of minke whales to vessel disturbance. A study into the response of minke whales to construction-related vessel traffic in Broadhaven Bay, northwest Ireland found a significant negative correlation between the presence of minke whale and both the number of overall vessels and the number of utility vessels (those emitting lower frequency noise but moving around more than construction vessels), suggesting that minke whale were displaced from the area, most likely due to vessel presence and/or disturbance (Anderwald *et al.*, 2013).

11.10.2.28 A study by Christiansen *et al.* (2013) showed that minke whales change their diving patterns and behaviour in response to disturbance from whale watching vessels. Analysis of respiration rates found that energy expenditure of minke whales was 28% higher during vessel interactions (regardless of swim speed) and swim speed was found to increase with vessel presence (Christiansen *et al.*, 2013). These combined physiological and behavioural changes are considered to represent a stress response. The study also suggested that a reduction in foraging activity at feeding grounds could result in reduced reproductive success (Christiansen *et al.*, 2013). It is important to note that noise levels were not measured in this study, therefore behavioural responses are considered to be related to vessel presence.

11.10.2.29 Christiansen *et al.* (2015) considered the spatial and temporal rates of minke whale exposure of the entire whale watching season and found no potential for a population-level effect as a result of disturbance.

11.10.2.30 The bioenergetic effects of disturbance from whale watching vessels on foetal growth were examined by Christiansen and Lusseau (2015) using a mechanistic model and found that the presence of whale watching vessels resulted in an immediate reduction in net energy intake by 63.5%. However, the impact of disturbance was negligible because it was considered below the threshold value for which whale watching vessels would have a significant impact on foetal growth, as the number of interactions with vessels was low during the foraging season (Christiansen and Lusseau, 2015).

11.10.2.31 It is expected that minke whales are more sensitive to low frequency sounds (Nowacek *et al.*, 2007) such as those produced by slow moving vessels, although limited information exists on the behavioural response of minke whales to construction-related vessels. Studies on the impact of whale watching vessels on minke whale behaviour have therefore been presented as a proxy to inform this assessment, although it is important to note that disturbance effects from whale watching vessels are direct, whilst those from construction and O&M vessels would be indirect. As a result, minke whales are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, minke whale are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

GREY SEAL

11.10.2.32 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to grey seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Terhune and Almon, 1983; Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for grey seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.10.2.33 Britton (2012) recorded a significant correlation between boat speed and the distance at which hauled-out grey seals on the Isle of Man showed alert behaviour. A similar association was also observed between boat speed and movement and flushing response (entering the water) although this was not tested. The duration of the boat interaction was, however, found to be important, with flushing occurring in all vessel interactions lasting four minutes or longer (Britton, 2012).

11.10.2.34 A study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (using the Southall *et al.* (2019) thresholds) (Trigg *et al.*, 2020).A study of vessel traffic and marine mammal presence at Broadhaven Bay, northwest Ireland found grey seals sightings decreased with increased vessel activity in the surrounding area, though the effect size was small, and the relationships between sightings and vessel numbers were weaker than those with environmental variables such as sea state (Anderwald *et al.*, 2013).

11.10.2.35 Grey seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, grey seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

HARBOUR SEAL

11.10.2.36 Seals are particularly sensitive to disturbance in regions where vessel traffic overlaps with productive coastal waters (Robards *et al.*, 2016). Vessel disturbance may be particularly detrimental to harbour seal if it changes their haul-out patterns or reduces the time they are able to spend resting or nursing pups during the breeding season. When disturbed, seals that are hauled-out typically 'flush' (enter) into the water which could be detrimental during pupping season (Johnson and Acevedo-Gutiérrez, 2007). Key haul-outs for harbour seal in proximity to the Proposed Development are at Arklow, co. Wicklow, along the coast of co. Dublin, and around Wexford Harbour (Duck and Morris, 2013; Morris and Duck, 2019).

11.10.2.37 Avoidance behaviour or alert reactions have been reported in harbour seal when vessels approach within 100 m of a haul-out (Richardson *et al.*, 1995). A study in which 37 harbour seals were telemetry tagged on the east coast of Scotland did not show any apparent response of seals at sea to close passing vessels (they neither moved towards nor away from them) (Onoufriou *et al.*, 2016).

11.10.2.38 Another telemetry study that included the tagging of 28 harbour seals in the UK found high exposure levels of harbour seals to shipping noise, and as a result 20 individuals may have experienced a TTS due to cumulative SELs exceeded the TTS-threshold for pinnipeds exposed to continuous underwater noise (183dB re 1 $\mu Pa^2{}_s$) (Jones *et al.*, 2017). The overlap between seals and vessel activity most frequently occurred within 50 km of the coast and in proximity to seal haul-outs. The study concluded that there was no evidence of reduced harbour seal presence as a result of vessel traffic, despite the spatial overlap and cumulative SELs (Jones *et al.*, 2017).

11.10.2.39 Harbour seals are considered to be of reasonable adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, harbour seals are assessed as having a Low sensitivity to behavioural disturbance from vessel activities.

Construction phase

MAGNITUDE OF IMPACT

11.10.2.40 During the construction phase, a maximum of 66 installation vessels will be present within the Array Area at any one time, resulting in a maximum of 4,150 vessel return trips over the five-year construction period, and a maximum of 1,797 vessel return trips per year (Table 11.10). Vessels that will be used during the construction phase include jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels, and other support vessels (Table 11.10).

INJURY FROM VESSEL ACTIVITIES

11.10.2.41 Vessel traffic associated with the Proposed Development has the potential to lead to an increase in vessel movements within the Marine Mammal Study Area. This increase in vessel movement could lead to an increase in interactions between marine mammals and vessels during offshore construction. Whilst a broad range of vessel types have been involved in collisions with marine mammals (Laist *et al.*, 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger strike impact (Schoeman *et al.*, 2020). For example, a study by Laist *et al.* (2001) found that in 89% of collisions in which the whale was killed or seriously injured vessels were travelling at speeds of 14 kn (7 m/s) or more, and the vessel exceeded a length of 80 m. Therefore, larger vessels travelling at 7 m/s or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al.*, 2001). The majority of vessels used during the construction phase are likely to be large vessels that will either be travelling considerably slower than 7 m/s or will be stationary for significant periods of time. Therefore, the actual increase in vessel traffic moving within the Proposed Development and to/from port will occur over short periods of the offshore construction activity. Smaller vessels involved in construction activities (i.e. tug/anchor handlers, guard vessels, survey vessels, and crew transfer vessels) are able to move to avoid marine mammals (when detected), even when an animal is close and the vessel is going at high speed, due to better manoeuvrability compared to larger vessels (Schoeman *et al.*, 2020). In contrast, large vessels, such as jack-up vessels, have low manoeuvrability and may require larger distances to avoid an animal, but travel at slower speeds. In addition, the Factored In Measures (see Table 11.15) which include an Environmental VMP, will ensure that vessel traffic will move along predictable routes, which is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.*, 2001; Lusseau 2003; 2006). The Environmental VMP provides best practice guidance to minimise interactions with marine mammals and define how vessels should behave in the presence of them.

11.10.2.42 It is also likely that the noise emissions from vessels involved in the construction phase will be detectable by marine mammals and therefore will deter animals from the areas of potential impact. Whilst construction of the Proposed Development will lead to an uplift in vessel activity, vessel movements will be largely restricted to within the Array Area or along the offshore Cable Corridor and Working Area routes and will follow existing shipping routes to/from ports. Due to the volume of vessel traffic around the Marine Mammal Study Area already, the introduction of additional vessels during the construction phase of the Proposed Development will not be a novel impact for marine mammals present in the area. Therefore, it is not expected that vessel activities during the construction phase would increase the risk of injury due to vessel collision.

11.10.2.43 The impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the construction phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.44 Disturbance to marine mammals by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (Pirotta *et al.*, 2015). It is not simple to disentangle these drivers, therefore, disturbance from vessels is assessed within this chapter in general terms, covering disturbance driven by both vessel presence and underwater noise.

11.10.2.45 Noise levels from construction vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, and various rotating machinery (e.g., power generation, pumps) in the vicinity of the Proposed Development. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed and ambient noise levels (Wilson *et al.*, 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the construction of the Proposed Development exceeds the background ambient noise level.

11.10.2.46 Vessel noise levels are typically in the range of 10 to 100 Hz (Erbe *et al.*, 2019) with an estimated source level of 168 SEL_{cum} dB re 1 µPa @ 1 m (Root Mean Square (RMS)) for large construction vessels and 161 SEL_{cum} dB re 1 µPa @ 1 m (RMS) for medium construction vessels, travelling at a speed of 10 knots (see Volume III, Appendix 11.1: Underwater Noise Assessment). In general, support and supply vessels (50-100 m) are expected to have broadband source levels in the range 165-180 dB re 1µPa, with the majority of energy below 1 kHz (OSPAR, 2009). Large commercial vessels (>100 m) produce relatively loud and predominately low frequency sounds, with the strongest energy concentrated below several hundred Hz (OSPAR, 2009).

11.10.2.47 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.10.2.48 Thomsen *et al.* (2006) estimated that harbour porpoises will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. In addition, a study on the impacts of construction-related activities at Beatrice and Moray East offshore windfarms showed that harbour porpoises are displaced by offshore windfarm construction vessels (Benhemma-Le Gall *et al.*, 2021). Types of construction-related vessels that were assessed in this study included offshore service vessels for pile driving and jacket/turbine installation, guard vessels, crew-transfer vessels, and port service craft (Benhemma-Le Gall *et al.*, 2021). The median construction-related vessel density across the Moray Firth during the study period was 1.4 vessels/km^2. PAM data recorded at the site showed that the hourly occurrence of porpoise detections declined within 2 km of construction vessels, but that no response was observed out to 4 km, suggesting that responses declined within increasing distance to vessels (Benhemma-Le Gall *et al.*, 2021).

11.10.2.49 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation and Volume III, Appendix 15.1: Navigational Risk Assessment).

11.10.2.50 Throughout the construction of the Proposed Development, the Environmental VMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals.

11.10.2.51 For seals, Jones *et al.* (2017) analysed the predicted co-occurrence of ships and seals at sea which demonstrated that there is a large degree of predicted co-occurrence UK-wide, particularly within 50 km of the coast close to seal haul-outs. However, there is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and seals. In areas where seal populations are showing high levels of growth, such as southeast England), ship co-occurrences are highest (Jones *et al.*, 2017).

11.10.2.52 Although co-occurrence of vessels and seals is well documented through telemetry studies (e.g. Jones *et al.*, 2017), Thomsen *et al.* (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. Where seals may respond, it is expected that any impact on behaviour would be short-term and localised and would return to baseline once the vessel disturbance has ended.

11.10.2.53 The implementation of an Environmental VMP (Table 11.15) will reduce the risk of vessel disturbance by providing guidance regarding the speed and movement of vessels, resulting in slower moving vessels travelling more predictable routes which are less likely to cause disturbance. This is supported by vessel simulation modelling by Findlay *et al.* (2023) which predicted that, when animals were exposed to vessels at a given distance with both a 20% and a 50% reduction in speed, all potential noise impacts were reduced. At a 20% reduction in speed, the vessel noise swath halved, reducing the average number of animals exposed by 50% and therefore reducing the number of animals that are likely to be disturbed (Findlay *et al.*, 2023). In addition, the study demonstrated that moderate slowdowns strongly reduce vessel source levels, with a 20% reduction in speed decreasing mean source levels by 6 dB and a 50% speed reduction by 18 dB (Findlay *et al.*, 2023).

11.10.2.54 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.10.2.55 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.56 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.2.57 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.10.2.58 During the operational and maintenance phase, a maximum of 30 vessels will be present within the Array Area at any one time, resulting in a maximum of 1,359 vessel return trips per year (Table 11.10). Vessels that will be used during the operational and maintenance phase include crew transfer vessels, jack-up vessels, cable repair vessels (Table 11.10).

INJURY FROM VESSEL ACTIVITIES

11.10.2.59 Baseline information on vessel traffic during the operational and maintenance phase is outlined in section 11.10.2.58 and. The operational and maintenance phase may last for up to 36.5 years.

11.10.2.60 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the operational and maintenance phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the operational and maintenance phase would increase the risk of injury due to vessel collision.

11.10.2.61 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.10.2.41 and Table 11.15, the implementation of the

Factored In Measures, including an Environmental VMP, will advise that vessels movements follow predictable routes and provides guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout O&M activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.10.2.62 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality, as highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.10.2.63 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the operational and maintenance phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.64 As stated in paragraphs 11.10.2.2 and 11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity during the operational and maintenance phase is not considered a novel impact for marine mammals present in the area.

11.10.2.65 Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 ships/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation and Volume III, Appendix 15.1: Navigational Risk Assessment). Considering a maximum of 22 O&M vessels will be present within the Array Area at any one time, vessel traffic in the area around the Proposed Development is not likely to exceed the value presented by Heinänen and Skov (2015) even with the addition of vessels involved in the O&M phase.

11.10.2.66 As discussed in paragraph 11.10.2.41 and Table 11.15, the implementation of the Factored In Measures, including an Environmental VMP, will advise that vessels movements follow predictable routes and provides guidance on how vessels should behave in the presence of marine mammals, which will minimise the magnitude of any impact. Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the operational and maintenance phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.10.2.67 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the construction phase has been assessed as **Negligible adverse**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.68 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the operational and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the operational and maintenance phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.2.69 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.10.2.70 Vessel traffic during the decommissioning phase is anticipated to be similar in nature, but of lower magnitude, to the construction phase (Table 11.10).

INJURY FROM VESSEL ACTIVITIES

11.10.2.71 As stated in paragraphs 11.10.2.2 and11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a high amount of vessel traffic (see Volume II, Chapter 15: Shipping and Navigation). Vessel movements will be within the Array Area or along the offshore Cable Corridor and Working Area and will follow existing shipping routes to/from ports. Therefore, the introduction of additional vessels during the decommissioning phase of the Proposed Development is not a novel impact for marine mammals present in the area and it is not expected that vessel activities during the decommissioning phase would increase the risk of injury from collision.

11.10.2.72 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. As discussed in paragraph 11.10.2.41 and Table 11.15, the implementation of the Factored In Measures, including an Environmental VMP, will advise that vessel movements follow predictable routes, and provides guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact. Furthermore, a proportion of these vessels will be stationary or slow moving throughout decommissioning activities for significant periods of time, further reducing the likelihood and any impacts relating to vessel collision.

11.10.2.73 Furthermore, all marine mammal species are deemed to be of low vulnerability given that vessel collision is not considered to be a significant cause of mortality highlighted from post-mortem examinations of stranded animals in the UK (CSIP, 2019).

11.10.2.74 Therefore, the impact of injury to all marine mammal species from vessel activities is considered to result in a very small proportion of the population affected, occur relatively frequently throughout the decommissioning phase, the effect is unlikely to occur given implementation of Factored In Measures, intermittent (during vessel movements only), and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.75 The potential impacts during the decommissioning phase are anticipated to be similar to or less than the construction phase as the Rehabilitation Schedule confirms that no piling will be undertaken (Table 11.15).

11.10.2.76 As stated in paragraphs 11.10.2.2 and11.10.2.3, the coastal areas and immediate surrounding waters of the Proposed Development already experience a relatively high amount of vessel traffic. Therefore, the increase in vessel activity as a result of construction is not considered a novel impact for marine mammals present in the area.

11.10.2.77 Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5 km^2). Comparatively, vessel traffic in the shipping and navigation Study Area averages 36 to 37 vessels per day (see Volume II, Chapter 15: Shipping and Navigation and Volume III, Appendix 15.1: Navigational Risk Assessment).The Environmental VMP (Table 11.15) will advise that vessel traffic moves along predictable routes and will provide guidance on how vessels should behave in the presence of marine mammals which will minimise the magnitude of the impact.

11.10.2.78 Therefore, the impact of disturbance to all marine mammal species from vessel activities is considered to result in a small proportion of the population affected, occur frequently throughout the decommissioning phase, the effect is reasonably expected to occur, have short-term and reversible consequences, and is very unlikely to affect the population trajectory given implementation of Factored In Measures. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

INJURY FROM VESSEL ACTIVITIES

11.10.2.79 For all marine mammal species, the magnitude of the impact of injury to marine mammals from vessel activities during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **High**. Therefore, the significance of injury to marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

DISTURBANCE FROM VESSEL ACTIVITIES

11.10.2.80 For all marine mammal species within this assessment, the magnitude of the impact of disturbance from vessel activities during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of disturbance of marine mammals from vessel activities during the decommissioning phase for all marine mammal species is **Slight adverse** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.2.81 The significance of effect from injury and/or disturbance to marine mammals from vessel activities during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.3 Impact 3 – Changes in fish and shellfish community affecting prey resources

11.10.3.1 Marine mammals are dependent on fish and shellfish species as prey resources, therefore there is potential for indirect effects on marine mammals to occur as a result of direct impacts on fish and shellfish and/or their supporting habitat.

11.10.3.2 The key prey species for marine mammals within this assessment are presented in Table 11.46.

Table 11.46: Key prey species for marine mammals

Species	Key prey species	Region	Reference
Harbour porpoise	Whiting, herring, poor cod	Ireland	Hernandez-Milian *et al.* (2011)
Bottlenose dolphin	Whiting, blue whiting, pollock, saithe, haddock, poor cod, European hake, horse mackerel, flatfish, pelagic squid, octopus.	Ireland	Hernandez-Milian *et al.* (2011; 2015)
Risso's dolphin	Octopus species, squid species, cuttlefish species, crustaceans, poor cod, haddock, whiting	Scotland	MacLeod *et al.* (2014)
Common dolphin	Poor cod, goby, blue whiting, whiting, cephalopods, Atlantic herring, European sprat, haddock	Ireland	Brophy *et al.* (2009)
Minke whale	Sandeel, herring, sprat, mackerel, poor cod, gobies	UK	Pierce *et al.* (2004); Whooley (2016); Robinson *et al.* (2023)
Grey seal	Poor cod, salmonids, sandeel, dragonet, whiting, bib, blue whiting, haddock, pollock, saithe, herring, rockling, Norway pout, mackerel, hake, eels, wrasse, perch, sole, halibut, dab, flatfish species, squid species, octopus species	Ireland	Gosch *et al.* (2014); Wilson and Hammond (2019)
Harbour seal	Sandeel, sole, poor cod, dragonet, whiting, rockling, Atlantic horse mackerel,	Ireland	Kavangah *et al.* (2010)

Species	Key prey species	Region	Reference
	crustaceans, squid species, octopus species		

SENSITIVITY OF THE RECEPTOR

11.10.3.3 Impacts to prey resources will be largely restricted to the boundaries of the Proposed Development and, therefore, marine mammals occurring within this area also have the potential to be affected. However, the fish and shellfish species identified in Volume II: Chapter 10: Fish, Shellfish, and Sea Turtle Ecology are typical of those present within the western Irish Sea, and as marine mammals are highly mobile, it is reasonable to assume that they will be able to feed on sufficient, similar prey resource that is available in the wider area.

11.10.3.4 While there may be particular prey species that comprise a high proportion of their diet, all marine mammals within this assessment are considered as generalist feeders, therefore they can exploit a variety of prey resources and are not reliant on a single prey species (Table 11.46). As a result, all marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Low sensitivity to changes in fish and shellfish community affecting prey resources.

Construction phase

MAGNITUDE OF IMPACT

11.10.3.5 Potential impacts on fish and shellfish during the construction phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Injury and/or disturbance as a result of underwater noise and vibration during pile driving and cable installation activities; and
- Accidental pollution.

11.10.3.6 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology, which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the construction phase providing that Factored In Measures are implemented.

11.10.3.7 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the construction phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the construction phase.

SIGNIFICANCE OF EFFECT

11.10.3.8 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the construction phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.3.9 The significance of effect from changes in fish and shellfish community affecting prey resources during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.10.3.10 Potential impacts on fish and shellfish during the operational and maintenance phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition;
- Accidental pollution;
- Long-term habitat loss;
- Alteration of seabed habitats arising from changes in physical processes; and
- Changes in EMF from subsea electrical cabling.

11.10.3.11 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology, which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the operational and maintenance phase.

11.10.3.12 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur continuously throughout the operational and maintenance phase, have very short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the operational and maintenance phase.

SIGNIFICANCE OF EFFECT

11.10.3.13 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the operational and maintenance phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the operational and maintenance phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.3.14 The significance of effect from changes in fish and shellfish community affecting prey resources during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.10.3.15 Potential impacts on fish and shellfish during the decommissioning phase of the Proposed Development are described in Volume II, Chapter 10: Fish, Shellfish and Sea Turtle Ecology and include:

- Temporary habitat loss/disturbance;
- Increased SSC and associated deposition; and
- Accidental pollution.

11.10.3.16 Potential impacts on fish and shellfish are assessed in Volume II: Chapter 10: Fish, Shellfish and Sea Turtle Ecology, which concluded no significant adverse residual effects in respect to fish and shellfish ecological receptors during the decommissioning phase.

11.10.3.17 Therefore, the impact on all marine mammals in this assessment are considered to be highly localised, occur relatively frequently throughout the decommissioning phase, have intermittent and/or short-term consequences, and is unlikely to occur as there is expected to be no significant impacts on fish and shellfish species. Therefore, the magnitude of impact is assessed as Negligible for all marine mammal species during the decommissioning phase.

SIGNIFICANCE OF EFFECT

11.10.3.18 For all marine mammal species, the magnitude of the impact of changes in fish and shellfish community affecting prey resources during the decommissioning phase has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase for all marine mammal species is **Not Significant**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.3.19 The significance of effect from changes in fish and shellfish community affecting prey resources during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.4 Impact 4 – Accidental pollution

11.10.4.1 There is the potential for an accidental release of pollutants to occur from vessels and equipment associated with the construction, operational and maintenance and decommissioning phases of the Proposed Development which may result in adverse effects on marine mammals. Pollutants may include diesel fuel, bentonite (from drilling activities), lubricants, grease and oils, anti-fouling biocides, and grout.

SENSITIVITY OF THE RECEPTOR

11.10.4.2 In the event of an accidental spill, given the density and distribution of marine mammals in the Marine Mammal Study Area, it is possible that individuals could come into contact with contaminants.

11.10.4.3 Direct impacts include ingestion, inhalation, and absorption. All of which may result in physiological responses with health and long-term survival and/or reproduction consequences, the most serious of which could be damage to the respiratory system (Helm *et al.*, 2015).

11.10.4.4 Indirect impacts include short- and long-term reductions in food availability, disruption to social bonds, reduced reproduction, and/or cumulative effects on individuals, populations, and the ecosystem (Helm *et al.*, 2015).

11.10.4.5 Cetaceans are at risk from oil pollution in the marine environment because they lack the ability to leave the water to avoid oil. Cetaceans are however highly mobile and wide ranging, therefore any contact with a spill would be expected to be brief. They are also capable of detecting surface slicks, for example, experiments with captive bottlenose dolphins have shown that they can visually discriminate between oil and uncontaminated water and avoid oil on the surface of the water (Geraci and St. Aubin, 1984). Dolphins appear to rely on tactile clues to detect and avoid oil and it is unlikely that they would be unknowingly subjected to prolonged or repeated exposure to oil in the wild (Helm *et al.*, 2015).

11.10.4.6 Cetaceans must surface periodically to breathe, potentially bringing them into contact with floating oil and volatile toxic components. The more extensive the slick, the more likely that an animal will surface within it (Geraci and St. Aubin, 1980). While oil does not readily penetrate cetacean skin, exposure could affect mucus membranes, eyes, and other external soft tissue areas, potentially resulting in mortality (Helm *et al.*, 2015).

11.10.4.7 In the event of an accidental spill, prey species may also become oiled. Ingestion of oil through consumption of contaminated prey may cause damage to internal organs and have long-term consequences for individuals (Helm *et al.*, 2015).

11.10.4.8 Unlike cetaceans, seals are reliant on terrestrial haul-out sites for resting, moulting, and breeding which makes them particularly vulnerable to the effects of pollution. Information on key haul-outs for grey seals and harbour seals in the vicinity of the Proposed Development is presented in section 11.5.2. Seals have been shown to develop conjunctivitis, corneal abrasion, and swollen eyelid membranes in response to exposure to crude oil (Geraci and St. Aubin, 1980). While external oiling is not expected to significantly impact the ability of adult seals to maintain their core body temperature as they rely on blubber for insulation, seal pups entering the water could be vulnerable as oil residues can reduce the thermal properties of neonate animals, increasing their susceptibility to hypothermia (Helm *et al.*, 2015).

11.10.4.9 All marine mammal species within this assessment are considered to be of reasonable adaptability, reasonable tolerance, have medium recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Medium sensitivity to accidental pollution.

Construction phase

MAGNITUDE OF IMPACT

11.10.4.10 The installation of the offshore infrastructure for the Proposed Development may lead to the accidental release of pollutants through spills and leaks from vessels and equipment. The project design parameters for Project Design Option 2 during the construction phase are outlined in Table 11.10 and include the installation of 47 WTGs, two OSPs, between 110 and 122 km of inter-array cables, between 25 and 28 km of interconnector cables, and between 35 and 40 km offshore export cables. There will also be up to 4,150 vessel round trips and 294 helicopter round trips during the construction phase (including activities at the landfall site).

11.10.4.11 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by construction vessels and within equipment. The release of a large inventory of fuel oil from a construction vessel is, however, considered to represent the greatest potential accidental pollution event from installation activities. In the event of an accidental spill from vessels, equipment or from construction activities, the spill would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022).

11.10.4.12 Given the Factored In Measures (see Table 11.15), the likelihood of accidental release is considered extremely low. The measures in the EMP include storage of chemicals in secure designated areas on vessels in line with appropriate regulations and guidelines, and double skinning of any tanks and pipes containing hazardous substances. All chemicals used will be subject to a chemical risk assessment to ensure risks are understood and minimised. The EMP also includes a MPCP which will contain key emergency contact details and response procedures in the event of a spill of any magnitude (TIER I, II or III) to ensure minimal impact. Complying with these procedures will also reduce the magnitude of any spill. Adherence to the Factored In

Measures outlined in Table 11.15, including the EMP and MPCP will significantly reduce the likelihood of an accidental pollution incident occurring, and the magnitude of its impact.

11.10.4.13 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the construction phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.4.14 For all marine mammal species, the magnitude of the impact of accidental pollution during the construction phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the construction phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.4.15 The significance of effect from accidental pollution during the construction phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.10.4.16 There is the potential for the accidental release of pollutants during the operational and maintenance phase of the Proposed Development as a result of the presence of offshore infrastructure, associated equipment, and vessel movements. The project design parameters for Project Design Option 2 during the operational and maintenance phase are outlined in Table 11.10. This includes synthetic compound, for example from antifouling biocides, heavy metal, and hydrocarbon contamination as a result of the presence of 47 WTGs and two OSPs as well as from maintenance activities. There will also be up to 1,359 vessel round trips and 485 helicopter round trips per year during the operational and maintenance phase.

11.10.4.17 The magnitude of the impact of accidental pollution will be dependent on the quantities of potential pollutants carried by operational and maintenance vessels and within equipment. Any accidental spill from vessels or equipment or from maintenance activities would be subject to immediate dilution and rapid dispersal (Marappan *et al.,* 2022). As discussed in paragraph 11.10.4.12 and Table 11.15, the implementation of the Factored In Measures, including an EMP and MPCP, will ensure that the likelihood of accidental release occurring is extremely low and, in the event that an accidental release does occur, will limit the magnitude of the impact.

11.10.4.18 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the operational and maintenance phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.4.19 For all marine mammal species, the magnitude of the impact of accidental pollution during the operational and maintenance phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the operational and maintenance phase for all marine mammal species is **Slight adverse,** which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.4.20 The significance of effect from accidental pollution during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

Decommissioning phase

MAGNITUDE OF IMPACT

11.10.4.21 The magnitude of the potential impact to marine mammals from accidental pollution during the decommissioning phase is expected to be the same as described previously for the construction phase (see paragraphs 11.10.4.10 to 11.10.4.12).

11.10.4.22 The impact of accidental pollution on marine mammals is considered unlikely to occur but would only occur once or infrequently if it did occur during the decommissioning phase. It is expected to have intermittent and reversible consequences for most individuals and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.4.23 For all marine mammal species, the magnitude of the impact of accidental pollution during the decommissioning phase has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium**. Therefore, the significance of effect from accidental pollution during the decommissioning phase for all marine mammal species is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.4.24 The significance of effect from accidental pollution during the decommissioning phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.5 Impact 5 - Changes in Electromagnetic Fields (EMF) from subsea electrical cabling

11.10.5.1 The conduction of electricity through subsea power cables has the potential to emit a localised EMF which could potentially affect the sensory mechanisms of marine mammal species (CMACS, 2003; Copping, 2018; Normandeau *et al.*, 2011).

11.10.5.2 There are no thresholds for assessing impacts to marine life from EMFs, therefore by necessity, this impact assessment is qualitative by nature, based on the available evidence base (a combination of laboratory experiments and field studies). An overview of the expected levels of EMF and the potential impacts associated are presented below.

SENSITIVITY OF THE RECEPTOR

11.10.5.3 The effects of EMF on marine mammals are not well understood and, more broadly, there has been a lack of studies investigating the effects of EMFs on the behaviour of magneto- and electrosensitive animals.

11.10.5.4 There is no evidence that seals can detect or respond to EMF, however there is evidence to suggest that some species of cetacean may be able to detect variations in magnetic fields, therefore it is plausible that they are magneto-sensitive (Normandeau *et al.*, 2011). Kirschvink *et al.* (1986) suggested that species that were sensitive to changes in the Earth's magnetic field and that are likely to be present within the Proposed Development include harbour porpoise, Risso's dolphin, and common dolphin. However, the majority of these have had a theoretical evidence base, coming to differing conclusions regarding species' sensitivity to changes in electric and magnetic fields (Normandeau *et al.*, 2011). The only evidence of electro-sensitivity in marine mammals to date is reported in Guiana dolphin (*Sotalia guianensis*) as they have been shown to possess an electroreceptive system which is used to detect electrical stimuli (Czech-Damal *et al.*, 2013).

11.10.5.5 Potential responses of cetaceans from EMF could include avoidance behaviour, disruption in orientation, and effects on feeding or social interaction (Normandeau *et al.*, 2011), although it is important to note that these responses are all currently hypothetical. Whilst subsea cables could create a very localised change in the geomagnetic field (Taormina *et al.*, 2018), modelling studies of EMF from cables suggests that the likelihood of such a change affecting a large enough area to elicit a significant course alteration would be low (Normandeau *et al.*, 2011).

11.10.5.6 Theoretically, there is the potential for some very localised behavioural effects, although no evidence exists at present that marine mammal species within this assessment are magneto-sensitive. All marine mammal species within this assessment are considered to be of high adaptability, high tolerance, have high recoverability, and are of high value. Therefore, all marine mammal species in this assessment are assessed as having a Negligible sensitivity to changes in EMF from subsea electrical cabling.

Operational and maintenance phase

MAGNITUDE OF IMPACT

11.10.5.7 EMFs are a combination of an electrical field and a magnetic field, with the electrical field generated by static charges and the magnetic field generated by moving currents.

11.10.5.8 Anthropogenic sources of EMF are primarily subsea cables used for power generation and telecommunications or submarine communications (Normandeau *et al.*, 2011; Tasker *et al.*, 2010). Therefore, the presence and operation of between 110 and 122 km of 66 kV inter-array cables, between 35 and 40 km of 220 kV offshore export cables, and between 25 and 28 km of 220 kV OSP interconnector cables during the lifetime of the Proposed Development (see Table 11.10) may lead to localised EMF effects on marine mammals.

11.10.5.9 Submarine cables can cause three different types of EMFs: electrical (E) fields, magnetic (B) fields, and induced electric (iE) fields. E-fields are measured in V/m and are generated by the voltage of the cable. B-fields are measured in μT or mG where 1 μT = 10 mG and are generated by the current of the power through the cable. They attenuate both horizontally and vertically away from the cable, with field strength directly related to the power of the current passing through the cable, rather than being specifically related to the voltage. iE-fields are measured in V/m and are generated by the fluctuation of the B-fields (in AC transmission) or by the motion of the seawater (or an organism) through the B-field. Therefore, they are dependent on the strength of the B-field, thus the strength of the iE-field is directly related to the B-field, which is strongest closest to the cable, attenuating horizontally and vertically away from it.

11.10.5.10 EMFs also occur naturally in the marine environment from a variety of sources including background levels from the Earth's magnetic field, and very small fields generated by electrical currents moving through organisms (Tricas and Gill, 2011). The Earth's static B-field is present in both terrestrial and aquatic environments and lies in the range 25 to 65 μT (Hutchison *et al.*, 2018). The B-field strength of the Irish Sea is approximately 49 μT (NOAA, 2020).

11.10.5.11 Measurements of EMF for subsea cables associated with offshore windfarms vary, with the strength of the B-field generated generally related to the wind speed captured by the turbines. A variety of design and installation factors affect EMF levels in the vicinity of the cables such as current flow, distance between cables, cable insulation, number of conductors, configuration of cable and burial depth. For example, EMFs produced by inter-array cables are smaller than those of export and OSP interconnector cables as they are lower powered in comparison. Furthermore, the B-fields generated by HVAC and HVDC cables are significantly different, with DC cables typically generating much larger EMFs than HVAC cables (Tricas and Gill, 2011). The transmission system used for the Proposed Development will only comprise HVAC.

11.10.5.12 CMACS (2003) reported that for a 132 kV three-phase AC cable with perfect shielding, the predicted B-field in close proximity to the cable was 1.6 μT and the respective iE-field was 91.25 μV/m above the cable if buried to 1 m depth, which reduced to 10 μV m-1 8 m from the cable. Gill *et al.* (2009) measured iE-fields of 30 μV/m and 110 μV/m at two different offshore windfarm cables (both three-phase AC, 36 kV, 100 A) close to the cables and B-fields of 0.23 μT and 6.5 μT, respectively. CSA (2019) compared offshore windfarm subsea cables and found EMF levels directly over live AC undersea power cables associated with offshore wind energy projects ranged between 5 to 15 mG (0.5 to 1.5 μT) for inter-array cables and 10 to 40 mG (1 to 4 μT) for export cables, at heights of 1 m above the seabed. At lateral distances of between 3 m and 7.5 m from the cable, B-fields greatly reduced to <0.1 to 7 mG (<0.01 to 0.7 μT) for inter-array cables, and <0.1 to 12 mG (<0.01 to 1.2 μT) for export cables, at heights of 1 m above the seabed. Measurements of the iE-fields directly over live AC undersea power cables in the same study ranged between 0.1 to 1.2 mV/m for the inter-array cables and 0.2 to 2.0 mV/m for export cables, at heights of 1 m above the seabed (CSA, 2019). At lateral distances of between 3 m and 7.5 m, iE-fields reduced to between 0.01 to 0.9 m V/m for inter-array cables and 0.02 to 1.1 mV/m for export cables at heights of 1 m above the seabed.

11.10.5.13 The strength of the B-field (and consequently, iE-fields) decreases rapidly horizontally and vertically with distance from source (Normandeau *et al.*, 2011). Burial of cables, in particular, can therefore reduce the strength of the B- and iE-fields. However, it is unlikely that cables can be buried to sufficient depths that will reduce the magnitude of the B-field, and hence the sediment-seawater interface iE-field, to the extent that these fields could not be detected by certain marine organisms on or close to the seabed (Gill *et al.*, 2005). A study conducted by CSA (2019) found that inter-array and export cables buried between depths of 1 m to 2 m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

11.10.5.14 While there may be some change to EMFs in the vicinity of inter-array, export, and OSP interconnector cables, the studies presented above indicate that these would likely be highly localised, with the strength of EMFs dissipating quickly with increased distance from the buried cables. The impact of EMFs on marine mammals is considered to occur throughout the operational and maintenance phase, is reasonably expected to occur, and have intermittent and recoverable consequences but is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

11.10.5.15 For all marine mammal species, the magnitude of the impact of changes in EMFs from subsea electrical cabling has been assessed as **Low adverse**, with the sensitivity of the receptor being **Negligible**. Therefore, the significance of effect from changes in EMFs from subsea electrical cabling during the operational and maintenance phase for all marine mammal species is **Imperceptible**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.5.16 The significance of effect from changes in EMFs from subsea electrical cabling during the operational and maintenance phase is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Mitigation already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.6 Impact 6 - Injury and/or disturbance to marine mammals from underwater noise during UXO clearance

11.10.6.1 It is possible that UXO items with a range of charge weights (or quantity of contained explosive) are present within the boundaries of the Proposed Development, therefore there is potential for UXO clearance to be required prior to construction. While it may be possible for identified UXO to be either avoided, removed, or relocated, there is potential that underwater detonation could be required where it is deemed necessary and unsafe to remove the UXO.

11.10.6.2 Methods of UXO clearance considered for the Proposed Development may include high order and low order detonation. It is important to note that while high-order detonation represents the worst-case scenario for UXO clearance, high order detonation may be avoided, and low-order clearance methods (deflagration) used instead.

11.10.6.3 The number of UXO that may require clearance and duration of UXO clearance operations are currently unknown. Therefore, it is important to note that the assessments for UXO clearance presented within this chapter are, at this stage, illustrative.

11.10.6.4 The severity of the consequences of UXO detonation will depend on several variables, including, but not limited to, the charge weight and its proximity to the receptor. Potential effects of underwater detonation of UXOs on marine mammals include auditory injury from exposure to the acoustic wave, resulting in permanent auditory injury or loss in hearing sensitivity (PTS), or temporary loss in hearing sensitivity (TTS); and behavioural disturbance which could impact on feeding, mating, breeding, and/or resting (Ketten, 2004; Richardson *et al.,* 1995; von Benda-Beckmann *et al.,* 2015).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY – PTS

11.10.6.5 All species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al*., 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al*., 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.10.6.6 The primary acoustic energy produced by a high order detonation is below the region of greatest sensitivity for most marine mammal species (harbour porpoise, dolphin species, seals) considered within this assessment (Southall *et al.,* 2019), with most acoustic energy produced below a few hundred Hz, and decreasing by SEL ~10 dB per decade above 100 Hz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). There is also a pronounced reduction in energy levels above ~5-10 kHz (von Benda-Beckmann *et al.,* 2015; Salomons *et al.,* 2021). Furthermore, recent evidence shows that the sound produced during UXO detonation has lower frequency components (<100 Hz) than was previously assumed (Robinson *et al.,* 2022), therefore this assessment is likely to be overly precautionary for species, such as minke whale, whose hearing sensitivity was previously assumed to overlap with the primary acoustic energy produced by a high order detonation.

11.10.6.7 If PTS were to occur within this low frequency range, it is unlikely that it would result in a significant impact on the vital rates of harbour porpoise, dolphin species, and seals. As a result, they are considered to be of high adaptability, reasonable tolerance, have no recoverability, and are of high value. Therefore, harbour porpoise, dolphin species, and seal species are assessed as having a Low sensitivity to PTS from underwater noise during UXO clearance. Minke whales are assessed as having a Medium sensitivity to PTS from underwater noise during UXO clearance, although as discussed in paragraph 11.10.6.6, this is precautionary.

BEHAVIOURAL DISTURBANCE

11.10.6.8 JNCC (2020) states that 'a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement'. Each donation will be of short-term duration; therefore, it is not expected that behavioural disturbance from a single UXO detonation would cause a significant impact.

11.10.6.9 As a result, all marine mammal species are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of high value. Therefore, they are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during UXO clearance.

Construction phase

MAGNITUDE OF IMPACT

AUDITORY INJURY – PTS

11.10.6.10 The following section provides the quantitative assessment of the impact of PTS from UXO clearance on marine mammals. A UXO detonation is defined as a single pulse, therefore both the weighted SEL_{cum} criteria and the unweighted SPL_{peak} criteria from Southall *et al.* (2019) have been presented in Table 11.18 and the source levels (unweighted SPL_{peak} and SEL_{ss}) for each charge weight are presented in Table 11.19, whereby SEL_{cum} is equivalent to SEL_{ss}. As a result, animal fleeing assumptions do not apply to the values presented. The predicted impact ranges for auditory injury (PTS-onset) from UXO clearance for each FHG are presented in Table 11.30 and the number of animals predicted to experience PTS-onset from UXO clearance are presented in Table 11.31.

11.10.6.11 Generally, the estimated auditory injury (PTS-onset) impact ranges increased with the size of the charge for all FHGs (Table 11.47). For harbour porpoise, the maximum PTS-onset impact range was 14 km (SPL_{peak}) (Table 11.47). This equates to a maximum of 234 individuals experiencing auditory injury (0.37% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) using the site-specific DAS density estimate (Table 11.48).

11.10.6.12 At all charge sizes, HF cetaceans (dolphin species) have the smallest predicted impact range of up to 840 m (SPL_{peak}) (Table 11.47). For bottlenose dolphin, Risso's dolphin, and common dolphin, the maximum PTS-onset impact range was 840 m (SPL_{peak}), which equates to <1 individual experiencing auditory injury from UXO clearance (Table 11.48).

11.10.6.13 For all FHGs, the unweighted SPL_{peak} impact ranges are higher than the weighted SEL_{ss} impact ranges with the exception of LF cetaceans, such as minke whale, due to the sensitivity of their hearing (Table 11.47). For minke whale, the maximum PTS-onset impact range was 11 km (SEL_{ss}) (Table 11.47). This equates to a maximum of 17 individuals experiencing auditory injury (0.09% of the reference population) from a high order UXO clearance using the greatest charge weight (800 kg plus donor) (Table 11.48).

11.10.6.14 For seals, the maximum PTS-onset impact range was 2.8 km (SPL_{peak}) (Table 11.47). This equates to two grey seals (0.12% of the reference population) and <1 harbour seal (<0.01% of the reference population) experiencing auditory injury from a high order UXO clearance using the greatest charge weight (Table 11.48).

11.10.6.15 For all FHGs, the auditory injury (PTS-onset) impact range for low order clearance is small, with a maximum range of <1.2 km (Table 11.47).

11.10.6.16 For all marine mammal species, the impact is considered to result in a very small proportion of the population affected and very unlikely to affect the population trajectory, although auditory injury (PTS) is expected to have a permanent change to the receptor. Therefore, the magnitude of impact is assessed as Low adverse for harbour porpoise, minke whale, and grey seal. For dolphin species and harbour seal, <1 animal is predicted to experience auditory injury (PTS), therefore the magnitude of impact is assessed as Negligible.

Table 11.47: Summary of auditory injury (PTS-onset) impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals.

Charge weight (kg)	PTS-onset (unweighted SPL_{peak})				PTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	1.2 km	70 m	220 m	240 m	110 m	<50 m	320 m	60 m
25 + donor	4.6 km	260 m	820 m	910 m	570 m	<50 m	2.2 km	390 m
55 + donor	6.0 km	340 m	1.0 km	1.1 km	740 m	<50 m	3.2 km	570 m
120 + donor	7.8 km	450 m	1.3 km	1.5 km	950 m	<50 m	4.7 km	830 m
240 + donor	9.8 km	560 m	1.7 km	1.9 km	1.1 km	<50 m	6.5 km	1.1 km
525 + donor	12.0 km	730 m	2.2 km	2.5 km	1.4 km	50 m	9.5 km	1.6 km
700 + donor	14.0 km	810 m	2.4 km	2.7 km	1.5 km	60 m	10.0 km	1.9 km
800 + donor	14.0 km	840 m	2.6 km	2.8 km	1.6 km	60 m	11.0 km	2.0 km

Table 11.48: Predicted impact of PTS-onset for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population. For further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor	0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor
Harbour porpoise	0.38	#	2	25	43	73	115	172	234	234	<1	<1	1	1	1	2	3	3
		%	<0.01	0.04	0.07	0.12	0.18	0.27	0.37	0.37	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.2803	#	1	19	32	54	85	127	173	173	<1	<1	<1	1	1	2	2	2
		%	<0.01	0.03	0.05	0.09	0.14	0.20	0.28	0.28	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bottlenose dolphin	0.0201	#	0	0	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	<0.01	<0.01	0.01	0.01	0.01	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	0.2352	#	0	<1	<1	<1	<1	<1	<1	1	0	0	0	0	0	0	0	0
		%	0.00	0.02	0.03	0.05	0.08	0.13	0.17	0.18	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Species	Density (animals/km²)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor	0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor
Risso's dolphin	0.031	#	0	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Common dolphin	0.0272	#	0	<1	<1	<1	<1	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Minke whale	0.045	#	<1	<1	<1	<1	<1	1	1	1	<1	1	1	3	6	13	14	17
		%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.03	0.06	0.07	0.09
	0.017	#	0	<1	<1	<1	<1	<1	<1	<1	<1	<1	1	1	2	5	5	6
		%	0.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.03	0.03
	0.08	#	<1	<1	<1	1	1	2	2	2	0	<1	<1	<1	<1	1	1	1

Species	Density (animals/km^2)	Impact	PTS-onset (unweighted SPL_{peak})								PTS-onset (weighted SEL_{ss})							
			0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor	0.5 kg (low order)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	700 kg + donor	800 kg + donor
Grey seal		%	<0.01	0.01	0.02	0.03	0.05	0.09	0.11	0.12	0.00	<0.01	<0.01	0.01	0.02	0.04	0.05	0.06
Harbour seal	0.0003	#	0	0	0	0	0	<1	<1	<1	0	0	0	0	0	0	0	0
		%	0.00	0.00	0.00	0.00	0.00	<0.01	<0.01	<0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TTS

11.10.6.17 The following section provides the qualitative assessment of the impact of TTS from UXO clearance on marine mammals. The predicted impact ranges for TTS-onset from UXO clearance for each FHG are presented in Table 11.49. As outlined in paragraph 11.7.5.6, no assessment of the number of animals, magnitude, sensitivity, or significance of effect is given.

11.10.6.18 Generally, the estimated TTS-onset impact ranges increased with the size of the charge for all FHGs. For harbour porpoises (VHF cetaceans), the maximum TTS-onset impact range was 26 km (SPL_{peak}) for a high order detonation using the greatest charge weight (800 kg plus donor) (Table 11.49).

11.10.6.19 For dolphin species (HF cetaceans), the maximum TTS-onset impact range was 1.5 km (SPL_{peak}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) Table 11.49).

11.10.6.20 For minke whale, the maximum TTS-onset impact range was 120 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.49).

11.10.6.21 For seals, the maximum TTS-onset impact range was 23 km (SEL_{ss}) for a high order detonation using the using the greatest charge weight (800 kg plus donor) (Table 11.49).

11.10.6.22 For all FHGs, the TTS-onset impact range for low order clearance is small, with a range of <4.5 km.

Table 11.49: Summary of TTS-onset impact ranges for UXO detonation using the impulsive noise criteria from Southall *et al.* (2019) for marine mammals.

Charge weight (kg)	TTS-onset (unweighted SPL_{peak})				TTS-onset (weighted SEL_{ss})			
	VHF cetacean	HF cetacean	LF cetacean	PCW	VHF cetacean	HF cetacean	LF cetacean	PCW
0.5 (low order)	2.3 km	130 m	410 m	450 m	930 m	<50 m	4.5 km	800 m
25 + donor	8.5 km	490 m	1.5 km	1.6 km	2.4 km	150 m	29 km	5.2 km
55 + donor	11 km	640 m	1.9 km	2.1 km	2.8 km	210 m	41 km	7.5 km
120 + donor	14 km	830 m	2.5 km	2.8 km	3.2 km	300 m	57 km	10 km
240 + donor	18 km	1.0 km	3.2 km	3.5 km	3.5 km	390 m	76 km	14 km
525 + donor	23 km	1.3 km	4.1 km	4.6 km	4.0 km	530 m	100 km	19 km
700 + donor	25 km	1.4 km	4.5 km	5.0 km	4.1 km	590 m	110 km	22 km
800 + donor	26 km	1.5 km	4.7 km	5.3 km	4.2 km	620 m	120 km	23 km

BEHAVIOURAL DISTURBANCE

11.10.6.23 This section presents the quantitative assessment for behavioural disturbance during UXO clearance using high order and low order methodologies as described in section 11.7.5.

26 KM EDR FOR HIGH ORDER CLEARANCE

11.10.6.24 The number of each marine mammal species predicted to experience behavioural disturbance as a result of high order UXO detonation using a 26 km EDR is quantified by multiplying the area of impact (assuming a 26 km EDR results in an impact area of 2,123.72 km^2) by the respective species-specific density estimate. The results are presented in Table 11.50 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.50: Predicted impact of disturbance to marine mammals from UXO assuming a 26 km EDR. For further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	807	1.29
	0.2803	595	0.95
Bottlenose dolphin	0.0201	43	14.57
	0.2352	499	170
Risso's dolphin	0.031	66	0.54
Common dolphin	0.0272	58	0.06
Minke whale	0.045	96	0.48
	0.017	36	0.18
Grey seal	0.08	170	10.22
Harbour seal	0.0003	1	0.35

11.10.6.25 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 807 harbour porpoises, 499 bottlenose dolphins, and 170 grey seals are predicted to be disturbed (Table 11.50).

11.10.6.26 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.50). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative. Using the uniform density estimate of 0.2803 animals/km^2 from the wider SCANS-IV surveys, it was estimated that 499 animals will experience behavioural disturbance as a result of UXO detonation, using the 26 km EDR (Table 11.50), which is considerably lower.

11.10.6.27 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys (Table 11.50). However, the percentage of the reference population impacted is not considered to be realistic as it does not account for the variability in coastal and offshore population densities and distributions within the Irish Sea. Furthermore, the design of broad scale surveys, such as SCANS, used to derive MU population estimates are not designed to capture localised, coastal populations such as that of Cardigan Bay; therefore, the reference population size has been under-estimated.

11.10.6.28 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.50).

11.10.6.29 While it is expected that a high order UXO detonation would elicit a startle response and therefore, only a very short-term duration behavioural response is expected (JNCC, 2020); however, there is no empirical evidence of any marine mammal species' response to these events. The impact is considered to result in a small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

5 KM EDR FOR LOW ORDER CLEARANCE

11.10.6.30 The 5 km EDR has been used in this assessment for illustrative purposes and should be viewed with caution as there is no evidence to support this impact range. The number of each marine mammal species predicted to experience behavioural disturbance as a result of low order UXO detonation using a 5 km EDR is quantified by multiplying the area of impact (78.54 km^2) by the respective species-specific density estimate. The results are presented in Table 11.51 and assessed as the proportion of the respective reference population (as presented in Table 11.7). A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.

Table 11.51: Predicted impact of disturbance to marine mammals from UXO assuming a 5 km EDR. For further information on the densities used, see Table 11.7

Species	Density (animals/km^2)	Number of animals disturbed	Percentage of the reference population
Harbour porpoise	0.38	30	0.05
	0.2803	22	0.04
Bottlenose dolphin	0.0201	2	0.54
	0.2352	18	6.30
Risso's dolphin	0.031	2	0.02
Common dolphin	0.0272	2	<0.01
Minke whale	0.045	4	0.02
	0.017	1	0.01
Grey seal	0.08	10	0.38
Harbour seal	0.0003	<1	0.01

11.10.6.31 The greatest estimated disturbance occurs for harbour porpoise, bottlenose dolphin, and grey seal, where up to 30 harbour porpoises, 18 bottlenose dolphins, and 10 grey seals are predicted to be disturbed (Table 11.51).

11.10.6.32 The estimated number of harbour porpoise and percentage of the reference population impacted is greatest when using the using the site-specific density estimate of 0.38 animals/km^2 from the DAS (Table 11.51). However, this assumes that the density within the site-specific Marine Mammal Study Area is the same across the wider extent of the Irish Sea and is therefore considered to be highly conservative.

11.10.6.33 The estimated number of bottlenose dolphins and percentage of the reference population impacted is greatest when using the density estimate of 0.2352 animals/km^2 from the SCANS-IV surveys and is therefore considered to be the most conservative estimate (Table 11.51).

11.10.6.34 The estimated number of minke whale and percentage of the reference population impacted is greatest when using the uniform density estimate of 0.045 animals/km^2 from the ObSERVE surveys and is therefore considered to be the most conservative estimate (Table 11.51).

11.10.6.35 The impact of low order detonation is considered to result in a very small proportion of the population affected with change expected to be recoverable, occur infrequently throughout the construction phase, is reasonably expected to occur, and have intermittent and temporary consequences that are very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT.

AUDITORY INJURY - PTS

11.10.6.36 For harbour porpoise, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to harbour porpoise from underwater noise during UXO clearance **is Slight adverse**, which is **not significant** in EIA terms.

11.10.6.37 For bottlenose dolphin, Risso's dolphin, and common dolphin, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from PTS to bottlenose dolphin, Risso's dolphin, and common dolphin from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

11.10.6.38 For minke whale, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Medium.** Therefore, the significance of effect from PTS to minke whale from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.10.6.39 For grey seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to grey seal from underwater noise during UXO clearance is **Slight adverse**, which is **not significant** in EIA terms.

11.10.6.40 For harbour seal, the magnitude of the impact of PTS from underwater noise during UXO clearance has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS to harbour seal from underwater noise during UXO clearance is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.10.6.41 For all marine mammal species, the impact of behavioural disturbance from underwater noise during UXO clearance has been assessed as Low adverse, with the sensitivity of the receptor being Low. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during UXO clearance is Slight adverse, which is not significant in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.6.42 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during UXO clearance is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.6.43 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, the Developer has committed to a UXO MMMP to further reduce the risk of PTS-onset, which also applies to both harbour and grey seals (which are not EPS).

11.10.7 Impact 7 - Injury and/or disturbance from underwater noise during site surveys

11.10.7.1 In 2023, the Developer submitted a Foreshore Licence Application (FLA) to carry out site surveys at the site of the Proposed Development. The details provided within this assessment are aligned with the Arklow Bank Wind Park – Foreshore Licence Application for Site Surveys – Annex IV Species Risk Assessment (RPS, 2023), and the accompanying Schedule of Works. Surveys will be carried out before the construction phase, prior to the installation of the offshore infrastructure, and routinely during the operational and maintenance phase.

11.10.7.2 The key parameters for assessment of Project Design Option 2 considers underwater noise from site surveys (Table 11.10). Site surveys of relevance to this chapter are those that produce underwater noise and include geophysical and geotechnical surveys. Geophysical surveys such as MBES and SSS typically produce sound sources that are sonar-based or impulsive. Geotechnical surveys such as vibrocoring, typically produce non-impulsive sound sources, whilst some geotechnical surveys, such as grab sampling will not result in any measurable noise (Table 11.52; Table 11.53). The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore examples of the different survey equipment and expected source levels are presented in Table 11.52 for geophysical equipment, and Table 11.53 for geotechnical survey equipment.

Table 11.52: Expected geophysical surveys and equipment, with indicative source levels.

Survey type	Equipment type	SEL (unweighted) (dB re 1µPa²s @1 m)	SPL rms T90 (dB re 1µPa @1 m)	SPL pk (dB re 1µPa @ 1 m)
Non-impulsive sonar-based surveys / equipment				
Multibeam EchoSounder (MBES)	Konsberg EM2040 or Reson Seabat 7125	N/A	213	N/A
Side scan sonar (SSS)	Edgetech FS4200 or Klein 5000	N/A	210	N/A

Survey type	Equipment type	SEL (unweighted) (dB re 1μPa^{2}s @1 m)	SPL$_{rms}$ T90 (dB re 1μPa @1 m)	SPL$_{pk}$ (dB re 1μPa @ 1 m)
Sub-bottom profiler (SBP)	Innomar SES Standard / Medium or Applied Acoustics AA251 or Egdetech 6205S	N/A	245	N/A
Impulsive surveys / equipment				
Seismic refraction	TI sleeve 10CU	195	214	224
Sparker (2DUHRS and 3DUHRS)	Geosource 200 – 400	182	214	219

Table 11.53 Expected geotechnical surveys and source levels.

Survey type	Source level (dB re 1μPa re 1 m (peak)	Source SEL (dB re 1 μPa^{2}s re 1 m) (unweighted)	SPL rms T90
Seismic Cone Penetration Test (CPT)[1]	220	189	203
Vibrocore	190	223[2]	187
Grab sample	N/A	N/A	N/A

[1]Equipment is pushed into the seabed and therefore would not result in a measurable noise source.

[2]Based on one hour of operation for a single core sample.

11.10.7.3 Underwater noise has the potential to impact marine mammals if the frequency is within their hearing range (Table 11.18) and the sound levels are greater than the relevant thresholds for the FHG in which the species is categorised. (Table 11.20; Southall *et al.*, 2019). Noise levels generated from site surveys (geophysical and geotechnical) were predicted by Seiche Ltd. Full details of the underwater noise modelling methodology, assumptions, and resulting impact ranges are detailed in Seiche Ltd. (2022).

SENSITIVITY OF THE RECEPTOR

AUDITORY INJURY

11.10.7.4 Very limited information exists on the impacts of site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns. However, all species of cetaceans rely on sonar for navigation, finding prey and communication (Southall *et al.*, 2007). The ecological consequences of PTS are uncertain, although a loss of hearing could affect key life functions such as communication, predator detection, foraging, mating and maternal fitness, and could lead to a change in an animal's health or vital rates (Erbe *et al.*, 2018). Relating a potential loss in hearing to a biologically significant response is challenging due to a paucity of empirical data, however a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals.

11.10.7.5 A study by Lucke *et al.* (2009) indicated that TTS could be induced in harbour porpoise at 350 m when exposed to an airgun impulse at a peak pressure of 200 $dB_{pk\text{-}pk}$ re 1 µPa with corresponding SEL of 164.5 dB re $\mu Pa^2{}_s$) in shallow waters (~4 m), however this study is highly conservative as it assumes that the animal would remain stationary throughout the exposure. Evidence from other studies suggests that harbour porpoises exposed to such noise sources would likely move away from the source, and therefore leave the impact range of PTS-onset (Hermannsen *et al.,* 2015). Furthermore, it is expected that vessel presence will act as a deterrent to harbour porpoise, reducing the risk of auditory injury (Benhemma-Le Gall *et al*., 2023). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any survey activity.

11.10.7.6 While PTS is a permanent effect which cannot be recovered from, the most likely response of a marine mammal to noise levels that could induce TTS is to flee the area (Southall *et al.,* 2007). Therefore, animals exposed to these noise levels that could induce TTS are likely to actively avoid hearing damage by moving away from the source.

11.10.7.7 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. However, it is unlikely that PTS and TTS from site surveys would significantly impact the survival of reproductive rates of marine mammal species in this assessment. As a result, they are considered to be of high adaptability, reasonable tolerance, have between no and full recoverability, and are of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to auditory injury from underwater noise during site surveys.

BEHAVIOURAL DISTURBANCE

11.10.7.8 Limited information exists on the impacts of behavioural disturbance from site surveys (geophysical and geotechnical) to marine mammals, with most available studies investigating the impact of seismic airguns.

11.10.7.9 An analysis of MMO reports found that small cetaceans (including harbour porpoise) have a tendency to swim away from seismic airguns at speed or tend to avoid survey vessels when airguns are firing up to a distance of ~1 km away (Moulton and Miller, 2005; Pirotta *et al.,* 2014; Stone, 2003). Acoustic data collected by Pirotta *et al.* (2013) showed that harbour porpoise that remained in the seismic survey impact area reduced their echolocation activity by 15% during the survey, which could be indicative of changes to foraging or social behaviour (van Beest *et al.,* 2018). Although, Thomspon *et al.* (2013) found that short-term disturbance by a seismic survey in the North Sea did not lead to long-term displacement of harbour porpoises as animals were typically detected again within a few hours following the survey works. Similarly, Hoekendijk *et al.* (2018) concluded that short-term, irregular disturbance events are unlikely to significantly affect the energetic status of harbour porpoise, particularly where surveys are conducted in shallow waters as sound cannot propagate as far.

11.10.7.10 For common dolphins, evidence suggests that there is no change in occurrence or sighting densities of common dolphin during active seismic surveys (Kavanagh *et al*., 2019; Stone *et al.*, 2017). Similarly, Risso's dolphin showed no response to seismic airguns (Stone *et al.,* 2017) or simulated military sonar (Southall *et al*., 2011). Whereas a study on minke whale investigating the impacts of exposure to naval sonar (with acoustic characteristics of 1.3 – 2 kHz to a maximum SL of 214dB re 1µPa @ 1 m) found that whales increased their swimming speeds to avoid the sound source (Kvadsheim *et al.,* 2017). Increases in metabolic rates associated with avoidance behaviour could have implications on energy expenditure and survival for individuals (Kvadsheim *et al.,* 2017).

11.10.7.11 Very limited studies on the effects of seismic airguns on seals, however other studies on the behavioural effects of impulsive noise sources to seals have shown varying responses of grey seals. During pile driving, grey seals were most commonly recorded changing behaviour from foraging to horizontal movement; although changes in swim speed, surfacing and diving behaviour and no response were also observed (Aarts *et al.,* 2018). A telemetry study during piling in southeast England showed that harbour seals within the area returned to usage levels similar to that of non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term (Russell *et al.,* 2016). Seals are generally considered to be relatively adaptable due to their generalist diets, wide foraging ranges, and adequate fat stores which enable them to compensate for lost foraging opportunities as a result of disturbance (Booth *et al.,* 2019; Smout *et al.,* 2014; Stansbury *et al.,* 2015).

11.10.7.12 The limited information available for the impacts of underwater noise from site surveys on marine mammals make it challenging to assess the risk for all species. Based on evidence available, all marine mammal species within this assessment are considered to be of high adaptability, reasonable tolerance, high recoverability, and of high value. Therefore, all marine mammal species are assessed as having a Low sensitivity to behavioural disturbance from underwater noise during site surveys.

Construction phase

MAGNITUDE OF IMPACT

PTS

11.10.7.13 The following section provides the assessment of the impact of PTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the PTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.10.7.14 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP) injury in the form of cumulative PTS could occur up to 517 m from the sound source, depending on the survey equipment and the functional hearing group being assessed. For the MBES, the greatest predicted impact range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (VHF and HF cetaceans) (Seiche Ltd., 2022). The threshold for cumulative PTS is not predicted to be exceeded for minke whale (LF cetaceans) (Seiche Ltd., 2022). For the SSS, the greatest predicted range for cumulative PTS is 25 m, for harbour porpoise, bottlenose dolphin, Risso's dolphin, and common dolphin (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative PTS is 517 m, for harbour porpoise (Seiche Ltd., 2022).

11.10.7.15 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker) injury in the form of instantaneous PTS could occur up to 22 m from the source and cumulative PTS could occur up to 130 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous PTS is 22 m and for cumulative PTS is 130 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for cumulative PTS is 14 m, for harbour porpoise (Seiche Ltd., 2022) The instantaneous PTS thresholds are not exceeded for any of the FHGs for the sparker surveys.

11.10.7.16 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling) injury in the form of instantaneous PTS could occur up to 15 m from the source and cumulative PTS could occur up to 62 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for cumulative PTS is 62 m, for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, cumulative PTS only occurs for VHF cetaceans (harbour porpoise) and is predicted to occur within 2 m of the source (Seiche Ltd., 2022).

11.10.7.17 In addition, the Factored In Measures (see Table 11.15 and RPS (2023)) which includes the implementation of a project-specific mitigation protocol during the geophysical surveys will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance.

11.10.7.18 The impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Negligible adverse for all marine mammal species.

TTS

11.10.7.19 The following section provides the qualitative assessment of the impact of TTS-onset from site surveys (geophysical and geotechnical) on marine mammals. Further detail with regards to the TTS-onset thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.10.7.20 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for non-impulsive geophysical survey sound sources (MBES, SSS and SBP), cumulative TTS could occur up to 3,150 m from the sound source. For the MBES, the greatest predicted range for cumulative TTS is 33 m for harbour porpoise (VHF cetaceans). For the SSS, the greatest predicted range for cumulative TTS is 97 m, for harbour porpoise (Seiche Ltd., 2022). For the SBP, the greatest predicted range for cumulative TTS is 3,150 m for harbour porpoise (Seiche Ltd., 2022).

11.10.7.21 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for impulsive geophysical survey sound sources (seismic refraction and sparker), instantaneous TTS could occur up to 40 m from the source and cumulative TTS could occur up to 1,524 m from the sound source (Seiche Ltd., 2022). For the seismic refraction surveys, the greatest predicted impact range for instantaneous TTS is 40 m and for cumulative TTS is 1,524 m, for harbour porpoise (Seiche Ltd., 2022). For sparker surveys, the greatest predicted impact range for instantaneous TTS is 32 m and for cumulative TTS is 68 m, for harbour porpoise (Seiche Ltd., 2022).

11.10.7.22 The Subsea Noise Assessment (Seiche Ltd., 2022) has concluded that for geotechnical surveys (seismic CPT and vibrocore sampling), instantaneous TTS could occur up to 33 m from the sound source and cumulative TTS could occur up to 856 m from the sound source (Seiche Ltd., 2022). For the seismic CPT, the greatest predicted impact range for instantaneous TTS is 33 m and for cumulative TTS is 856 m for harbour porpoise (Seiche Ltd., 2022). For vibrocore sampling, the greatest predicted impact range for cumulative TTS is 607 m for harbour porpoise (Seiche Ltd., 2022).

11.10.7.23 It is important to note that the Factored In Measures (see Table 11.15 and RPS (2023)) which will include the implementation of a project-specific mitigation protocol during the geophysical surveys, will reduce the risk of marine mammal experiencing TTS although the focus of this will be to minimise the risk of PTS. As a minimum it will adhere to international best practice, including DAHG (2014) guidance.

BEHAVIOURAL DISTUBANCE

11.10.7.24 The following section provides the assessment of the impact of behavioural disturbance from site surveys (geophysical and geotechnical) on marine mammals. For impulsive noise sources, the threshold for mild disturbance is 140 dB re 1 μPa (rms) and the threshold for strong disturbance is 160 dB re 1 µPa (rms). For continuous/non-impulsive noise the threshold for disturbance is 120 dB re 1 µPa (rms). Further detail with regard to the thresholds used and the predicted impact ranges are presented in Seiche Ltd. (2022).

11.10.7.25 The Subsea Noise Assessment (Seiche Ltd., 2022) concluded that for non-impulsive geophysical survey sound sources, disturbance could occur for all FHGs up to 4,950 m from the sound source.

11.10.7.26 For impulsive sound sources, disturbance could occur out to 700 m for a sparker and out to 1,324 m for seismic refraction for all FHGs (Seiche Ltd., 2022).

11.10.7.27 The Subsea Noise Assessment concluded that for geotechnical surveys, disturbance could occur for all FHGs out to 10 km for vibrocore surveys and 1.5 km for seismic CPT surveys for strong disturbance (Seiche Ltd., 2022).

11.10.7.28 Therefore, the impact of disturbance to all marine mammal species from site surveys is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed Low adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

PTS

11.10.7.29 For all marine mammal species, the impact of PTS-onset from underwater noise during site surveys has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise during site surveys is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.10.7.30 For all marine mammal species, the impact of behavioural disturbance from underwater noise during site surveys has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.7.31 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during site surveys is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.7.32 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). The Developer has conducted an Annex IV Species Risk Assessment (RPS, 2023) for species listed under Annex IV of the Habitats Directive and EPS to determine if the proposed surveys could have the potential risk of auditory injury or disturbance to these species and outlines proposed mitigation within the risk assessment report to further reduce the risk of injury and disturbance. Within this document, the Developer has committed to a project-specific mitigation protocol during the geophysical surveys that will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance (see RPS, 2023).

Operational and maintenance phase

11.10.7.33 Routine geophysical surveys will be undertaken of the inter-array cables, inter-connector cables, and export cables throughout the operational and maintenance phase. Surveys will occur every six months during the first two years and annually thereafter (Table 11.10).

11.10.7.34 The exact equipment to be deployed during the site surveys are yet to be confirmed, therefore an illustrative assessment has been conducted by assuming that equipment will be the same as that proposed in the FLA. The conclusions of this assessment should be interpreted with a high level of precaution given the lack of information regarding the equipment types that will be used.

MAGNITUDE OF IMPACT

PTS

11.10.7.35 Based on the results of the Subsea Noise Assessment (Seiche Ltd., 2022) conducted for site surveys during the construction phase as part of the FLA, it is assumed that the magnitude of impact of PTS-onset from surveys during the operational and maintenance phase will be similar, assuming the same equipment is used.

11.10.7.36 Therefore, the impact of PTS-onset to all marine mammal species from site surveys is considered to result in a very small proportion of the population affected, although auditory injury (PTS) is expected to have a permanent change to the receptor. The impact is expected to occur relatively frequently throughout the construction phase, although the effect is unlikely to occur given implementation of Factored In Measures and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as **Negligible** adverse for all marine mammal species.

TTS

11.10.7.37 The impact ranges for TTS-onset from site surveys on marine mammals are expected to be similar to those presented in Seiche Ltd. (2022), assuming the same equipment is used in both the construction and operational and maintenance phases (see paragraphs 11.10.7.20 to 11.10.7.22).

11.10.7.38 It is important to note that the Factored In Measures (see Table 11.15) which will include the implementation of a project-specific mitigation protocol during the geophysical surveys, will reduce the risk of marine mammal experiencing TTS although the focus of this will be to minimise the risk of PTS. As a minimum it will adhere to international best practice, including DAHG (2014) guidance.

BEHAVIOURAL DISTURBANCE

11.10.7.39 Based on the results of the Subsea Noise Assessment (Seiche Ltd., 2022) conducted for site surveys during the construction phase as part of the FLA, it is assumed that the magnitude of impact of behavioural disturbance from surveys during the operational and maintenance phase will be similar, assuming the same equipment is used.

11.10.7.40 Therefore, the impact of disturbance to all marine mammal species from site surveys is considered to result in a small proportion of the population affected, occur frequently throughout the construction phase, the effect is reasonably expected to occur, have intermittent and reversible consequences, and is very unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed **Low** adverse for all marine mammal species.

SIGNIFICANCE OF EFFECT

PTS

11.10.7.41 For all marine mammal species, the impact of PTS-onset from underwater noise during site surveys has been assessed as **Negligible**, with the sensitivity of the receptor being **Low.** Therefore, the significance of effect from PTS-onset to all marine mammal species from underwater noise during site surveys is **Not Significant**, which is **not significant** in EIA terms.

BEHAVIOURAL DISTURBANCE

11.10.7.42 For all marine mammal species, the impact of behavioural disturbance from underwater noise during site surveys has been assessed as **Low adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from behavioural disturbance to all marine mammal species from underwater noise during site surveys is **Slight adverse**, which is **not significant** in EIA terms.

RESIDUAL EFFECT ASSESSMENT

11.10.7.43 The significance of effect from injury and/or disturbance to marine mammals from underwater noise during site surveys is not significant in EIA terms. Therefore, no additional mitigation to the Factored In Measures already identified in Table 11.15 are considered necessary. No ecologically significant adverse residual effects have been predicted in respect of marine mammals.

11.10.7.44 It is important to note that all cetaceans are an EPS and under EPS legislation it is an offence to injure a single individual (this includes PTS auditory injury). Therefore, an Annex IV Species Risk Assessment for species listed under Annex IV of the Habitats Directive and EPS should be conducted once survey equipment is known to determine if the proposed surveys could have the potential risk of auditory injury or disturbance to these species and outlines proposed mitigation within the risk assessment report to further reduce the risk of injury and disturbance. Within this document, the Developer has committed to a project-specific mitigation protocol during the geophysical surveys that will minimise the risk of PTS, and as a minimum will adhere to international best practice, including DAHG (2014) guidance.

11.11 Cumulative impacts assessment methodology

11.11.1 Methodology

11.11.1.1 The Cumulative Impact Assessment (CIA) takes into account the impacts associated with the Proposed Development together with other proposed and reasonably foreseeable projects, plans and existing and permitted projects. The projects and plans selected as relevant to the CIA presented within this chapter are based upon the results of a screening exercise (see Volume III, Appendix 3.2: Cumulative Impact Assessment Screening). Each project and plan have been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon effect-receptor pathways and the spatial/temporal scales involved.

11.11.1.2 When assessing the potential cumulative impacts of the Proposed Development, it is essential to consider that some projects, particularly those labelled as 'proposed' or outlined in development plans, may not materialise or may not fully manifest as described in their worst-case scenarios. Therefore, it is imperative to incorporate a degree of certainty (or uncertainty) regarding the potential impacts from such proposals. For example, projects under construction are likely to contribute to cumulative impacts (assuming effects or spatial pathways exist), whereas proposals awaiting approval are less likely to contribute, as some may not attain approval or may not be realised due to various factors.

11.11.1.3 In light of this, all projects and plans considered alongside the Proposed Development have been categorised into 'tiers', reflecting their current stage within the planning and development process. This enables the CIA to present various future development scenarios, each carrying different potential for actualisation. This approach facilitates assigning appropriate weight to each scenario (tier) when evaluating potential cumulative impacts. The tiering methodology is provided in Volume III, Appendix 3.2: CIA Screening.

11.11.1.4 Due to the commitments made by the Developer in respect of the Foreshore Licence FS007339 and Foreshore Licence Application FS007555 (Table 11.15), FS007339 and FS007555 have been screened out of the cumulative impact assessment.

Phase 1 offshore wind projects

11.11.1.5 All Phase One projects (North Irish Sea Array (NISA), Dublin Array, Codling Wind Park, Oriel, Sceirde Rocks) have been awarded a Maritime Area Consent (MAC), however none of the projects will have formally submitted applications for planning consent and will not be awarded consent within the timescales for delivery of the EIAR for the Proposed Development. Notwithstanding this, due to the likely similar development timelines of the Phase One projects and the resultant risk associated with cumulative effects, there is a requirement to assess Phase One projects within the EIAR, as far as available information allows. This approach also aligns with a request from An Bord Pleanála that Phase One projects should collaborate and share project information where appropriate. The Phase One projects therefore fall outside of the standard hierarchy and have been assessed based on information that has been shared between the East Coast Phase One projects (North Irish Sea Array, Dublin Array, Codling Wind Park, Oriel) and is believed to be accurate at the time of preparing the EIAR.

11.11.1.6 Using information provided by the East Coast Phase One projects, the following assumptions were used in the CIA:

- Installation of monopile foundations in 2028 by the Proposed Development;
- Installation of monopile foundations in 2028 by North Irish Sea Array;
- Installation of monopile foundations in 2027 for Codling Wind Park;
- Installation of monopile foundations in 2027 for Oriel; and
- Installation of monopile foundations in 2029 for Dublin Array.

11.11.1.7 It has been assumed that UXO clearance will occur the year prior to piling due to lack of information available at the time of this assessment.

11.11.1.8 Given the proximity of the East Coast Phase One offshore wind projects to each other, and the associated risk of cumulative effects resulting from disturbance of marine mammals by underwater noise, the iPCoD framework (Harwood *et al.,* 2014; King *et al.,* 2015) was used to predict the potential population consequences of the predicted impacts of disturbance resulting from piling to harbour porpoise, bottlenose dolphin, grey seal, and harbour seal. This approach uses the predicted impacts of disturbance for each of the projects in isolation, and considers their impact cumulatively.

11.11.1.9 iPCoD modelling was conducted using two different indicative piling scenarios to account for Phase One projects that are still considering monopile and pin pile foundations. The scenarios are presented in Table 11.54 below.

11.11.1.10 The methodology, input parameters used, and assumptions made are fully described in Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling. However, it is important to note that the precautions built into the iPCoD model mean that the results are considered to be highly precautionary. Despite these limitations and uncertainties, this assessment has been carried out according to best practice and using the best available scientific information. Therefore, the information provided is considered to be sufficient to carry out an adequate assessment, although precaution should be applied when interpreting the results and subsequently in making conclusions.

Table 11.54: Proposed piling scenarios used in iPCoD modelling for the East Coast Phase One offshore wind projects

Scenario 1	Scenario 2
• Monopiles at all five Phase 1 projects; and • Piling January 2027 to December 2029, inclusive.	• Monopiles at the Proposed Development, Oriel, Codling Wind Park; • Pin pile jackets at NISA and Dublin Array; and • Piling January 2027 to December 2029, inclusive.

Screening projects

11.11.1.11 The selection of projects and plans pertinent to the assessment of impacts to marine mammals is based on an initial screening exercise conducted on a long list. The CIA methodology and long list used in the CIA are detailed in Volume III, Appendix 3.2: Cumulative Impact Assessment Screening.

11.11.1.12 To compile the CIA long list, a range has been applied to identify relevant offshore projects to screen in. For marine mammals, with respect to offshore windfarm projects, the range is defined as the species-specific MUs, encompassing the Celtic and Irish Sea MU for harbour porpoise, the Irish Sea MU for bottlenose dolphins, the Celtic and Greater North Seas MU for common dolphins, Risso's dolphins, and minke whales, and the East RoI MU for both harbour and grey seals. For all other planned offshore projects, the International Council for the Exploration of the Sea (ICES) 7a Celtic Sea region was used for screening due to the smaller scale that these projects have in nature in comparison to commercial offshore windfarms. Each project, plan, or activity has then been evaluated and screened in or out based on effect-receptor pathways, data reliability, and the temporal and spatial scales involved.

11.11.1.13 The temporal scope considered in the CIA for marine mammals spans from 2021 to 2034 inclusive. This timeframe facilitates a quantitative assessment of impacts to the MUs both prior to the construction of the Proposed Development (since the baseline data were compiled), and during the potential construction window for the Proposed Development. The anticipated construction timeline for the Proposed Development is from 2026 to 2030 with piling activities occurring in 2028, and assuming that UXO clearance will occur the year beforehand (i.e. 2027). It is therefore important to note that while the assessment of magnitude considers the full temporal scope of 2021 to 2034, importance is placed on the proportion of the population that will be potentially impacted by piling at the Proposed Development cumulatively with Tier 1 and 2 projects in 2028.

11.11.1.14 As a result, the following offshore project types were screened out of the CIA short list:

- All projects located outside of the relevant species MU boundary;
- All projects that are already operational (prior to 2021) (given that they are considered to have existing impacts included within the baseline);
- All projects where there is no expected temporal overlap with the construction window of the Proposed Development; and
- All projects where the construction timeframe is unknown.

Projects screened in

11.11.1.15 The specific projects screened into this CIA, and the tiers into which they have been allocated are presented in Table 11.55. Timeline information is sourced from Environmental Statement (ES) and Preliminary Environmental Impact Report (PEIR) chapters that are publicly available.

11.11.1.16 Numerous other projects are situated within the Irish Sea and the relevant species MUs; however, the majority of these projects are in the conceptual or early planning stages, and there is no publicly available information regarding the construction timeline for these projects.

Table 11.55: List of other projects and plans considered within the cumulative impact assessment

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Tier 1 Projects							
Nearte Na Goithe	Under construction	435.4	434.4	A 450 MW offshore windfarm with up to 54 turbines.	2020 – 2024	From 2025	Potential cumulative impact exists.
Triton Knoll	Operational	444.6	443.8	An 875 MW English Round 2 offshore windfarm with 90 turbines. Fully operational.	2020 – 2022	From 2023	Potential cumulative impact exists.
Inch Cape	Under construction	456.4	455.4	A 1.1 GW Scottish offshore windfarm with up to 72 turbines.	2025 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Seagreen Phase 1	Operational	474.6	473.6	An operational offshore windfarm with 114 turbines and a total generating capacity of 1,075 MW.	2020 – 2023	From 2024	Potential cumulative impact exists.
Saint-Brieuc	Under construction	480.6	479.9	A 496 MW offshore windfarm with 62 turbines.	2021 – 2024	From 2025	Potential cumulative impact exists.
Hornsea Project Two	Operational	499.3	498.5	A 1.32 GW English Round 3 offshore	2020 – 2022	From 2023	Potential cumulative impact exists.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
				windfarm with 165 turbines. Fully operational.			
Courseulles-sur-mer	Under construction	515.1	514.4	A 450 MW offshore windfarm. Under construction.	2021 – 2024	From 2025	Potential cumulative impact exists.
Fécamp	Under construction	527.1	526.5	A 497 MW offshore windfarm with 71 turbines. Under construction.	2022 – 2023/2024	From 2025	Potential cumulative impact exists.
Dogger Bank – Creyke Beck B	Under construction	530.9	530.0	A 1.2 GW English Round 3 offshore windfarm. Under construction.	2020 – 2025	From 2026	Potential cumulative impact exists.
Dogger Bank – Creyke Beck A	Under construction	535.5	534.6	A 1.2 GW English Round 3 offshore windfarm. Under construction.	2020 – 2024	From 2025	Potential cumulative impact exists.
Dogger Bank - Teesside B (Sofia)	Under construction	565.3	564.3	A 1.4 GW English Round 3 offshore windfarm with 100 turbines.	2023 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
East Anglia Three	Under construction	583.4	582.7	A 1.4 GW English Round 3 offshore windfarm with up to 100 turbines.	2022 – 2026	From 2027	Potential for temporal overlap with Proposed

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
							Development construction phase.
Moray West	Under construction	591.3	590.3	An 882 MW Scottish offshore windfarm with 60 turbines.	Pre-2021 – 2025	From 2026	Potential cumulative impact exists.
Dogger Bank C – Teesside A	Under construction	600.8	599.9	A 1.2 GW English Round 3 offshore windfarm.	2021 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Moray East	Operational	603.5	602.6	A 950 MW offshore windfarm with up to 100 turbines.	2017 – 2022	From 2023	Potential cumulative impact exists.
Hollandse Kust F	Under construction	623.5	622.9	A Dutch offshore windfarm.	2021 – 2024	From 2025	Potential cumulative impact exists.
Saint-Nazaire	Operational	652.1	651.4	A 480 MW French offshore windfarm.	Pre-2021 – 2021	From 2022	Potential cumulative impact exists.
Hollandse Kust (Zuid)	Under construction	668.2	667.6	A 1.5 GW offshore windfarm in the Netherlands.	2021 – 2023	From 2024	Potential cumulative impact exists.
Hollandse Kust (Noord)	Operational	677.3	676.7	A 759 MW offshore windfarm in the Netherlands.	2022 – 2023	From 2024	Potential cumulative impact exists.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Borkum Riffgrund 3	Under construction	804.7	803.9	A 913 MW German offshore windfarm.	Unknown – 2025	From 2026	Potential cumulative impact exists.
Kaskasi II	Operational	910.6	909.8	A 342 MW German offshore windfarm.	2021 – 2023	From 2024	Potential cumulative impact exists.
Vesterhav Syd	Operational	961.1	960.2	A 168 MW Danish offshore windfarm.	2022 – 2023	From 2024	Potential cumulative impact exists.
Vesterhav Nord	Under construction	981.8	980.9	A 176 MW Danish offshore windfarm.	2022 – 2024	From 2025	Potential cumulative impact exists.
CeltixConnect	Active	49.2	48.3	Telecom cable.	2022 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Greenlink Interconnector	Under construction	79.6	79.0	Power cable.	2021 – 2024	From 2025	Potential cumulative impact exists.
Celtic Interconnector	Under construction	151.9	151.3	Power cable.	2023 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
West Anglesey demonstration zone	Under construction	85.0	84.1	Tidal.	2023 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Tier 2 Projects							
Erebus Floating Wind Demo	Consented	133.3	132.7	Consented for up to 7 turbines.	2025/2026 – 2026/2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Awel y Môr	Consented	148.5	147.6	Consented for up to 50 turbines.	2026 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
TwinHub	Consented	256.2	255.6	Floating wind demonstration site with up to 4 turbines.	2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Atlantic Marine Energy Test Site	Consented	314.3	308.8	Test site for wave energy converters and floating wind.	2024 – 2025	From 2026	Potential cumulative impact exists.
Hornsea Project Four	Consented	476.4	475.5	A 2.6 GW English Round 3 offshore windfarm with up to 180 turbines.	2025 – 2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
East Anglia Two	Consented	548.4	547.8	A 900 MW English Round 3 offshore windfarm with up to 75 turbines.	2024/2025 – 2027	From 2028	Potential for temporal overlap with Proposed

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
							Development construction phase.
Hornsea Project Three	Consented	550.6	549.7	A 2.9 GW English Round 3 offshore windfarm.	2027 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Norfolk Vanguard West	Consented	551.6	550.9	A 1.4 GW offshore windfarm in the Norfolk zone.	2023 – 2025	From 2026	Potential cumulative impact exists.
East Anglia One North	Consented	556.0	555.4	An 800 MW English Round 3 offshore windfarm with up to 67 turbines.	2024/2025 – 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Dieppe Le Tréport	Consented	561.4	560.7	A 496 MW French offshore windfarm with 62 turbines.	2024 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Norfolk Vanguard East	Consented	582.4	581.7	A 1.4 GW offshore windfarm in the Norfolk zone.	2023 – 2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Pentland Floating	Consented	649.3	648.5	A 100 MW Scottish floating offshore windfarm.	2024 – 2026	From 2027	Potential for temporal overlap with Proposed

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
							Development construction phase.
Iles d'Yeu et de Noirmoutier	Consented	682.7	682.0	A 500 MW offshore windfarm.	2024 – 2025	From 2026	Potential cumulative impact exists.
EnBW He Dreiht	Consented	811.0	810.2	A 960 MW German offshore windfarm.	Unknown – 2025	Unknown	Potential for temporal overlap with Proposed Development construction phase.
Gode Wind 3	Consented	869.0	868.2	A 242 MW German offshore windfarm.	2024 – Unknown	Unknown	Potential for temporal overlap with Proposed Development construction phase.
Holyhead Deep	Consented	84.0	83.1	Tidal.	2026 – 2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Tier 3 Projects							
Valorous	Pre-planning application	141.9	141.3	Pre-lease offshore windfarm (Project planning and design phase).	2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Mona	Planning application submitted	146.7	145.7	English Round 4 project with up to	2026 – 2027	From 2028	Potential for temporal overlap with Proposed

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
				107 turbines. Lease awarded.			Development construction phase.
Llyr 1	Pre-planning application	148.0	147.3	A 200 MW test and demonstration site for floating offshore wind with up to 10 turbines.	2026 – 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Llyr 2	Pre-planning application	151.9	151.2	A 200 MW test and demonstration site for floating offshore wind with up to 10 turbines.	2026 – 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Morgan	Pre-planning application	165.3	164.3	English Round 4 project with up to 96 turbines.	2028 – 2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Morecambe	Pre-planning application	174.2	173.3	English Round 4 project with up to 40 turbines.	2026/2027 – 2028/2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
White Cross	Planning application submitted	174.7	174.0	A 100 MW floating offshore wind demonstration project with up to 8 turbines.	2026 – 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Isle of Man (Mooir Vannin)	Pre-planning application	179.2	178.2	A 1.4 GW offshore windfarm with up to 100 turbines.	2030 – unknown	unknown	Potential for temporal overlap with Proposed Development construction phase.
North Channel Wind 2	Pre-planning application	204.0	203.1	A 420 MW offshore windfarm in Northern Ireland.	2029 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
North Channel Wind 1	Pre-planning application	227.9	227.0	A 1 GW offshore windfarm in Northern Ireland.	2029 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Shearwater One	Pre-planning application	310.7	309.8	A hybrid hydrogen / offshore wind project with a generating capacity of 3 GW.	Unknown – 2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.
Berwick Bank	Planning application submitted	446.4	445.4	A 4.1 GW Scottish offshore windfarm.	2024 – 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Rampion 2	Planning application submitted	450.7	450.0	An extension of Rampion offshore windfarm with 90 turbines.	2026/2027 – 2029/2030	From 2030	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Outer Dowsing	Planning application submitted	465.5	464.7	A 1.5 GW English Round 4 offshore windfarm.	2026 – 2031	From 2032	Potential for temporal overlap with Proposed Development construction phase.
Sheringham Shoal Extension	Pre-planning application	465.5	464.8	An extension of Sheringham Shoal offshore windfarm. Awaiting planning decision.	2023 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Centre-Manche 1	Pre-planning application	468.9	468.2	A 1 GW French offshore windfarm.	2025 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Dudgeon Extension	Planning application submitted	475.2	474.5	An extension of Dudgeon offshore windfarm. Awaiting planning decision.	2026/2028 – 2028/2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Centre-Manche 2	Pre-planning application	476.8	476.1	A 1.4 GW French offshore windfarm.	Unknown – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Dogger Bank South (West)	Pre-planning application	504.9	504.0	An English Round 4 offshore windfarm with a combined capacity (with Dogger Bank	2025 – unknown	From 2027	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
				South (East)) of 3 GW.			
Morven	Pre-planning application	514.6	513.6	A 291 MW Scottish offshore windfarm. Concept/Early Planning	Unknown – 2025	From 2026	Potential cumulative impact exists.
Bowdun	Pre-planning application	528.0	527.0	A 1,008 MW Scottish offshore windfarm. Concept/Early Planning	2029/2031 – 2033	From 2034	Potential for temporal overlap with Proposed Development construction phase.
Dogger Bank South (East)	Pre-planning application	530.3	529.4	An English Round 4 offshore windfarm with a combined capacity (with Dogger Bank South (West)) of 3 GW.	2025 – unknown	From 2026	Potential cumulative impact exists.
North Falls	Pre-planning application	536.8	536.3	An extension of Greater Gabbard offshore windfarm with a generating capacity of 504 MW.	2025 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Five Estuaries	Planning application submitted	553.3	552.8	An extension of Galloper offshore windfarm with a generating capacity of 353. Development	2027 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
				Consent Order (DCO) submitted in March 2024.			
Bellrock	Pre-planning application	565.9	564.9	A 1.2 GW Scottish floating offshore windfarm.	2024 – 2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.
Dunkerque	Pre-planning application	590.0	589.5	A 600 MW French offshore windfarm. Consent application submitted.	2026 – 2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.
Muir Mhòr	Pre-planning application	597.7	596.7	A 798 MW Scottish floating offshore windfarm. Concept/Early Planning.	Unknown – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Salamander	Pre-planning application	598.4	597.4	A 100 MW floating offshore windfarm with up to 7 turbines.	2026 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Campion	Pre-planning application	600.9	599.9	A floating offshore windfarm with a generating capacity of up to 2 GW.	2024 – 2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Spiorad na Mara	Pre-planning application	605.0	604.1	A 900 MW offshore windfarm with up to 66 turbines.	2028 – 2031	From 2032	Potential for temporal overlap with Proposed Development construction phase.
Caledonia	Pre-planning application	606.6	605.7	A 2 GW offshore windfarm.	2026 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Sud de la Bretagne	Pre-planning application	608.3	607.6	A French offshore windfarm. In planning.	2029 – unknown	unknown	Potential for temporal overlap with Proposed Development construction phase.
Cedar	Pre-planning application	608.7	607.7	A floating offshore windfarm within the North Sea Renewables Grid.	2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.
IJmuiden Ver	Pre-planning application	613.8	613.2	A 6 GW offshore windfarm in the Netherlands.	Unknown – 2028/2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Broadshore	Pre-planning application	632.1	631.2	A Scottish floating offshore windfarm of up to 900 MW.	2024 – 2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Green Volt	Pre-planning application	635.0	634.0	A floating offshore windfarm that will electrify an oil and gas platform.	2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Talisk	Pre-planning application	646.7	645.8	A 500 MW Scottish floating offshore windfarm.	Unknown – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Cenos	Pre-planning application	649.6	648.6	A Scottish offshore floating windfarm of up to 1400 MW.	2027 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Marram	Pre-planning application	652.4	651.4	A Scottish floating offshore windfarm of up to 3 GW.	Unknown – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Havbredey	Pre-planning application	653.3	652.4	A Scottish floating offshore windfarm of up to 1500 MW.	2032 – 2036	Unknown	Potential cumulative impact exists.
Stromar	Pre-planning application	653.9	652.9	A Scottish floating offshore windfarm of up to 1 GW.	2028 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
West of Orkney	Pre-planning application	659.0	658.1	A 2 GW Scottish offshore windfarm.	Unknown – 2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Buchan	Pre-planning application	661.1	660.1	A Scottish floating offshore windfarm of up to 1 GW.	2029 – 2033	Unknown	Potential for temporal overlap with Proposed Development construction phase.
Ayre	Pre-planning application	690.5	689.5	A 1 GW Scottish floating offshore windfarm.	2029 - 2032	From 2023	Potential for temporal overlap with Proposed Development construction phase.
Beech	Pre-planning application	721.0	720.0	A 1 GW Scottish offshore windfarm.	2026 - 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Ten Noorden van de Wadden	Pre-planning application	748.6	747.8	A 700 MW offshore windfarm in the Netherlands.	2027 - 2031	From 2032	Potential for temporal overlap with Proposed Development construction phase.
N-9.3	Pre-planning application	772.8	772.0	A 1.5 GW German offshore windfarm.	From 2029	Unknown	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
N-9.1	Pre-planning application	778.4	777.6	A 2 GW German offshore windfarm.	From 2029	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-9.4	Pre-planning application	782.9	782.1	A 1 GW German offshore windfarm.	From 2030	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-6.7	Pre-planning application	783.9	783.1	A 270 MW German offshore windfarm.	From 2028	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-6.6	Pre-planning application	790.7	789.9	A 630 MW German offshore wind farm.	From 2028	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-9.2	Pre-planning application	791.8	791.0	A 2 GW German offshore wind farm.	From 2029	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-10.2	Pre-planning application	799.0	798.2	A 500 MW German offshore wind farm.	From 2030	Unknown	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Nordsøen III vest	Pre-planning application	807.8	806.9	A 3 GW Danish offshore windfarm.	Unknown - 2027	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-10.1	Pre-planning application	808.1	807.2	A 2 GW German offshore windfarm.	From 2030	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-7.2	Pre-planning application	809.7	808.9	A 980 MW German offshore windfarm.	Unknown – 2027	Unknown	Potential for temporal overlap with Proposed Development construction phase.
Nordsøen II vest	Pre-planning application	829.8	828.9	A 2 GW Danish offshore windfarm.	Unknown – 2030	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-3.6	Pre-planning application	848.2	847.4	A 480 MW German offshore windfarm.	2028 - Unknown	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-3.5	Pre-planning application	852.5	851.7	A 420 MW German offshore windfarm.	2028 – Unknown	Unknown	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
N-3.8	Pre-planning application	853.6	852.8	A 433 MW German offshore windfarm.	2026 – Unknown	Unknown	Potential for temporal overlap with Proposed Development construction phase.
N-3.7	Pre-planning application	866.2	865.4	A 225 MW German offshore windfarm.	2026 – Unknown	Unknown	Potential for temporal overlap with Proposed Development construction phase.
Arven	Pre-planning application	868.3	867.3	A 2.3 GW Scottish floating offshore windfarm.	2024 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.
Thor	Pre-planning application	933.1	932.2	A 1GW Danish offshore windfarm.	2025 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
Mares Connect	Proposed	37.5	36.6	Power cable.	2024 – 2027	From 2028	Potential for temporal overlap with Proposed Development construction phase.
Xlinks	Proposed	192.3	191.6	Power cable.	2027 – 2029	From 2030	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Erebus / Valorous proposed cable route	Proposed	123.7	123.0	Power cable.	2025 – 2026	From 2027	Potential for temporal overlap with Proposed Development construction phase.
LirIC	Proposed	204.6	203.7	Power cable.	Unknown – 2028	From 2029	Potential for temporal overlap with Proposed Development construction phase.
Phase 1 Projects							
Codling Wind Park (formerly known as Codling I and Codling II)	Proposed	18.2	17.3	'Relevant Project'. Updated application expected to be made under the Maritime Area Planning Act 2021.	2027 – 2028 (piling in 2027)	From 2029	Potential for temporal overlap with Proposed Development construction phase.
Dublin Array (formerly known as Bray and Kish Offshore Windfarms)	Proposed	25.8	24.9	'Relevant Project'. Updated application expected to be made under the Maritime Area Planning Act 2021.	2028 – 2032 (piling from 2028 – 2031)	From 2033	Potential for temporal overlap with Proposed Development construction phase.
North Irish Sea Array	Proposed	65.1	64.1	'Relevant Project'. Updated application expected to be made under the	2027 – 2029 (piling from 2027 – 2028)	From 2030	Potential for temporal overlap with Proposed Development construction phase.

Project/Plan	Status	Distance from Array Area (km)	Distance from Cable Corridor and Working Area (km)	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
				Maritime Area Planning Act 2021.			
Oriel	Proposed	108.1	107.2	'Relevant Project'. Updated application expected to be made under the Maritime Area Planning Act 2021.	2026-2028 (piling from 2026 – 2027)	From 2030	Potential for temporal overlap with Proposed Development construction phase.
Sceirde Rocks	Proposed	264.3	254.1	'Relevant Project'. Updated application expected to be made under the Maritime Area Planning Act 2021.	2026 – 2030	From 2031	Potential for temporal overlap with Proposed Development construction phase.

Screening impact pathways

11.11.1.17 Certain impacts assessed solely for the Proposed Development are not factored into the marine mammal CIA due to several factors:

- The impacts are highly localised in nature;
- Existing management and mitigation measures implemented at the Proposed Development and other projects will effectively diminish the likelihood of these impacts; and
- The potential significance of the impact from the Proposed Development alone has been evaluated as either Not Significant (due to Negligible conclusion for magnitude of impact) or Imperceptible (due to Negligible conclusion for sensitivity of the receptor).

11.11.1.18 The impacts excluded from the marine mammal CIA for these reasons encompass:

- *Auditory injury (PTS):* Activities such as pile driving and UXO clearance may lead to PTS, but robust mitigation measures will be enforced to minimise injury risk to marine mammals to imperceptible levels, as mandated by European Protected Species (EPS) legislation;
- *Injury from vessel activities*: It is anticipated that all offshore energy projects will adopt a VMP or adhere to guidelines to further reduce the already minimal risk of vessel collisions with marine mammals;
- *Disturbance from vessel activities*: Similar to collision risk, it is expected that all offshore energy projects will implement a VMP or adhere to best practice recommendations to mitigate the potential of disturbance to marine mammals;
- *Changes in fish and shellfish community affecting prey resources*: Changes in prey availability are highly localised and Not Significant, which is not significant in EIA terms;
- *Accidental pollution*: It is anticipated that all offshore energy projects will implement an EMP to ensure that the potential release from pollutants is minimised and strictly controlled; and
- *Changes in EMF from subsea cabling:* Changes are of Imperceptible significance, which is not significant in EIA terms.

11.11.1.19 Consequently, the impacts considered within the marine mammal CIA are primarily focused on the potential for disturbance arising from underwater noise during the construction phase of offshore developments (where data are available). Table 11.56 presents the potential impacts, development phase, and the list of projects / plans with which the two Project Design Options have been cumulatively assessed.

Table 11.56: Potential cumulative impacts, phases, scenarios, and projects to be considered cumulatively

Potential cumulative impact	Phase			Projects considered cumulatively	Justification for projects considered cumulatively
	C	O	D		
Disturbance to marine mammals from underwater noise	✓	×	×	Project parameters associated with Project Design Option 1 or 2 plus the projects listed in Table 11.55.	Outcome of the CIA will be highest when the greatest number of schemes are undertaking activities that generate underwater noise concurrently.

Assessment methodology for disturbance to marine mammals from underwater noise

11.11.1.20 For the Proposed Development, an indicative number of animals disturbed per day has been taken as the maximum number calculated within the alone assessments. For all other offshore projects, an indicative number of animals disturbed per day has been calculated using species-specific densities within the corresponding SCANS-IV survey blocks for each cetacean species (Gilles *et al.,* 2023) and a fixed EDR approach. For projects that are situated outside of the SCANS-IV survey boundaries, cetacean densities were derived from the corresponding

ObSERVE survey stratum (Rogan *et al.,* 2018a). However, it is important to note that this approach is highly precautionary given the high level of uncertainty and assumptions within this assessment, as described in further detail below.

11.11.1.21 The EDR threshold parameters used to assess the number of animals potentially disturbed from offshore projects are:

- A 26 km EDR for piling of all offshore windfarm projects (fixed and floating) in UK and Irish waters based on guidance from JNCC (2020) for unabated pile driving of a monopile, and an impact area of 2,123.72 km^2;
- A 26 km EDR for UXO clearance based on the high order detonation of UXOs only (JNCC, 2020), and an impact area of 2,123.72 km^2;
- A 15 km EDR for piling of EU offshore windfarm projects based on the current noise abatement expectations for those countries, and an impact area of 706.9 km^2;
- A 12 km EDR for seismic surveys based on guidance from JNCC (2020), and an impact area of 452.4 km^2;
- A 5 km EDR for tidal and wave projects (assuming that noise piling or blasting activities will occur) and an impact area of 78.5 km^2; and
- A 5 km EDR for subsea cabling based on guidance from JNCC (2020) (assuming that only geophysical surveys will be undertaken) and an impact area of 78.5 km^2.

11.11.1.22 Seismic surveys have been considered as Tier 3 projects as the potential number of seismic surveys that could be undertaken is unknown. Based on the size of the MU and its location, it has been assumed that there could be:

- One seismic survey occurring on any given day in the Irish Sea included within the CIA for bottlenose dolphin;
- Two seismic surveys occurring on any given day in the Celtic and Irish Seas within the CIA for harbour porpoise; and
- Four seismic surveys occurring on any given day in North Sea and one seismic survey occurring on any given day in the Celtic and Irish Seas within the CIA for Risso's dolphin, common dolphin, and minke whale.

11.11.1.23 Given that the East region of RoI MU for grey seal and harbour seal are coastal and have a relatively small spatial extent, no seismic surveys are anticipated to take place within these areas. As such, no cumulative impacts from seismic surveys on seals are considered within this assessment.

11.11.1.24 To estimate the number of cetaceans predicted to be disturbed from seismic surveys, the average density across the seas in which they are assumed to occur was calculated using the abundance of the corresponding SCANS-IV survey blocks and is presented in Table 11.57, below.

Table 11.57: A summary of parameters used to predict the number of cetaceans to be disturbed from seismic surveys

Species	Assumed location of seismic surveys	Abundance	Area (km^2)	Density (animals/km^2)
Harbour porpoise	Celtic and Irish Seas	55,888	346,007	0.162
Bottlenose dolphin	Irish Sea	16,125	46,007	0.350
Risso's dolphin	North Sea; Celtic and Irish Seas	4,589 (North Sea); 6,931 (Celtic and Irish Seas)	575,000 (North Sea);	0.008 (North Sea); 0.020 (Celtic and Irish Seas)

			346,007 (Celtic and Irish Seas)	
Common dolphin	North Sea; Celtic and Irish Seas	1,814 (North Sea); 162,716 (Celtic and Irish Seas)	575,000 (North Sea); 346,007 (Celtic and Irish Seas)	0.003 (North Sea); 0.470 (Celtic and Irish Seas)
Minke whale	North Sea; Celtic and Irish Seas	7,856 (North Sea); 4,094 (Celtic and Irish Seas)	575,000 (North Sea); 346,007 (Celtic and Irish Seas)	0.014 (North Sea); 0.012 (Celtic and Irish Seas)

Assumptions and precaution within the CIA

11.11.1.25 There are many assumptions that need to be made when undertaking a CIA, particularly on such large spatial scales; consequently, significant levels of precaution / conservatism within this CIA will result in the estimated effects being unrealistic. The main areas of precaution / conservatism in the assessment are:

- Assumption that all UXO detonations will use high order methodologies due to lack of information regarding preferences for low order methodologies per project (which would have a 5 km EDR);
- Assumption that floating offshore wind projects will involve piling given a lack of information on anchoring systems that will be used;
- Number of developments assumed to be active at one time is unrealistic given availability of vessels worldwide;
- Inclusion of lower tier developments (Tier 3) with a lack of publicly available information (ES/PEIR). By including projects that have either no consent, no ES/EIAR, no PEIR or no submitted information, then the worst-case scenarios have to be assumed in the absence of other information;
- Assumption that pile driving and UXO clearance could happen at any time during the construction period as exact timings are unknown. This creates an assumption that noisy activities will occur over consecutive years where in reality for most projects, it will be a year for each, this results in disturbance levels far greater than would ever occur in reality;
- Assumption that there is no spatial overlap in impact footprints between individual activities when summing across concurrent activities. This is highly unrealistic considering the proximity of some of the offshore windfarm projects to each other;
- Assumption that all offshore windfarm projects will install monopiles as a worst-case scenario is highly precautionary. Project design envelope for most offshore windfarms also includes pin piles as a foundation option which have 15 km EDR instead of 26 km EDR as per JNCC (2020) guidance, and therefore would disturb fewer animals;
- The duration and timelines presented in PEIR and ES chapters are worst-case scenarios and the true period of piling activity will likely be shorter for each project;
- Assumption that the EDRs can be applied across all species. The EDRs were developed for harbour porpoise and there is no advice available for other marine mammal species. This is considered conservative because the species in this assessment typically show less of a disturbance response compared to harbour porpoise.
- EDRs are based on published ranges where the bulk of the effect had been detected. Therefore, they are not equivalent to 100% deterrence or disturbance ranges from the area, nor are they seen to represent the limit range at which effects have been detected.
- For example, pile driving at the first seven large-scale offshore windfarms in the German Bight (including monopiles and piling without noise abatement) found declines in porpoise out to only 17 km (Brandt *et al.,* 2018). Furthermore, acoustic monitoring during piling at Gemini offshore windfarm in the Netherlands (7.5 m monopiles) showed that the avoidance distance of harbour porpoises was in the range of 10-20 km (Geelhoed *et al.,* 2018). There is also evidence of impact ranges decreasing over the period of pile installation at offshore windfarm

sites. For example, in the Moray Firth, Graham *et al*. (2019) reported a 50% probability of harbour porpoises to respond within 7.4 km from the location of the first pile driven, which decreased to 1.3 km from the location of the last pile driven. This suggests individuals may, to some degree, habituate to piling activities over time.

- In the absence of site-specific underwater noise modelling outputs for all the projects included in the cumulative assessment, using the 26 km EDR has been identified as the best approach. However, caution should be applied when making direct comparisons across projects where numbers of disturbed animals have been derived from underwater noise modelling, as compared to the EDR approach, as these are not directly comparable.
- In the absence of a recommended methodology to quantitatively assess the impact from seismic surveys, a highly precautionary approach has been taken. This has resulted in an unrealistic scenario because it assumes that seismic airguns would be continuously firing within the survey day when they are required to be turned off at the end of each survey line when the vessel turns (turns can take 2-3 hours and several can occur in a single day). This is exemplified by a review of seismic surveys undertaken within UK waters during 2018, which showed that airguns only operated for 52% of the time during potential survey days (BEIS, 2020).

11.12 Cumulative impact assessment

11.12.1.1 A description of the significance of cumulative effects upon marine mammals arising from each identified impact is given below.

11.12.2 Project Design Option 1 and 2 - Impact 1 – Disturbance to marine mammals from underwater noise

SENSITIVITY OF THE RECEPTOR

11.12.2.1 During the project alone assessment, all marine mammal species were assessed as having a Low sensitivity to behavioural disturbance from underwater noise during pile driving, UXO clearance, and site surveys. The exception to this was grey seal which has a Negligible sensitivity to behavioural disturbance from underwater noise during pile driving but a Low sensitivity for UXO clearance and site surveys. Therefore, for the purpose of the CIA, all marine mammal species are assessed as having a Low sensitivity overall to underwater noise from pile driving, UXO clearance, and site surveys.

Construction phase

11.12.2.2 For pile driving, the Proposed Development alone was predicted to have a Slight adverse impact on harbour porpoise, bottlenose dolphin, Risso's dolphin, common dolphin, and harbour seal based on both Project Design Options due to disturbance to marine mammals from underwater noise. For grey seal, the Proposed Development alone was predicted to have an Imperceptible impact on disturbance from underwater noise as a result of pile driving. Given the temporary and intermittent consequences on individuals which are unlikely to affect the population trajectory, the magnitude of impact for pile driving was considered to be Low to Medium adverse for both Project Design Options.

11.12.2.3 For UXO clearance, the Proposed Development alone was predicted to have a Slight adverse impact on all marine mammal species based on both Project Design Options due to disturbance to marine mammals from underwater noise. Given the temporary and intermittent consequences on individuals which are unlikely to affect the population trajectory, the magnitude of impact for UXO clearance was considered to be Low adverse for both Project Design Options.

11.12.2.4 For site surveys the Proposed Development alone was predicted to have a Slight adverse impact on all marine mammal species based on both Project Design Options due to disturbance to marine mammals from underwater noise. Given the temporary and intermittent consequences on individuals which are unlikely to affect the population trajectory, the magnitude of impact for pile driving is considered to be Low adverse for both Project Design Options.

TIER 1

MAGNITUDE OF IMPACT

HARBOUR PORPOISE

11.12.2.5 The highest number of harbour porpoises predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of harbour porpoise predicted to be disturbed in 2028 is estimated as 3,380 animals (5.41% of the MU population) (Table 11.58). The number of harbour porpoise predicted to be impacted by the Proposed Development represents 100% of this total. As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Low adverse for harbour porpoises.

BOTTLENOSE DOLPHIN

11.12.2.6 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of bottlenose dolphins predicted to be disturbed in 2028 is estimated as 2,092 animals (713.96% of MU population) (Table 11.59). The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 100% of this total.

11.12.2.7 As discussed previously within the alone assessment, the number of animals available in the area that could be disturbed are being over-predicted as it exceeds the MU population size of 293 animals. However, this population size does not take into account the connectivity of the MU population with other areas. Studies have shown large scale movement of bottlenose dolphins around Ireland and indicated connectivity with the population on the west coast of the RoI (O'Brien *et al.*, 2009). Long distance movements from the Atlantic to the North Sea between populations in the UK and Ireland have also been reported by Robinson *et al.* (2012). Therefore, the size of the reference population used from the Irish Sea MU is likely to be an under-representation of the number of bottlenose dolphins that may be present in the MU Study Area. Equally, the most recent abundance estimates from the semi-resident population at Cardigan Bay in West Wales (which is within the Irish Sea MU) alone were 147 individuals (95% CI: 127 to 194; NRW, 2018). The design of broad scale surveys, such as SCANS, used to derive MU population estimates are not designed to capture localised, coastal populations such as that of the semi-resident population in Cardigan Bay, providing further evidence to suggest that the reference population size has been under-estimated.

11.12.2.8 Furthermore, it is important to highlight the significant difference between the SCANS-III and SCANS-IV abundance estimates of bottlenose dolphins in the Irish Sea. The SCANS-IV abundance estimate for the Irish Sea (blocks CS-D and CS-E) is 8,326 animals (Gilles *et al.,* 2023) whereas the MU population is derived from the lower SCANS-III abundance estimates, resulting in a population size of 293 (IAMMWG, 2023). As a result, the number of animals predicted to be disturbed using the density estimate from SCANS-IV is not comparable with the MU population size, given the much higher abundance estimates for the most recent SCANS surveys. Consequently, this disparity results in a highly unrealistic proportion of the MU population estimated as impacted given that the population size is under-estimated. If the population size is taken to be 8,326 animals, the percentage of the population predicted to be disturbed reduces to 25.13%.

11.12.2.9 A key source of precaution in this assessment is that the harbour porpoise EDRs have been used for bottlenose dolphins, as there is no equivalent for this species. Harbour porpoise have a higher hearing sensitivity than bottlenose dolphins (Southall *et al.,* 2019) and are considered to be particularly responsive to anthropogenic disturbance, with multiple studies showing that porpoises respond (avoidance and reduced vocalisation) to a variety of anthropogenic noise sources to distances of multiple kilometres (e.g. Brandt *et al.,* 2013; Thompson *et al.,* 2013; Tougaard *et al.,* 2013; Brandt *et al.,* 2018; Sarnocinska et al., 2020; Thompson *et al.,* 2020; Benhemma-Le Gall *et al.,* 2021; Benhemma-Le Gall *et al.,* 2023).

11.12.2.10 Studies have shown that dolphin species show comparatively less of a disturbance response from underwater noise compared to harbour porpoise (e.g. Kastelein *et al.*, 2006; Stone *et al.*, 2017). For example, bottlenose dolphins in the Moray Firth have been shown to remain in the impacted area during both seismic activities and pile installation activities (Fernandez-Betelu *et al.,* 2021), which demonstrates a reduced behavioural response (i.e. displacement) as compared to harbour porpoise. Considering the above, it can be concluded that using EDRs derived from studies on harbour porpoise as a proxy for bottlenose dolphins is likely to result in an over-estimate of the number of bottlenose dolphins predicted to experience disturbance.

11.12.2.11 As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Medium adverse for bottlenose dolphins, which is considered to be precautionary due to the caveats and assumptions discussed above.

RISSO'S DOLPHIN

11.12.2.12 The highest number of Risso's dolphins predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of Risso's dolphins predicted to be disturbed in 2028 is estimated as 276 animals (2.25% of the MU population) (Table 11.60). The number of Risso's dolphins predicted to be impacted by the Proposed Development represents 100% of this total. As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Low adverse for Risso's dolphins.

COMMON DOLPHIN

11.12.2.13 The highest number of common dolphins predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of common dolphins predicted to be disturbed in 2028 is estimated as 429 animals (0.42% of the MU population) (Table 11.61). The number of common dolphins predicted to be impacted by the Proposed Development represents 100% of this total. As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Low adverse for common dolphins.

MINKE WHALE

11.12.2.14 The highest number of minke whales predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of minke whales predicted to be disturbed in 2028 is estimated as 400 animals (1.99% of the MU population) (Table 11.62). The number of minke whales predicted to be impacted by the Proposed Development represents 100% of this total. As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Low adverse for minke whales.

GREY SEAL

11.12.2.15 The highest number of grey seals predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of harbour porpoise predicted to be disturbed in 2028 is estimated as 300 animals (18.01% of the MU population) (Table 11.63). The number of grey seals predicted to be impacted by the Proposed Development represents 100% of this total. As a result, the magnitude of impact is assessed as Low adverse for grey seals.

HARBOUR SEAL

11.12.2.16 The highest number of harbour seals predicted to be disturbed across Tier 1 projects between 2021 and 2034 is in 2022, 2023, 2024, 2025, and 2026. This is predicted to occur within the construction period of the Proposed Development (2026 – 2030), although for the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028. Therefore, the highest number of harbour seals is predicted to occur in the absence of the Proposed Development.

11.12.2.17 The maximum cumulative number of harbour seal predicted to be disturbed is estimated as 23 animals (12.64% of the MU population) (Table 11.64). The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to and is unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for harbour seals.

TIERS 1 AND 2

MAGNITUDE OF IMPACT

HARBOUR PORPOISE

11.12.2.18 The assessment of Tier 1 and 2 projects is considered to be the most realistic as this includes projects that are permitted. This means that full environmental impact assessments are available and there is reasonable confidence in the timelines of project construction.

11.12.2.19 The highest number of harbour porpoises predicted to be disturbed across Tier 1 and 2 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of harbour porpoise predicted to be disturbed in 2028 is estimated as 4,496 animals (7.19% of MU population), assuming piling on the same day as the Proposed Development at Awel y Môr offshore windfarm and Holyhead Deep tidal energy project (Table 11.58). The number of harbour porpoises predicted to be impacted by the Proposed Development represents 75% of this total.

11.12.2.20 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to and is unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for harbour porpoises.

BOTTLENOSE DOLPHIN

11.12.2.21 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1 and 2 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of bottlenose dolphins predicted to be disturbed in 2028 is estimated as 2,132 animals (727.65% of MU population), assuming piling on the same day as the Proposed Development at Awel y Môr offshore windfarm and Holyhead Deep tidal energy project (Table 11.59). If the population size is assumed to be 8,326 animals, the percentage of the population predicted to be disturbed reduces to 25.60%. The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 98% of this total.

11.12.2.22 As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Medium adverse for bottlenose dolphins, which is considered to be precautionary due to the caveats and assumptions discussed above in paragraphs 11.12.2.7 to 11.12.2.10.

RISSO'S DOLPHIN

11.12.2.23 The highest number of Risso's dolphins predicted to be disturbed across Tier 1 and 2 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of Risso's dolphins predicted to be disturbed in 2028 is estimated as 276 animals (2.25% of the MU population) (Table 11.60). The number of Risso's dolphins predicted to be impacted by the Proposed Development represents 100% of this total. As a result, the magnitude of impact is considered to be equal to that of the alone assessment and is assessed as Low adverse for Risso's dolphins.

COMMON DOLPHIN

11.12.2.24 The highest number of common dolphins predicted to be disturbed across Tier 1 and 2 projects between 2021 and 2034 is in 2026. This is predicted to occur within the construction period of the Proposed Development (2026 – 2030), although for the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028. Therefore, the highest number of dolphins is predicted to occur in the absence of the Proposed Development.

11.12.2.25 The maximum cumulative number of common dolphins predicted to be disturbed in 2026 is estimated as 3,625 animals (3.53% of the MU population), assuming fourteen offshore windfarms are piling, and two tidal projects and three cable projects are constructing (Table 11.61).

11.12.2.26 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of common dolphins predicted to be disturbed is estimated as 452 animals (0.44% of the MU population), assuming five offshore windfarms are piling, and one tidal project is constructing on the same day as piling at the Proposed Development (Table 11.61). The number of common dolphins predicted to be impacted by the Proposed Development represents 95% of this total.

11.12.2.27 The predicted extent of the cumulative disturbance from Tier 1 and 2 projects is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event an individual is exposed to which are unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for common dolphins.

MINKE WHALE

11.12.2.28 The highest number of minke whales predicted to be disturbed across Tier 1 and 2 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of minke whales predicted to be disturbed in 2028 is estimated as 462 animals (2.30% of the MU population), assuming five offshore windfarms are piling, and one tidal project is constructing on the same day as piling at the Proposed Development (Table 11.62). The number of minke whales predicted to be impacted by the Proposed Development represents 87% of this total.

11.12.2.29 The predicted extent of the cumulative disturbance from Tier 1 and 2 projects is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event an individual is exposed to which are unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Low adverse for minke whales.

GREY SEAL

11.12.2.30 No Tier 2 projects were included in this part of the cumulative assessment for grey seals, as none are within their respective MU. Therefore, the magnitude of impact is the same as that of the assessment of Tier 1 projects and is assessed as Low adverse for grey seals.

HARBOUR SEAL

11.12.2.31 No Tier 2 projects were included in this part of the cumulative assessment for harbour seals, as none are within their respective MU. Therefore, the magnitude of impact is the same as that of the assessment of Tier 1 projects and is assessed as Low adverse for harbour seals.

TIERS 1, 2, AND 3

MAGNITUDE OF IMPACT

11.12.2.32 The assessment of Tier 3 projects is very uncertain because these projects are not yet consented. It is important to note that the Tier 3 projects are less likely to contribute to a cumulative impact due to the uncertainty that they will go ahead, therefore there is little confidence in the results of this assessment.

HARBOUR PORPOISE

11.12.2.33 The highest number of harbour porpoises predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of harbour porpoise predicted to be disturbed in 2028 is estimated as 6,865 animals (10.98% of the MU population), assuming four offshore windfarms are piling, two cable projects are constructing, and two seismic surveys occur on the same day as piling at the Proposed Development (Table 11.58). The number of harbour porpoises predicted to be impacted by the Proposed Development represents 49% of this total.

11.12.2.34 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted occur across multiple projects over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Medium adverse for harbour porpoises.

BOTTLENOSE DOLPHIN

11.12.2.35 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2027 and 2028, which coincides with the assumed UXO clearance campaign and the expected pile driving campaign of the Proposed Development. The maximum cumulative number of bottlenose dolphins predicted to be disturbed in 2027 and 2028 is estimated as 2,353 animals (807.07% of the MU population), assuming three offshore windfarms are piling, one tidal project and one cable project are constructing, and one seismic survey occurs on the same day as piling at the Proposed Development (Table 11.59). If the population size is assumed to be 8,326 animals, the percentage of the population predicted to be disturbed reduces to 28.26%. The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 89% of this total.

11.12.2.36 Overall, the predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population relative to the most recent abundance estimates for this area using the SCANS IV surveys, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. The overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. However, the cumulative disturbance is not considered enough to affect the long-term viability of the population. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Medium adverse for bottlenose dolphins.

RISSO'S DOLPHIN

11.12.2.37 The highest number of Risso's dolphins predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2030. This is predicted to occur within the construction period of the Proposed Development (2026 – 2030), although for the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028. Therefore, the highest number of dolphins is predicted to occur in the absence of the Proposed Development.

11.12.2.38 The maximum cumulative number of Risso's dolphins predicted to be disturbed in 2030 is estimated as 679 animals (5.54% of the MU population) (Table 11.60).

11.12.2.39 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of Risso's dolphins predicted to be disturbed is estimated as 601 animals (4.09% of the MU population), assuming 33 offshore windfarms are piling, one tidal project and two cable projects are constructing, and five seismic surveys occur on the same day as piling at the Proposed Development (Table 11.60). The number of Risso's dolphins predicted to be impacted by the Proposed Development represents 46% of this total.

11.12.2.40 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. Considering the small proportion of the population affected and the extensive area of the respective MU, the cumulative impacts are unlikely to affect the population trajectory. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Low adverse for Risso's dolphins.

COMMON DOLPHIN

11.12.2.41 The highest number of common dolphins predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2026. This is predicted to occur within the construction period of the Proposed Development (2026 – 2030), although for the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028. Therefore, the highest number of dolphins is predicted to occur in the absence of the Proposed Development.

11.12.2.42 The maximum cumulative number of common dolphins predicted to be disturbed in 2026 is estimated as 9,346 animals (9.10% of the MU population), assuming piling across projects on the same day (Table 11.61).

11.12.2.43 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of common dolphins predicted to be disturbed is estimated as 1,382 animals (1.35% of the MU population), assuming 33 offshore windfarms are piling, one tidal project and two cable projects are constructing, and five seismic surveys occur on the same day as piling at the Proposed Development (Table 11.61). The number of common dolphins predicted to be impacted by the Proposed Development represents 31% of this total.

11.12.2.44 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. Considering the small proportion of the population affected and the extensive area of the respective MU, the cumulative impacts are unlikely to affect the population trajectory. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Low adverse for common dolphins.

MINKE WHALE

11.12.2.45 The highest number of minke whales predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of minke whales predicted to be disturbed in 2028 is estimated as 1,331 animals (6.62% of the MU population), assuming 33 offshore windfarms are piling, one tidal project and two cable projects are constructing, and five seismic surveys occur on the same day as piling at the Proposed Development (Table 11.62). The number of minke whales predicted to be impacted by the Proposed Development represents 30% of this total.

11.12.2.46 It is important to note that minke whale densities are higher in the summer, and significantly fewer minke whales will be present to be disturbed outside of the key summer months. The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. Considering small proportion of the population affected and the extensive area of the respective MU, the cumulative impacts are unlikely to affect the population trajectory. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Medium adverse for minke whales.

GREY SEAL

11.12.2.47 The highest number of grey seals predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2024, 2025, and 2026. For the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028, therefore, the highest number of seals is predicted to occur in the absence of the Proposed Development.

11.12.2.48 The maximum cumulative number of grey seals predicted to be disturbed is estimated as 309 animals (18.59% of the MU population), assuming two cable projects are constructing (Table 11.63).

11.12.2.49 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of grey seals predicted to be disturbed is estimated as 300 animals (18.05%

of the MU population) (Table 11.63). The number of grey seals predicted to be impacted by the Proposed Development represents 100% of this total.

11.12.2.50 The predicted extent of the cumulative disturbance from Tier 1, 2, and 3 projects is to a relatively small proportion of the MU population, with short-term behavioural changes expected from each disturbance event an individual is exposed to which are unlikely to affect the population trajectory. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Medium adverse for grey seals.

HARBOUR SEAL

11.12.2.51 The highest number of harbour seals predicted to be disturbed across Tier 1, 2, and 3 projects between 2021 and 2034 is in 2024, 2025, and 2026. For the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028, therefore, the highest number of seals is predicted to occur in the absence of the Proposed Development.

11.12.2.52 The maximum cumulative number of harbour seals predicted to be disturbed is estimated as 46 animals (25.27% of the MU population), assuming two cable projects are constructing (Table 11.64).

11.12.2.53 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of harbour seals predicted to be disturbed is estimated as one animal (0.55% of the MU population) (Table 11.64). The number of harbour seals predicted to be impacted by the Proposed Development represents 100% of this total.

11.12.2.54 The predicted extent of the cumulative disturbance from Tier 1, 2, and 3 projects is to a relatively small proportion of the MU population, with short-term behavioural changes expected from each disturbance event an individual is exposed to which are unlikely to affect the population trajectory. Whilst it is unlikely that all Tier 3 projects will progress to construction, the magnitude of impact is assessed using a precautionary approach as Medium adverse for harbour seals.

TIERS 1, 2, 3, AND PHASE ONE PROJECTS

MAGNITUDE OF IMPACT

HARBOUR PORPOISE

11.12.2.55 For projects with higher data confidence (Tier 1 and 2), the cumulative number of harbour porpoise predicted to be disturbed is low (≤1% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with higher numbers between 2026 and 2030 (≤7.19% of the MU population) (Table 11.58). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 1.21% of the MU population.

11.12.2.56 Across all Tiers and Phase One projects, the highest impact is predicted to occur in 2028 which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of harbour porpoise predicted to be disturbed in 2028 is estimated as 8,250 animals (13.20% of the MU population) assuming five offshore windfarms are piling, high order UXO clearance at one offshore windfarm, one tidal project and two cable projects are constructing, and two seismic surveys occur on the same day as piling at the Proposed Development (Table 11.58). The number of harbour porpoises predicted to be impacted by the Proposed Development represents 41% of this total.

11.12.2.57 However, it is important to recognise that the likelihood of all Tier 1, 2, 3 and Phase One projects undertaking noisy activities at the same time is extremely unlikely. The highest predicted impact occurs in 2028 when five offshore windfarms are assumed to be piling, high order UXO clearance at one offshore windfarm, one tidal project and two cable projects are constructing, and two seismic surveys occur as well as pile driving at the Proposed Development. Logistically, this is improbable due to the number of vessels, particularly for piling, that are currently available for such works.

11.12.2.58 There is also precaution surrounding the estimated number of harbour porpoise predicted to experience behavioural disturbance from seismic surveys. Large 2D and 3D seismic surveys used in oil and gas exploration can produce large impact ranges (12 km EDR for harbour porpoise). Thompson *et al.* (2013) show that the disturbance impact is short-lived as harbour porpoise have been shown to return to the impacted area within 19 hours following the cessation of survey activity. This change in behaviour is therefore considered to be short-term and recoverable, making the magnitude of impact from seismic surveys more likely to be Negligible.

11.12.2.59 Despite insufficient information on piling schedules across the projects to undertake a specific population-level assessment, it is possible to infer the potential for a population-level effect based on previous theoretical modelling. For example, the Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea (DEPONS) model has been used to predict the potential population level effects of cumulative offshore windfarm construction in the North Sea. A study by Nabe-Nielsen *et al.* (2018) showed that the harbour porpoise population in the North Sea was unlikely to be significantly impacted by the construction of 60 offshore windfarms with 65 turbines each. This scenario results in 3,900 days of disturbance between 2011 and 2020 (unless impact ranges are assumed to be larger than those indicated in existing studies i.e. >50 km) but the modelled population showed a recovery to baseline size within 6 – 7 years, despite a decline of up to 20% in population size. This scenario far exceeds that predicted in this CIA, therefore population decline would be expected to be significantly smaller with a quicker recovery to baseline.

11.12.2.60 iPCoD modelling was used to assess the cumulative impact of the Phase One projects on the east coast of RoI only (ABWP2, North Irish Sea Array, Dublin Array, Codling Wind Park, Oriel) (Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling). For both piling scenarios, the iPCoD results for harbour porpoise show that the predicted level of disturbance is insufficient to result in any changes at the population level. The impacted population is predicted to continue to a stable trajectory at 99.6-99.7% of the size of the un-impacted population.

11.12.2.61 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for harbour porpoises.

Table 11.58: Number of harbour porpoise disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							807	3,380						
Celtic IC	1			5	5	5	5								
CeltixConnect	1		40	40	40	40	40								
Greenlink IC	1	1	1	1	1										
Saint-Brieuc	1	49	49	49	49										
West Anglesey demo zone	1			22	22	22	22								
Atlantic Marine Energy Test Site	2				100	100									
Awel y Môr	2						1,094	1,094	1,094	1,094	1,094				
Erebus Floating Wind Demo	2					33	33	33							

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Holyhead Deep	2						22	22	22	22					
TwinHub	2						33								
Erebus/Valorous Potential Cable Route	3					1	1								
Isle of Man (Mooir Vannin)	3										1,094	1,094			
LirIC	3								22						
Llyr 1	3						33	33							
Llyr 2	3						33	33							
Mares connect	3				40	40	40	40							
Mona	3						1,094	1,094							
Morecambe	3						1,094	1,094	1,094	1,094					
Morgan	3								1,094	1,094					

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
North Channel Wind 1	3									1,094	1,094				
North Channel Wind 2	3									595	595				
Valorous	3									33					
White Cross	3						33	33							
Xlinks	3							13	13	13					
Codling Wind Park	Phase One							595							
Dublin Array	Phase One								595	595					
North Irish Sea Array	Phase One							595	595						
Oriel	Phase One						595	595							
Seismic Survey 1	3	73	73	73	73	73	73	73	73	73	73	73	73	73	73
Seismic Survey 2	3	73	73	73	73	73	73	73	73	73	73	73	73	73	73
TOTAL: Tier 1		50	90	117	117	67	67	807	3,380	0	0	0	0	0	0

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
% MU		0.08 %	0.14 %	0.19 %	0.19 %	0.11 %	0.11 %	1.29 %	5.41 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1 & 2		50	90	117	217	200	1,249	1,956	4,496	1,116	1,094	0	0	0	0
% MU		0.08 %	0.14 %	0.19 %	0.35 %	0.32 %	2.00 %	3.13 %	7.19 %	1.79 %	1.75 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1, 2 & 3		196	236	263	403	387	3,723	4,442	6,865	5,185	4,023	1,240	146	146	146
% MU		0.31 %	0.42 %	0.42 %	0.64 %	0.62 %	5.96 %	7.11 %	10.98 %	8.29 %	6.44 %	1.98 %	0.23 %	0.23 %	0.23 %
TOTAL: Tiers 1, 2, 3 & Phase One		196	236	263	403	387	4,513	6,422	8,250	5,975	4,218	1,240	146	146	146
% MU		0.31 %	0.38 %	0.42 %	0.64 %	0.62 %	7.22 %	10.27 %	13.20 %	9.56 %	6.75 %	1.98 %	0.23 %	0.23 %	0.23 %

BOTTLENOSE DOLPHIN

11.12.2.62 For projects with higher data confidence (Tier 1 and 2), the cumulative number of bottlenose dolphins predicted to be disturbed is low (≤1% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with higher numbers in 2028 (≤25.61% of the MU population) (Table 11.59). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 2.63% of the MU population, assuming a population size of 8,326 animals.

11.12.2.63 The highest number of bottlenose dolphins predicted to be disturbed across Tier 1, 2, 3, and Phase One projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of bottlenose dolphins predicted to be disturbed in 2028 is estimated as 3,351 animals, assuming four offshore windfarms are piling, high order UXO clearance at one offshore windfarm, one tidal project and one cable project are constructing, and one seismic survey occurs on the same day as piling at the Proposed Development (Table 11.59). If the population size is assumed to be 8,326 animals, the percentage of the population predicted to be disturbed is 40.25%. The number of bottlenose dolphins predicted to be impacted by the Proposed Development represents 62% of this total. The average proportion of the population potentially disturbed between all years considered in this CIA (2021 to 2034) represents 8.70% of the MU population, assuming a population size of 8,326 animals based on the most recent SCANS IV surveys that covered the MU area. It is important to note that the Tier 3 projects are less likely to contribute to a cumulative impact due to the uncertainty that they will go ahead, and thus there is little confidence in the result of this assessment.

11.12.2.64 iPCoD modelling was used to assess the cumulative impact of the East Coast Phase One projects (Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling). When using the dose-response function, the results of the iPCoD modelling for bottlenose dolphin show a clear deviation from the baseline resulting from disturbance caused by pile driving across the five Phase One projects. The mean impacted population size initially decreases very slightly from the mean un-impacted population size in response to piling, after which it continues on the same, stable trajectory at 95-96% of the mean un-impacted population size. As the iPCoD model does not currently allow for a density-dependent response, there is no way for the impacted population to increase in size after the piling disturbance. The impacted population does, however, continue on a stable trajectory in the long-term.

11.12.2.65 Similarly, when using the level B harassment thresholds for bottlenose dolphin, the results of the iPCoD modelling show a clear deviation from the baseline resulting from disturbance caused by pile driving disturbance across the five East Coast Phase One projects (Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling). The mean impacted population size initially decreases very slightly from the mean un-impacted population size in response to piling, after which it continues on the same, stable trajectory at 98% of the mean un-impacted population size. As the iPCoD model does not currently allow for a density-dependent response, there is no way for the impacted population to increase in size after the piling disturbance. The impacted population does, however, continue on a stable trajectory in the long-term.

11.12.2.66 There are numerous precautions and assumptions made within this assessment relating to the MU population size, EDR approach, vessel logistics, and inclusion of Tier 3 projects which result in an assessment with limited confidence which should be interpreted with a high level of precaution. Overall, the predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population relative to the most recent abundance estimates for this area using the SCANS IV surveys, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. As the total numbers of animals potentially disturbed over the period are driven by the Proposed Development (98% contribution to Tier 1 and Tier 2 projects when the Proposed Development is piling), it can be assumed that the effects on population trajectory will be similar to the results for the Proposed Development alone. As such, the cumulative disturbance is not considered enough to affect the long-term viability of the population. Therefore, the magnitude of impact is assessed as Medium adverse for bottlenose dolphins.

Table 11.59: Number of bottlenose dolphin disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							499	2,092						
CeltixConnect	1		18	18	18	18	18								
Greenlink IC	1	33	33	33	33										
West Anglesey demo zone	1			18	18	18	18								
Awel y Môr	2						22	22	22	22	22				
Holyhead Deep	2						18	18	18	18					
Isle of Man (Mooir Vannin)	3										22	22			
LirIC	3								18						
Mares connect	3				18	18	18	18							

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Mona	3						22	22							
Morecambe	3						22	22	22	22					
Morgan	3								22	22					
North Channel Wind 1	3									22	22				
North Channel Wind 2	3									499	499				
Codling Wind Park	Phase One							499							
Dublin Array	Phase One								499	499					
North Irish Sea Array	Phase One							499	499						
Oriel	Phase One						499	499							
Seismic Survey 1	3	159	159	159	159	159	159	159	159	159	159	159	159	159	159

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
TOTAL: Tier 1		33	51	69	69	36	36	499	2,092	0	0	0	0	0	0
% MU		11.26%	17.41%	23.55%	23.55%	12.29%	12.29%	170.31%	713.99%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL: Tiers 1 & 2		33	51	69	69	36	76	539	2,132	40	22	0	0	0	0
% MU		11.26%	17.41%	23.55%	23.55%	12.29%	25.94%	183.96%	727.65%	13.65%	7.51%	0.00%	0.00%	0.00%	0.00%
TOTAL: Tiers 1, 2 & 3		192	210	228	246	213	297	2,353	2,353	764	724	181	159	159	159
% MU		65.53%	71.67%	77.82%	83.96%	72.70%	101.37%	803.07%	803.07%	260.75%	247.10%	61.77%	54.27%	54.27%	54.27%
TOTAL: Tiers 1, 2, 3 & Phase One		192	210	228	246	213	796	2,257	3,351	1,263	724	181	159	159	159
% MU		65.53%	71.67%	77.82%	83.96%	72.70%	271.67%	770.31%	1143.69%	431.06%	247.10%	61.77%	54.27%	54.27%	54.27%

RISSO'S DOLPHIN

11.12.2.67 For projects with higher data confidence (Tier 1 and 2), the cumulative number of Risso's dolphins predicted to be disturbed is low (≤1% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with slightly higher numbers in 2028 (≤2.25% of the MU population) (Table 11.60). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 0.75% of the MU population.

11.12.2.68 The highest number of Risso's dolphins predicted to be disturbed across Tier 1, 2, 3, and Phase One projects is in 2030. This is predicted to occur within the construction period of the Proposed Development (2026 – 2030), although for the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028. Therefore, the highest number of Risso's dolphins predicted to be disturbed across Tier 1, 2, 3, and Phase One projects occurs in the absence of the Proposed Development.

11.12.2.69 The maximum cumulative number of Risso's dolphins predicted to be disturbed in 2030 is estimated as 679 animals (5.54% of the MU population), assuming 38 offshore windfarms are piling and five seismic survey occur on the same day (Table 11.60).

11.12.2.70 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of Risso's dolphins predicted to be disturbed is estimated as 611 animals (4.98% of the MU population), assuming 35 offshore windfarms are piling, one tidal project and two cable projects are constructing, and five seismic surveys occur on the same day as piling at the Proposed Development (Table 11.60). The number of Risso's dolphins predicted to be impacted by the Proposed Development represents 45% of this total.

11.12.2.71 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. Considering the small proportion of the population affected and the extensive area of the respective MU, the cumulative impacts are unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for Risso's dolphins.

Table 11.60: Number of Risso's dolphin disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							66	276						
Borkum Riffgrund 3	1				0	0									
Celtic IC	1			3	3	3	3								
CeltixConnect	1		0	0	0	0	0								
Courseulles-sur-mer	1	0	0	0	0										
Dogger Bank - Creyke Beck A	1	0	0	0	0										
Dogger Bank - Creyke Beck B	1	0	0	0	0	0									
Dogger Bank - Teesside B (Sofia)	1			0	0	0	0								
Dogger Bank C - Teesside A	1	0	0	0	0	0	0								

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
East Anglia Three	1		0	0	0	0	0								
Fécamp	1		0	0	0										
Greenlink IC	1	0	0	0	0										
Hollandse Kust (Noord)	1		0	0											
Hollandse Kust (Zuid)	1	0	0	0											
Hollandse Kust F	1	0	0	0	0										
Hornsea Project Two	1	0	0												
Inch Cape	1					0	0								
Kaskasi II	1	0	0	0											
Moray East	1	80	80												
Moray West	1	80	80	80	80	80									
Neart Na Gaoithe	1	0	0	0	0										

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Saint-Brieuc	1	0	0	0	0										
Seagreen Phase 1	1	0	0	0											
Triton Knoll	1	0	0												
Vesterhav Nord	1		0	0	0										
Vesterhav Syd	1		0	0											
West Anglesey demo zone	1			0	0	0	0								
Atlantic Marine Energy Test Site	2				19	19									
Awel y Môr	2						0	0	0	0	0				
Dieppe Le Tréport	2				0	0	0								
East Anglia One North	2				0	0	0	0							
East Anglia Two	2				0	0	0	0							

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
EnBW He Dreiht	2					0									
Erebus Floating Wind Demo	2					12	12	12							
Gode Wind 3	2				0	0	0	0	0	0	0	0	0	0	0
Holyhead Deep	2						0	0	0	0					
Hornsea Project Four	2					0	0	0	0	0					
Hornsea Project Three	2							0	0	0	0				
Norfolk Vanguard East	2			0	0	0	0	0	0	0					
Norfolk Vanguard West	2			0	0	0									
Pentland Floating	2				80	80	80								
TwinHub	2						12								
Arven	3							50	50	50	50				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Ayre	3									80	80	80	80		
Beech	3								0						
Bellrock	3				0	0	0	0	0						
Berwick Bank	3				0	0	0	0							
Bowdun	3									0	0	0	0	0	
Broadshore	3				80	80	80	80	80						
Buchan	3									149	149	149	149	149	
Caledonia	3						80	80	80	80	80				
Campion	3				0	0	0	0	0						
Cedar	3								0						
Cenos	3							0	0	0	0				
Centre-Manche 1	3					0	0	0	0	0	0				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Centre-Manche 2	3										0				
Dogger Bank South (East)	3					0									
Dogger Bank South (West)	3					0	0								
Dudgeon Extension	3						0	0	0	0	0				
Dunkerque	3						0	0	0						
Erebus/Valorous Potential Cable Route	3					0	0								
Five Estuaries	3							0	0	0	0				
Green Volt	3							80							
Havbredey	3												61	61	61
IJmuiden Ver	3								0	0					
Isle of Man (Mooir Vannin)	3										0	0			
LirIC	3								0						

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Llyr 1	3						12	12							
Llyr 2	3						12	12							
Mares connect	3				0	0	0	0							
Mona	3						0	0							
Morecambe	3						0	0	0	0					
Morgan	3								0	0					
Morven	3					0									
Muir Mhòr	3										0				
N-3.5	3								0	0	0	0	0	0	0
N-3.6	3				0	0	0								
N-3.7	3						0	0	0	0	0	0	0	0	0
N-3.8	3						0	0	0	0	0	0	0	0	0

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
N-6.6	3								0	0	0	0	0	0	0
N-6.7	3								0	0	0	0	0	0	0
N-7.2	3							0							
N-9.1	3									0	0	0	0	0	0
N-9.2	3									0	0	0	0	0	0
N-9.3	3									0	0	0	0	0	0
N-9.4	3										0	0	0	0	0
N-10.1	3										0	0	0	0	0
N-10.2	3										0	0	0	0	0
Nordsren II vest	3										0				
Nordsren III vest	3							0							
North Channel Wind 1	3									0	0				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
North Channel Wind 2	3									5	5				
North Falls	3					0	0	0	0	0	0				
Outer Dowsing	3						0	0	0	0	0	0			
Rampion 2	3						0	0	0	0					
Salamander	3						0	0	0	0	0				
Shearwater One	3								6						
Sheringham Shoal Extension	3			0	0	0	0								
Spiorad na Mara	3								0	0	0	0			
Stromar	3								80	80	80				
Talisk	3										61				
Ten Noorden van de Wadden	3							0	0	0	0	0			
Thor	3					0	0								

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Valorous	3									12					
West of Orkney	3									80					
White Cross	3						12	12							
Xlinks	3							4	4	4					
Codling Wind Park	Phase One							5							
Dublin Array	Phase One								5	5					
North Irish Sea Array	Phase One							5	5						
Oriel	Phase One						5	5							
Sceirde Rocks	Phase One						0	0	0	0	0				
Seismic Survey 1	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Seismic Survey 2	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Seismic Survey 3	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Seismic Survey 4	3	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Seismic Survey 5	3	9	9	9	9	9	9	9	9	9	9	9	9	9	9
TOTAL: Tier 1		160	160	83	83	83	3	66	276	0	0	0	0	0	0
% MU		1.30 %	1.30 %	0.68 %	0.68 %	0.68 %	0.02 %	0.54 %	2.25 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1 & 2		160	160	83	182	194	107	78	276	0	0	0	0	0	0
% MU		1.30 %	1.30 %	0.68 %	1.69 %	1.58 %	0.87 %	0.64 %	2.25 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1, 2 & 3		185	185	108	287	299	328	423	601	565	679	254	315	235	235
% MU		1.51 %	1.51 %	0.88 %	2.34 %	2.44 %	2.67 %	3.45 %	4.90 %	4.61 %	5.54 %	2.07 %	2.57 %	1.92 %	1.92 %
TOTAL: Tiers 1, 2, 3 & Phase 1		185	185	108	287	299	333	438	611	570	679	254	315	235	235
% MU		1.51 %	1.51 %	0.88 %	2.34 %	2.44 %	2.72 %	3.57 %	4.98 %	4.65 %	5.54 %	2.07 %	2.57 %	1.92 %	1.92 %

COMMON DOLPHIN

11.12.2.72 For projects with higher data confidence (Tier 1 and 2), the cumulative number of common dolphins predicted to be disturbed is low (≤1% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with slightly higher numbers in 2026 (≤3.53% of the MU population) (Table 11.61). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 0.69% of the MU population.

11.12.2.73 The highest number of common dolphins predicted to be disturbed across Tier 1, 2, 3, and Phase One projects between 2021 and 2034 is in 2026. This is predicted to occur within the construction period of the Proposed Development (2026 – 2030), although for the purposes of the assessment the number of animals disturbed has been calculated assuming that UXO clearance will occur in 2027 and piling in 2028. Therefore, the highest number of common dolphins predicted to be disturbed across Tier 1, 2, 3, and Phase One projects occurs in the absence of the Proposed Development.

11.12.2.74 The maximum cumulative number of common dolphins predicted to be disturbed in 2026 is estimated as 10,627 animals (10.35% of the MU population) (Table 11.61).

11.12.2.75 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of common dolphins predicted to be disturbed is estimated as 2,721 animals (2.65% of the MU population), assuming 35 offshore windfarms are piling, one tidal project and two cable projects are constructing, and five seismic surveys occur on the same day as piling at the Proposed Development (Table 11.61). The number of common dolphins predicted to be impacted by the Proposed Development represents 16% of this total.

11.12.2.76 The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. Considering the small proportion of the population affected and the extensive area of the respective MU, the cumulative impacts are unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for common dolphins.

Table 11.61: Number of common dolphin disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							58	429						
Borkum Riffgrund 3	1				0	0									
Celtic IC	1			9	9	9	9								
CeltixConnect	1		2	2	2	2	2								
Courseulles-sur-mer	1	10	10	10	10										
Dogger Bank - Creyke Beck A	1	7	7	7	7										
Dogger Bank - Creyke Beck B	1	7	7	7	7	7									
Dogger Bank - Teesside B (Sofia)	1			7	7	7	7								
Dogger Bank C - Teesside A	1	0	0	0	0	0	0								

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
East Anglia Three	1		0	0	0	0	0								
Fécamp	1		10	10	10										
Greenlink IC	1	66	66	66	66										
Hollandse Kust (Noord)	1		0	0											
Hollandse Kust (Zuid)	1	0	0	0											
Hollandse Kust F	1	0	0	0	0										
Hornsea Project Two	1	7	7												
Inch Cape	1					7	7								
Kaskasi II	1	0	0	0											
Moray East	1	0	0												
Moray West	1	0	0	0	0	0									
Neart Na Gaoithe	1	0	0	0	0										

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Saint-Brieuc	1	259	259	259	259										
Seagreen Phase 1	1	0	0	0											
Triton Knoll	1	7	7												
Vesterhav Nord	1		12	12	12										
Vesterhav Syd	1		12	12											
West Anglesey demo zone	1			2	2	2	2								
Atlantic Marine Energy Test Site	2				0	0									
Awel y Môr	2						0	0	0	0	0				
Dieppe Le Tréport	2				10	10	10								
East Anglia One North	2				0	0	0	0							
East Anglia Two	2				0	0	0	0							

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
EnBW He Dreiht	2					0									
Erebus Floating Wind Demo	2					1,786	1,786	1,786							
Gode Wind 3	2				0	0	0	0	0	0	0	0	0	0	0
Holyhead Deep	2						2	2	2	2					
Hornsea Project Four	2					7	7	7	7	7					
Hornsea Project Three	2							7	7	7	7				
Norfolk Vanguard East	2			7	7	7	7	7	7	7					
Norfolk Vanguard West	2			7	7	7									
Pentland Floating	2				0	0	0								
TwinHub	2						1,786								
Arven	3							0	0	0	0				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Ayre	3									0	0	0	0		
Beech	3								0						
Bellrock	3				0	0	0	0	0						
Berwick Bank	3				0	0	0	0							
Bowdun	3									0	0	0	0	0	
Broadshore	3				0	0	0	0	0						
Buchan	3									0	0	0	0	0	
Caledonia	3						0	0	0	0	0				
Campion	3				0	0	0	0	0						
Cedar	3								0						
Cenos	3							0	0	0	0				
Centre-Manche 1	3					10	10	10	10	10	10				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Centre-Manche 2	3										10				
Dogger Bank South (East)	3					7									
Dogger Bank South (West)	3					7	7								
Dudgeon Extension	3						7	7	7	7	7				
Dunkerque	3						10	10	10						
Erebus/Valorous Potential Cable Route	3					66	66								
Five Estuaries	3							0	0	0	0				
Green Volt	3							0							
Havbredey	3												0	0	0
IJmuiden Ver	3								0	0					
Isle of Man (Mooir Vannin)	3										0	0			
LirIC	3								4						

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Llyr 1	3						1,786	1,786							
Llyr 2	3						1,786	1,786							
Mares connect	3				2	2	2	2							
Mona	3						0	0							
Morecambe	3						0	0	0	0					
Morgan	3								0	0					
Morven	3					0									
Muir Mhòr	3										0				
N-3.5	3								0	0	0	0	0	0	0
N-3.6	3				0	0	0								
N-3.7	3						0	0	0	0	0	0	0	0	0
N-3.8	3						0	0	0	0	0	0	0	0	0

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
N-6.6	3								0	0	0	0	0	0	0
N-6.7	3								0	0	0	0	0	0	0
N-7.2	3							0							
N-9.1	3									0	0	0	0	0	0
N-9.2	3									0	0	0	0	0	0
N-9.3	3									0	0	0	0	0	0
N-9.4	3										0	0	0	0	0
N-10.1	3										0	0	0	0	0
N-10.2	3										0	0	0	0	0
Nordsren II vest	3										0				
Nordsren III vest	3							0							
North Channel Wind 1	3									0	0				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
North Channel Wind 2	3									58	58				
North Falls	3					0	0	0	0	0	0				
Outer Dowsing	3						7	7	7	7	7	7			
Rampion 2	3						30	30	30	30					
Salamander	3						0	0	0	0	0				
Shearwater One	3								116						
Sheringham Shoal Extension	3			7	7	7	7								
Spiorad na Mara	3								356	356	356	356			
Stromar	3								0	0	0				
Talisk	3										0				
Ten Noorden van de Wadden	3							0	0	0	0	0			
Thor	3					0	0								

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Valorous	3									1,786					
West of Orkney	3									0					
White Cross	3						1,786	1,786							
Xlinks	3							173	173	173					
Codling Wind Park	Phase One							58							
Dublin Array	Phase One								58	58					
North Irish Sea Array	Phase One							58	58						
Oriel	Phase One						58	58							
Sceirde Rocks	Phase One						1,223	1,223	1,223	1,223	1,223				
Seismic Survey 1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Seismic Survey 2	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Seismic Survey 3	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Seismic Survey 4	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Seismic Survey 5	3	213	213	213	213	213	213	213	213	213	213	213	213	213	213
TOTAL: Tier 1		363	399	403	391	34	27	58	429	0	0	0	0	0	0
% MU		0.35 %	0.39 %	0.39 %	0.38 %	0.03 %	0.03 %	0.06 %	0.42 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1 & 2		363	399	417	415	1,851	3,625	1,867	452	23	7	0	0	0	0
% MU		0.35 %	0.39 %	0.41 %	0.62 %	1.80 %	3.53 %	1.82 %	0.44 %	0.02 %	0.01 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1, 2 & 3		580	616	641	641	2,157	9,346	7,681	1,382	2,667	672	580	217	217	217
% MU		0.56 %	0.60 %	0.62 %	0.62 %	2.10 %	9.10 %	7.48 %	1.35 %	2.60 %	0.65 %	0.56 %	0.21 %	0.21 %	0.21 %
TOTAL: Tiers 1, 2, 3 & Phase One		580	616	641	641	2,167	10,627	9,078	2,721	3,948	1,895	580	217	217	217
% MU		0.56 %	0.60 %	0.62 %	0.62 %	2.11 %	10.35 %	8.84 %	2.65 %	3.85 %	1.85 %	0.56 %	0.21 %	0.21 %	0.21 %

MINKE WHALE

11.12.2.77 For projects with higher data confidence (Tier 1 and 2), the cumulative number of minke whales predicted to be disturbed is low (≤1% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with higher numbers in 2028 (≤2.30% of the MU population). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 0.89% of the MU population.

11.12.2.78 The highest number of minke whales predicted to be disturbed across Tier 1, 2, 3, and Phase One projects between 2021 and 2034 is in 2028, which coincides with the expected pile driving campaign of the Proposed Development. The maximum cumulative number of minke whales predicted to be disturbed in 2028 is estimated as 1,890 animals (9.39% of the MU population) assuming 35 offshore windfarms are piling, one tidal project and two cable projects are constructing, and five seismic surveys occur on the same day as piling at the Proposed Development (Table 11.62). The number of minke whales predicted to be impacted by the Proposed Development represents 21% of this total.

11.12.2.79 It is important to note that minke whale densities are higher in the summer, and significantly fewer minke whales will be present to be disturbed outside of the key summer months. The predicted extent of the cumulative disturbance is to a small proportion of the MU population, with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals. Considering the small proportion of the population affected and the extensive area of the respective MU, the cumulative impacts are unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for minke whales.

Table 11.62: Number of minke whale disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							96	400						
Borkum Riffgrund 3	1				11	11									
Celtic IC	1			0	0	0	0								
CeltixConnect	1		0	0	0	0	0								
Courseulles-sur-mer	1	0	0	0	0										
Dogger Bank - Creyke Beck A	1	14	14	14	14										
Dogger Bank - Creyke Beck B	1	14	14	14	14	14									
Dogger Bank - Teesside B (Sofia)	1			14	14	14	14								
Dogger Bank C - Teesside A	1	32	32	32	32	32	32								

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
East Anglia Three	1		0	0	0	0	0								
Fécamp	1		0	0	0										
Greenlink IC	1	1	1	1	1										
Hollandse Kust (Noord)	1		11	11											
Hollandse Kust (Zuid)	1	11	11	11											
Hollandse Kust F	1	11	11	11	11										
Hornsea Project Two	1	14	14												
Inch Cape	1					14	14								
Kaskasi II	1	0	0	0											
Moray East	1	25	25												
Moray West	1	25	25	25	25	25									
Neart Na Gaoithe	1	89	89	89	89										

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Saint-Brieuc	1	2	2	2	2										
Seagreen Phase 1	1	89	89	89											
Triton Knoll	1	14	14												
Vesterhav Nord	1		7	7	7										
Vesterhav Syd	1		7	7											
West Anglesey demo zone	1			1	1	1	1								
Atlantic Marine Energy Test Site	2				0	0									
Awel y Môr	2						19	19	19	19	19				
Dieppe Le Tréport	2				0	0	0								
East Anglia One North	2				0	0	0	0							
East Anglia Two	2				0	0	0	0							

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
EnBW He Dreiht	2					11									
Erebus Floating Wind Demo	2					17	17	17							
Gode Wind 3	2				0	0	0	0	0	0	0	0	0	0	0
Holyhead Deep	2						1	1	1	1					
Hornsea Project Four	2					14	14	14	14	14					
Hornsea Project Three	2							14	14	14	14				
Norfolk Vanguard East	2			14	14	14	14	14	14	14					
Norfolk Vanguard West	2			14	14	14									
Pentland Floating	2				25	25	25								
TwinHub	2						17								
Arven	3							26	26	26	26				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Ayre	3									25	25	25	258		
Beech	3								89						
Bellrock	3				89	89	89	89	89						
Berwick Bank	3				89	89	89	89							
Bowdun	3									89	89	89	89	89	
Broadshore	3				26	26	26	26	26						
Buchan	3									26	26	26	26	26	
Caledonia	3						25	25	25	25	25				
Campion	3				89	89	89	89	89						
Cedar	3								89						
Cenos	3							89	89	89	89				
Centre-Manche 1	3					0	0	0	0	0	0				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Centre-Manche 2	3										0				
Dogger Bank South (East)	3					14									
Dogger Bank South (West)	3					14	14								
Dudgeon Extension	3						14	14	14	14	14				
Dunkerque	3						0	0	0						
Erebus/Valorous Potential Cable Route	3					1	1								
Five Estuaries	3							0	0	0	0				
Green Volt	3							26							
Havbredey	3												47	47	47
IJmuiden Ver	3								11	11					
Isle of Man (Mooir Vannin)	3										19	19			
LirIC	3								1						

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Llyr 1	3						17	17							
Llyr 2	3						17	17							
Mares connect	3				0	0	0	0							
Mona	3						19	19							
Morecambe	3						19	19	19	19					
Morgan	3								19	19					
Morven	3					89									
Muir Mhòr	3										89				
N-3.5	3								0	0	0	0	0	0	0
N-3.6	3				0	0	0								
N-3.7	3						0	0	0	0	0	0	0	0	0
N-3.8	3						0	0	0	0	0	0	0	0	0

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
N-6.6	3								11	11	11	11	11	11	11
N-6.7	3								11	11	11	11	11	11	11
N-7.2	3							0							
N-9.1	3									11	11	11	11	11	11
N-9.2	3									11	11	11	11	11	11
N-9.3	3									11	11	11	11	11	11
N-9.4	3										11	11	11	11	11
N-10.1	3										11	11	11	11	11
N-10.2	3										11	11	11	11	11
Nordsren II vest	3										11				
Nordsren III vest	3							11							
North Channel Wind 1	3									19	19				

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
North Channel Wind 2	3									29	29				
North Falls	3					0	0	0	0	0	0				
Outer Dowsing	3						14	14	14	14	14	14			
Rampion 2	3						0	0	0	0					
Salamander	3						89	89	89	89	89				
Shearwater One	3								29						
Sheringham Shoal Extension	3			14	14	14	14								
Spiorad na Mara	3								63	63	63	63			
Stromar	3								25	25	25				
Talisk	3										47				
Ten Noorden van de Wadden	3							11	11	11	11	11			
Thor	3					0	0								

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Valorous	3									17					
West of Orkney	3									25					
White Cross	3						17	17							
Xlinks	3							1	1	1					
Codling Wind Park	Phase One							29							
Dublin Array	Phase One								29	29					
North Irish Sea Array	Phase One							29	29						
Oriel	Phase One						29	29							
Sceirde Rocks	Phase One						501	501	501	501	501				
Seismic Survey 1	3	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Seismic Survey 2	3	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Seismic Survey 3	3	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Seismic Survey 4	3	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Seismic Survey 5	3	5	5	5	5	5	5	5	5	5	5	5	5	5	5
TOTAL: Tier 1		341	366	328	221	111	61	96	400	0	0	0	0	0	0
% MU		1.69 %	1.82 %	1.63 %	1.10 %	0.55 %	0.30 %	0.48 %	1.99 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1 & 2		341	366	356	274	206	168	175	462	62	33	0	0	0	0
% MU		1.69 %	1.82 %	1.77 %	1.36 %	1.02 %	0.84 %	0.87 %	2.30 %	0.31 %	0.16 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1, 2 & 3		370	395	399	610	660	750	892	1,331	782	886	375	304	279	190
% MU		1.84 %	1.96 %	1.98 %	3.03 %	3.28 %	3.73 %	4.43 %	6.62 %	3.89 %	4.40 %	1.86 %	1.51 %	1.39 %	0.94 %
TOTAL: Tiers 1, 2, 3 & Phase One		370	395	399	610	660	1,280	1,480	1,890	1,312	1,387	364	304	279	190
% MU		1.84 %	1.96 %	1.98 %	3.03 %	3.28 %	6.36 %	7.36 %	9.39 %	6.52 %	6.89 %	1.81 %	1.51 %	1.39 %	0.94 %

GREY SEAL

11.12.2.80 For projects with higher data confidence (Tier 1 and 2), the cumulative number of grey seals predicted to be disturbed is very low (0% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with higher numbers from 2022 to 2028 (≤18.05% of the MU population) (Table 11.63). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 6.79% of the MU population.

11.12.2.81 The highest number of grey seals predicted to be disturbed across Tier 1, 2, 3, and Phase One projects between 2021 and 2034 is in 2027, which coincides with the assumed UXO clearance campaign of the Proposed Development. The maximum cumulative number of grey seals predicted to be disturbed in 2027 is estimated as 2,422 animals (145.73% of the MU population) assuming two offshore windfarms are piling, two offshore windfarms are undertaking UXO clearance, and one cable project is constructing on the same day as the Proposed Development (Table 11.63). The number of grey seals predicted to be impacted by the Proposed Development represents 7% of this total.

11.12.2.82 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of grey seals predicted to be disturbed is estimated as 2,019 animals (121.48% of the MU population), assuming one offshore windfarm is piling, and one is undertaking UXO clearance on the same day as piling at the Proposed Development (Table 11.63). The number of grey seals predicted to be impacted by the Proposed Development represents 15% of this total.

11.12.2.83 The number of animals available in the area that could be disturbed are being over-predicted as it exceeds the MU population size of 1,662 animals within the East region of RoI. Considering the typical foraging distances of grey seals (Carter *et al.,* 2022), it is possible that seals from the East and South-east survey regions of the RoI presented in Morris and Duck (2019), and from the Wales and Northern Ireland Management Units (SCOS, 2022), could also be disturbed by construction activities at projects screened into this assessment, including the Proposed Development. Therefore, for the purposes of the CIA it is more appropriate to consider the population of the East and South-east RoI, Wales MU, and Northern Ireland MU for grey seal as 9,936 animals. If the population size is assumed to be 9,936 animals, the percentage of the population predicted to be disturbed in 2028 reduces to 20.32%.

11.12.2.84 iPCoD modelling was used to assess the cumulative impact of the Phase One projects on the east coast of RoI only (ABWP2, North Irish Sea Array, Dublin Array, Codling Wind Park, Oriel). The modelling results show that the level of disturbance predicted under both piling schedules is not sufficient to result in any changes at the population level, since the impacted population is predicted to continue at an increasing trajectory at the same size as the un-impacted population.

11.12.2.85 It is important to note that there are numerous precautions and assumptions made within this assessment relating to the MU population size, EDR approach, and inclusion of Tier 3 projects which result in an assessment where there is limited confidence. Therefore, the results should be interpreted with a high level of caution given these caveats. Overall, the predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population (assuming the population includes the East and South-east regions of RoI, Wales, and Northern Ireland) with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for grey seals.

Table 11.63: Number of grey seal disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							170	300						
CeltixConnect	1		222	222	222	222	222								
Mares connect	3				87	87	87	87							
Codling Wind Park	Phase One							358							
Dublin Array	Phase One								534	534					
North Irish Sea Array	Phase One							1,185	1,185						
Oriel	Phase One						622	622							
TOTAL: Tier 1		0	222	222	222	222	222	170	300	0	0	0	0	0	0
% MU		0.00 %	13.36 %	13.36 %	13.36 %	13.36 %	13.36 %	10.23 %	18.05 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1 & 2		0	222	222	222	222	222	170	300	0	0	0	0	0	0

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
% MU		0.00 %	13.36 %	13.36 %	13.36 %	13.36 %	13.36 %	10.23 %	18.05 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1, 2 & 3		0	222	222	309	309	309	257	300	0	0	0	0	0	0
% MU		0.00 %	13.36 %	13.36 %	18.59 %	18.59 %	18.59 %	15.46 %	18.05 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1, 2, 3 & Phase 1		0	222	222	309	309	931	2,422	2,019	534	0	0	0	0	0
% MU		0.00 %	13.36 %	13.36 %	18.59 %	18.59 %	56.02 %	145.73%	121.48%	32.13 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %

HARBOUR SEAL

11.12.2.86 For projects with higher data confidence (Tier 1 and 2), the cumulative number of harbour seals predicted to be disturbed is very low (0% of the MU population) across the majority of years in the period under consideration (2021 – 2034), with higher numbers from 2022 to 2026 (≤12.64% of the MU population) (Table 11.64). The average proportion of the population potentially disturbed by Tier 1 and 2 projects between all years considered in this CIA (2021 to 2034) is 4.59% of the MU population.

11.12.2.87 The highest number of harbour seals predicted to be disturbed across Tier 1, 2, 3, and Phase One projects between 2021 and 2034 is in 2027, which coincides with the assumed UXO clearance campaign of the Proposed Development. The maximum cumulative number of harbour seals predicted to be disturbed in 2027 is estimated as 694 animals (381.32% of the MU population) assuming two offshore windfarms are piling, two offshore windfarms are undertaking UXO clearance, and one cable project is constructing on the same day as the Proposed Development (Table 11.64). The number of harbour seals predicted to be impacted by the Proposed Development represents <1% of this total.

11.12.2.88 When the Proposed Development is expected to be piling in 2028, the maximum cumulative number of harbour seals predicted to be disturbed is estimated as 304 animals (167.03% of the MU population), assuming one offshore windfarm is piling, and one is undertaking UXO clearance on the same day as piling at the Proposed Development (Table 11.64). The number of harbour seals predicted to be impacted by the Proposed Development represents <1% of this total.

11.12.2.89 The number of animals available in the area that could be disturbed are being over-predicted as it exceeds the MU population size of 182 animals within the East region of RoI. Considering the typical foraging distances of harbour seals (Carter *et al.,* 2022), it is possible that seals from the East and South-east survey regions of the RoI presented in Morris and Duck (2019), and from the Wales and Northern Ireland Management Units (SCOS, 2022), could also be disturbed by construction activities at projects screened into this assessment, including the Proposed Development. Therefore, for the purposes of the CIA it is more appropriate to consider the population of the East and South-east RoI, Wales MU, and Northern Ireland MU for harbour seal as 1,378 animals. If the population size is assumed to be 1,378 animals, the percentage of the population predicted to be disturbed in 2028 reduces to 22.06%.

11.12.2.90 Given the residency of harbour seals and their limited home ranges, it is possible that the same individuals could experience sufficient days of repeated disturbance to impact vital rates, potentially to a sufficient proportion of the population to result in changes in the population trajectory. To investigate the cumulative impact of disturbance on the harbour seal population, iPCoD modelling was used for the Phase One projects on the east coast of RoI only (ABWP2, North Irish Sea Array, Dublin Array, Codling Wind Park, Oriel). The modelling results show that the level of disturbance predicted under both piling schedules is not sufficient to result in any changes at the population level, since the impacted population is predicted to continue at a stable trajectory at the same size as the un-impacted population (Volume III, Appendix 11.3: Phase 1 Irish Offshore Windfarms: Cumulative iPCoD Modelling).

11.12.2.91 It is important to note that there are numerous precautions and assumptions made within this assessment relating to the MU population size, EDR approach, and inclusion of Tier 3 projects which result in an assessment where there is limited confidence. Therefore, the results should be interpreted with a high level of caution given these. Overall, the predicted extent of the cumulative disturbance is to a relatively small proportion of the MU population (assuming the population includes the East and South-east regions of RoI, Wales, and Northern Ireland) with short-term behavioural changes expected from each disturbance event that an individual is exposed to. However, as the overall disturbance effect is predicted to occur across multiple projects and over several years, the temporary changes in behaviour and/or distribution of individuals could result in potential reductions in reproductive rates of some individuals, although is unlikely to affect the population trajectory. Therefore, the magnitude of impact is assessed as Medium adverse for harbour seals.

Table 11.64: Number of harbour seal disturbed by underwater noise in the CIA.

The Project construction window is indicated by red bars. Orange = Not yet/no longer operational; Grey = Abandoned/not in use; Blue = Construction; Pale blue = UXO; Peach = Monopiling; Navy = Operation and maintenance.

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
Proposed Development	-							1	1						
CeltixConnect	1		23	23	23	23	23								
Mares connect	3				23	23	23	23							
Codling Wind Park	Phase One							11							
Dublin Array	Phase One								54	54					
North Irish Sea Array	Phase One							249	249						
Oriel	Phase One						410	410							
TOTAL: Tier 1		0	23	23	23	23	23	1	1	0	0	0	0	0	0
% MU		0.00 %	12.64 %	12.64 %	12.64 %	12.64 %	12.64 %	0.55 %	0.55 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %	0.00 %
TOTAL: Tiers 1 & 2		0	23	23	23	23	23	1	1	0	0	0	0	0	0

Project	Tier	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
% MU		0.00%	12.64%	12.64%	12.64%	12.64%	12.64%	0.55%	0.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL: Tiers 1, 2 & 3		0	23	23	46	46	46	24	1	0	0	0	0	0	0
% MU		0.00%	12.64%	12.64%	25.27%	25.27%	25.27%	13.19%	0.55%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL: Tiers 1, 2, 3 & Phase One		0	23	23	46	46	456	694	304	54	0	0	0	0	0
% MU		0.00%	12.64%	12.64%	25.27%	25.27%	250.55%	381.32%	167.03%	29.67%	0.00%	0.00%	0.00%	0.00%	0.00%

SIGNIFICANCE OF EFFECT

11.12.2.92 For all marine mammal species, the magnitude of the impact of disturbance from underwater noise has been assessed as **Medium adverse**, with the sensitivity of the receptor being **Low**. Therefore, the significance of effect from disturbance to all marine mammal species from underwater noise is **Slight adverse**, which is **not significant** in EIA terms.

11.13 Transboundary effects

11.13.1.1 A screening of transboundary impacts has been carried out and has identified that there was no potential for significant transboundary effects with regards to marine mammals from the Proposed Development upon the interests of other states.

11.13.1.2 The potential transboundary impacts are summarised below:

- Injury and/or disturbance to marine mammals from underwater noise and vibration during pile-driving. Overall, the effect of injury will be of **Not Significant to Slight adverse** significance, and disturbance will be of **Imperceptible to Slight adverse** significance, neither of which is significant in EIA terms;
- Injury and/or disturbance to marine mammals from vessel activities. Overall, the effect of injury will be **Not Significant**, and disturbance will be of **Slight adverse** significance, which is not significant in EIA terms.
- Changes in the fish and shellfish community affecting prey resources. Overall, the effect will be of **Imperceptible** to **Slight adverse** significance, which is not significant in EIA terms.
- Accidental pollution. Overall, the effect will be of **Slight adverse** significance, which is not significant in EIA terms;
- Changes in EMF from subsea electrical cabling. Overall, the effect will be of **Imperceptible** significance, which is not significant in EIA terms;
- Injury and/or disturbance to marine mammals from underwater noise during UXO clearance. Overall, the effect of injury will be of **Not Significant to Slight adverse** significance, and disturbance will be of **Slight adverse** significance, neither of which is significant in EIA terms; and
- Injury and/or disturbance to marine mammals from underwater noise during site surveys. Overall, the effect of injury will be **Not Significant**, and disturbance will be of **Slight adverse** significance, which is not significant in EIA terms.

11.14 Summary of effects

11.14.1.1 This chapter has investigated the potential effects on marine mammals arising from the Proposed Development. The range of potential impacts and associated effects has been informed by the Scoping Opinion and consultation responses from stakeholders, alongside reference to existing legislation and guidance.

11.14.1.2 The impacts considered include direct impacts, for example, behavioural disturbance due to underwater noise during pile driving, as well as indirect impacts, such as changes in fish and shellfish communities affecting prey resource. This has included assessment of cumulative impacts, for example underwater noise from various offshore energy developments within the species-specific MUs.

11.14.1.3 Potential impacts considered in this chapter, alongside any mitigation and residual effects are summarised in Table 11.65 and Table 11.66. Throughout the construction, operational and maintenance, and decommissioning phases of the Proposed Development, all impacts assessed were found to have either Imperceptible, Not Significant, or Slight adverse effects on all marine mammal receptors. As a result, no impact pathway was considered to be significant in terms of the EIA Regulations.

Table 11.65: Summary of potential environmental impacts, mitigation and monitoring for Project Design Option 1

Description of impact	Phase C	Phase O	Phase D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
1. Injury and/or disturbance to marine mammals from underwater noise during pile driving	✓	×	×	A MMMP will be implemented (see Volume III, Appendix 25.2: Marine Mammal Mitigation Plan). Full details of Factored In Measures can be found in section 11.7.3.	Auditory injury (PTS) C: Negligible to Low adverse Behavioural disturbance C: Low to medium adverse	Auditory injury (PTS) C: Low Behavioural disturbance C: Negligible to Low	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Imperceptible to Slight adverse (not significant in EIA terms)	None	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Imperceptible to Slight adverse (not significant in EIA terms)	Monitoring has been proposed to understand the potential for behavioural disturbance to marine mammals during piling. Such monitoring will include both visual monitoring and the use of Passive Acoustic Monitoring (PAM). The details of this monitoring commitments are set out in Volume II, Chapter 4: Description of Development, Table 4.10.
2. Injury and/or disturbance to marine mammals from vessel activities	✓	✓	✓	An Environmental VMP will be implemented (see Volume III, Appendix 25.10: Environmental Vessel Management Plan). Full details of Factored In Measures can be found in	Injury C: Negligible O: Negligible D: Negligible Behavioural disturbance C: Low adverse O: Low adverse D: Low adverse	Injury C: High O: High D: High Behavioural disturbance C: Low O: Low D: Low	Injury C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not significant in EIA terms)	None	Injury C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not significant in EIA terms)	N/A

Description of impact	Phase C	Phase O	Phase D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				section 11.7.3.			Behavioural disturbance C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)		Behavioural disturbance C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	
3. Changes in fish and shellfish community affecting prey resources	✓	✓	✓	N/A	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not significant in EIA terms)	None	C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not significant in EIA terms)	N/A
4. Accidental pollution	✓	✓	✓	An EMP will be implemented (see Volume	C: Low adverse O: Low adverse	C: Medium O: Medium D: Medium	C: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms)	N/A

Description of impact	Phase C	O	D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				III, Appendix 25.1: Environmental Management Plan). A Marine Pollution Contingency Plan will be implemented (Volume III, Appendix 25.1 EMP, Annex 2) Full details of Factored In Measures can be found in section 11.7.3.	D: Low adverse		O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)		O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	
5. Changes in EMF from subsea electrical cabling	✗	✓	✗	Commitment to the burial of cables where possible and protected where not possible, as set out in Volume II, Chapter 4:	O: Low adverse	O: Negligible	O: Imperceptible (not significant in EIA terms)	None	O: Imperceptible (not significant in EIA terms)	N/A

Description of impact	Phase C	O	D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				Description of Development						
6. Injury and/or disturbance to marine mammals from underwater noise during UXO clearance	✓	×	×	A MMMP will be implemented. Full details of Factored In Measures can be found in section 11.7.3	Auditory injury (PTS) C: Negligible to Low adverse Behavioural disturbance C: Low adverse	Auditory injury (PTS) C: Low to Medium Behavioural disturbance C: Low	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	None	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	N/A
7. Injury and/or disturbance from underwater noise during site surveys	✓	×	×	A MMMP will be implemented. Full details of Factored In Measures can be found in section 11.7.3	Auditory injury (PTS) C: Negligible Behavioural disturbance C: Low adverse	Auditory injury (PTS) C: Low Behavioural disturbance C: Low	Auditory injury (PTS) C: Not Significant (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	None	Auditory injury (PTS) C: Not Significant (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	N/A

Table 11.66: Summary of potential environmental impacts, mitigation and monitoring for Project Design Option 2

Description of impact	Phase C	Phase O	Phase D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
1. Injury and/or disturbance to marine mammals from underwater noise during pile driving	✓	×	×	A MMMP will be implemented (see Volume III, Appendix 25.2: Marine Mammal Mitigation Plan). Full details of Factored In Measures can be found in section 11.7.3.	Auditory injury (PTS) C: Negligible to Low adverse Behavioural disturbance C: Low to medium adverse	Auditory injury (PTS) C: Low Behavioural disturbance C: Negligible to Low	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Imperceptible to Slight adverse (not significant in EIA terms)	None	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Imperceptible to Slight adverse (not significant in EIA terms)	Monitoring has been proposed to understand the potential for behavioural disturbance to marine mammals during piling. Such monitoring will include both visual monitoring and the use of Passive Acoustic Monitoring (PAM). The details of this monitoring commitments are set out in Volume II, Chapter 4: Description of Development, Table 4.10.
2. Injury and/or disturbance to marine mammals from vessel activities	✓	✓	✓	An Environmental VMP will be implemented (see Volume III, Appendix 25.10: Environmental Vessel Management Plan). Full details of Factored In	Injury C: Negligible O: Negligible D: Negligible Behavioural disturbance C: Low adverse O: Low adverse	Injury C: High O: High D: High Behavioural disturbance C: Low O: Low D: Low	Injury C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not	None	Injury C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not	N/A

Description of impact	Phase C	Phase O	Phase D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				Measures can be found in section 11.7.3.	D: Low adverse		significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)		significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	
3. Changes in fish and shellfish community affecting prey resources	✓	✓	✓	N/A	C: Negligible O: Negligible D: Negligible	C: Low O: Low D: Low	C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not significant in EIA terms)	None	C: Not Significant (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Not Significant (not significant in EIA terms)	N/A

Description of impact	Phase C	O	D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
4. Accidental pollution	✓	✓	✓	An EMP will be implemented (see Volume III, Appendix 25.1: Environmental Management Plan). A Marine Pollution Contingency Plan will be implemented (Volume III, Appendix 25.1 EMP, Annex 2) Full details of Factored In Measures can be found in section 11.7.3.	C: Low adverse O: Low adverse D: Low adverse	C: Medium O: Medium D: Medium	C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	N/A
5. Changes in EMF from subsea electrical cabling	×	✓	×	Commitment to the burial of cables where possible and protected where not possible, as	O: Low adverse	O: Negligible	O: Imperceptible (not significant in EIA terms)	None	O: Imperceptible (not significant in EIA terms)	N/A

Description of impact	Phase C	Phase O	Phase D	Factored In Measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				set out in Volume II, Chapter 4: Description of Development.						
6. Injury and/or disturbance to marine mammals from underwater noise during UXO clearance	✓	×	×	A MMMP will be implemented. Full details of Factored In Measures can be found in section 11.7.3	Auditory injury (PTS) C: Negligible to Low adverse Behavioural disturbance C: Low adverse	Auditory injury (PTS) C: Low to Medium Behavioural disturbance C: Low	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	None	Auditory injury (PTS) C: Not Significant to Slight adverse (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	N/A
7. Injury and/or disturbance from underwater noise during site surveys	✓	×	×	A MMMP will be implemented. Full details of Factored In Measures can be found in section 11.7.3	Auditory injury (PTS) C: Negligible Behavioural disturbance C: Low adverse	Auditory injury (PTS) C: Low Behavioural disturbance C: Low	Auditory injury (PTS) C: Not Significant (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	None	Auditory injury (PTS) C: Not Significant (not significant in EIA terms) Behavioural disturbance C: Slight adverse (not significant in EIA terms)	N/A

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