WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Chapter 12: Marine Mammal and Marine Turtle Ecology

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Glossary of Acronyms

Acronym	Definition
ABS	American Bureau of Shipping
ADDs	Acoustic Deterrent Devices
ALDFG	Abandoned, Lost, or Discarded Fishing Gear
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BAP	Biodiversity Action Plan
BCA	Bristol Channel Approaches
BEEP	Bycatch Evidence Evaluation Protocol
BEIS	Department for Business, Energy and Industrial Strategy
BND	Bottlenose Dolphin
BSH	the German Federal Maritime and Hydrographic Agency
BSI	British Standards Institution
CBD	Convention on Biological Diversity
CCW	Countryside Council for Wales
CD	Common Dolphin
CEA	Cumulative Effect Assessment
CEMP	Construction Environmental Management Plan
CGNS	Celtic and Greater North Seas
CHSR	Conservation of Habitats and Species Regulations (2017)
CIEEM	Chartered Institute of Ecology and Environmental Management
CIS	Celtic and Irish Sea
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora (1975)
CODA	Cetacean Offshore Distribution and Abundance
COHSR	Conservation of Offshore Marine Habitats and Species Regulations (2017)
CPOD	Cetacean Porpoise Detectors
CRoW	Countryside and Rights of Way Act
CSIP	Cetacean Strandings Investigation Programme
CWT	Cornwall Wildlife Trust
DAERA	Department of Agriculture, Environment and Rural Affairs
DAS	Discretionary Advice Service
DECC	Department for Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DOW	Dudgeon Offshore Wind Farm
ECC	Export Cable Corridor
EDR	Effective Deterrence Radius
EIA	Environmental Impact Assessment

Acronym	Definition
EMFs	Electromagnetic Field
EPP	Evidence Plan Process
EPS	European Protect Species
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
FCS	Favourable Conservation Status
FORTUNE	Floating Offshore Wind Turbine Noise
FPSO	Floating Production Storage Offloading
GBS	Gravity Based Structure
GPS	Global Positioning System
GS	Grey Seal
HDD	Horizontal Directional Drilling
HF	High Frequency
HP	Harbour Porpoise
HRA	Habitats Regulation Assessment
HVAC	High Voltage Alternate Cable
IAC	Inter-array cable
IALA	International Association of Marine Aids to Navigation and Lighthouse Authorities
IAMMWG	Inter-Agency Marine Mammal Working Group
IEC	International Electrotechnical Commission
IPC	Infrastructure Planning Commission
IPCC	Intergovernmental Panel on Climate Change
IUCN Red List	The International Union for Conservation of Nature's Red List of Threatened Species
IWC	International Whaling Commission
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservancy Council
km	Kilometre
LAT	Lowest Astronomical Tide
LF	Low Frequency
m	Metre
META	Marine Energy Test Area
MHWS	Mean High-Water Springs
ML	Marine Licence
MMMP	Marine Mammal Mitigation Protocol
MMMU	Marine Mammal Management Unit
MMO	Marine Management Organisation

Acronym	Definition
MoD	Ministry of Defence
MPS	Marine Policy Statement
MRE	Marine Renewable Energy
MSR	Marine Strategy Regulations
MU	Management Units
MW	Megawatts
NE	Natural England
NEQ	Net Explosive Quantity
nm	Nautical Mile
NMFS	National Marine Fisheries Service
NPL	National Physical Laboratory
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NRW	Natural Resource Wales
NSIP	Nationally Significant Infrastructure Project
NW	North West
OCSW	Offshore Channel and Southwest England
OESEA	Offshore Energy Strategic Environmental Assessments
ORE	Offshore Renewable Energy
OSP	Offshore Substation Platform
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Windfarm
OWL	Offshore Wind Ltd
PBR	Potential Biological Removal
PCW	Phocid Carnivores in Water
PDE	Project Design Envelope
PEMP	Project Environmental Management Plan
PLGR	Pre-Lay Grapnel Run
PTEC	Perpetuus Tidal Energy Centre
PTS	Permanent Threshold Shift
RIAA	Report to Inform an Appropriate Assessment
RMS	Root Mean Square
RMU	Regional Management Unit
RoC	Review of Consents
ROV	Remotely Operated Vehicle
RoI	Republic of Ireland
SAC	Special Area of Conservation
SCANS-III	Small Cetaceans in the European Atlantic and North Sea

Acronym	Definition
SCI	Sites of Community Importance
SCOS	Special Committee on Seals
SD	Standard Deviation
SE	South East
SEL_{cum}	Cumulative Effect from Sound Exposure Level
SEL_{ss}	Sound Exposure Level for a single strike
SIP	Site Integrity Plan
SMASS	Scottish Marine Animal Stranding Scheme
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SoS	Secretary of State
SPA	Special Protection Area
SPL_{peak}	Peak Sound Pressure Level
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
SW	South West
TLP	Tension Leg Platform
TNT	Trinitrotoluene
TTS	Temporary Threshold Shift
UK	United Kingdom
UWN	Underwater Noise
UXO	Unexploded Ordnance
VHF	Very High Frequency
VMS	Vessel Monitoring Systems
VMP	Vessel Management Plan
WCA	Wildlife and Countryside Act (1981)
WTG	Wind Turbine Generator

Glossary of Terminology

Defined Terms	Description
Applicant	Offshore Wind Limited
Commitment	A term used interchangeably with mitigation. Commitments are Embedded Mitigation Measures. Commitments are either Primary (Design) or Tertiary (Inherent) and embedded within the assessment at the relevant point in the EIA (e.g. at Scoping). The purpose of commitments is to reduce and/or eliminate Likely Significant Effects (LSE's), in EIA terms
Cumulative effects	The effect of the Offshore Project taken together with similar effects from a number of different projects, on the same single receptor/resource. Cumulative effects are those that result from changes caused by other past, present or reasonably foreseeable actions together with the Offshore Project
Decibel (dB)	A customary scale commonly used (in various ways) for reporting levels of sound. A difference of 10 dB corresponds to a factor of 10 in sound power. The actual sound measurement is compared to a fixed reference level and the "decibel" value is defined to be 10 log10(actual/reference) where (actual/reference) is a power ratio. Because sound power is usually proportional to sound pressure squared, the decibel value for sound pressure is 20 log10(actual pressure/reference pressure). The standard reference for underwater sound is 1 micro pascal (μPa). The dB symbol is followed by a second symbol identifying the specific reference value (e.g., re 1 μPa).
Department for Business, Energy and Industrial Strategy	Government department that is responsible for business, industrial strategy, science and innovation and energy and climate change policy and consent under Section 36 of the Electricity Act.
Design Envelope	A description of the range of possible components that make up the Offshore Project design options under consideration. This envelope is used to define the Offshore Project for Environmental Impact Assessment purposes when the exact parameters are not yet known.
Designated Site	Sites designated for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Areas of Conservation (cSAC), Sites of Community Importance (SCI), Special Areas of Conservation (SAC) and Special Protection Areas (SPA) and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017.
Development Area	The area comprising the Onshore Development Area and the Offshore Development Area
Engineer, Procure, Construct and Install	A common form of contracting for offshore construction. The contractor takes responsibility for a wide scope and delivers via own and subcontract resources.

Defined Terms	Description
Environmental impact assessment	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and maintenance, and decommissioning.
Export Cable Corridor	The area in which the export cables will be laid, from the Offshore Substation Platform to the Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor.
Front end engineering and design	Front-end engineering and design (FEED) studies address areas of windfarm system design and develop the concept of the windfarm in advance of procurement, contracting and construction.
High Voltage Alternating Current	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction
In-combination effects	In-combination effects are those effects that may arise from the development proposed in combination with other plans and projects proposed/consented but not yet built and operational
Inter-array cables	Cables which link the wind turbines to each other and the Offshore Substation Platform
Inter-related effects	Multiple effects on a given receptor such as benthic habitats (e.g. direct habitat loss or disturbance, sediment plumes, scour, jack-up vessel use etc.) may interact to produce a different or greater effect on this receptor than when the effects are considered in isolation.
Landfall	Where the offshore export cables come ashore.
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest
Mean sea level	The average tidal height over a long period of time.
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or

Defined Terms	Description
	eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by OWL as the EIA process progresses.
Offshore Development Area	The Windfarm Site and Offshore Export Cable Corridor to Landfall.
Offshore Export Cable Corridor	The proposed offshore area in which the export cables will be laid, from the perimeter of the Windfarm Site to Landfall.
Offshore export cables	The cables which would bring electricity from the Offshore Substation Platform to the Landfall.
Offshore infrastructure	All of the offshore infrastructure including wind turbines, Offshore Substation Platform(s) and all cable types.
Offshore Substation Platform(s)	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore Transmission Owner	An OFTO, appointed in UK by Ofgem (Office of Gas and Electricity Markets), has ownership and responsibility for the transmission assets of an offshore windfarm.
Peak pressure	The highest pressure above or below ambient that is associated with a sound wave.
Peak-to-peak pressure	The sum of the highest positive and negative pressures that are associated with a sound wave.
Permanent Threshold Shift (PTS)	A permanent total or partial loss of hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the air, and thus a permanent reduction of hearing acuity.
Platform link cable	This is an electrical cable which links one or more offshore platforms.
Root Mean Square (RMS)	The square root of the arithmetic average of a set of squared instantaneous values. Used for presentation of an average sound pressure level.
Safety zones	An area around a structure or vessel which should be avoided
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
Service operation vessel	A vessel that provides accommodation, workshops and equipment for the transfer of personnel to turbine during OMS. Vessels in service today are typically up to 85m long with accommodation for about 60 people
Sound Exposure Level (SEL)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Sound Exposure Level, cumulative (SEL_{cum})	Single value for the collected, combined total of sound exposure over a specified time or multiple instances of a noise source.

Defined Terms	Description
Sound Exposure Level, single strike (SEL_{ss})	Calculation of the sound exposure level representative of a single noise impulse, typically a pile strike.
Sound Pressure Level (SPL)	The sound pressure level is an expression of sound pressure using the decibel (dB) scale; the standard frequency pressures of which are 1 µPa for water and 20 µPa for air.
Sound Pressure Level Peak (SPL_{peak})	The highest (zero-peak) positive or negative sound pressure, in decibels.
Temporary Threshold Shift (TTS)	Temporary reduction of hearing acuity because of exposure to sound over time. Exposure to high levels of sound over relatively short time periods could cause the same level of TTS as exposure to lower levels of sound over longer time periods. The mechanisms underlying TTS are not well understood, but there may be some temporary damage to the sensory cells. The duration of TTS varies depending on the nature of the stimulus.
The Regulations	The Conservation of Habitats and Species Regulations 2017, and the Conservation of Offshore Marine Habitats and Species Regulations 2017.
Unweighted sound level	Sound levels which are "raw" or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a "weighting envelope" in the frequency domain, typically to make an unweighted level relevant to a particular species. Examples of this are the dB(A), where the overall sound level has been adjusted to account for the hearing ability of humans in air, or the filters used by Southall et al. (2019) for marine mammals.
White Cross Offshore Windfarm	100MW capacity offshore windfarm including associated onshore and offshore infrastructure.
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present
Works completion date	Date at which construction works are deemed to be complete and the windfarm is handed to the operations team. In reality, this may take place over a period of time.

12. Marine Mammal and Marine Turtle Ecology

12.1 Introduction

1. This chapter of the Environmental Statement (ES) presents the potential effects of the White Cross Offshore Windfarm Project (the Offshore Project) on marine mammals and marine turtles. Specifically, this chapter considers the potential impact of the Offshore Project seaward of Mean High-Water Springs (MHWS) during its construction, operation and maintenance, and decommissioning phases. It considers the potential impacts by providing an overview of the existing environment, followed by an assessment of the potential effects associated with the impacts.

2. The ES has been finalised with due consideration of pre-application consultation to date (see **Chapter 7: Consultation**) and the ES will accompany the application to the Marine Management Organisation (MMO) on behalf of the Secretary of State (SoS) for Business for The Department for Business, Energy and Industrial Strategy (BEIS) for Section 36 Consent and Marine Licences under the Marine and Coastal Access Act 2009.

3. The assessment should be read in conjunction with the following linked chapters:

- **Chapter 3: Policy and Legislative Context**
- **Chapter 5: Project Description**
- **Chapter 6: Environment Impact Assessment (EIA) Methodology**
- **Chapter 8: Marine and Coastal Processes**
- **Chapter 9: Marine Water and Sediment Quality**
- **Chapter 10: Benthic and Intertidal Ecology**
- **Chapter 11: Fish and Shellfish Ecology**
- **Chapter 14: Shipping and Navigation.**

4. Additional information to support the marine mammal and marine turtle assessment is included in:

- **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**
- **Appendix 12.B: Marine Mammal and Marine Turtle Cumulative Effect Assessment (CEA) Screening Report**
- **Appendix 12.C: Draft Marine Mammals Mitigation Protocol (MMMP)**
- **Appendix 12.D: In Principle Site Integrity Plan (SIP) for the Bristol Channel Approaches (BCA) Special Area of Conservation (SAC)**.

5. This ES chapter:

- Presents the existing environmental baseline established from desk studies, and consultation
- Presents the potential environmental effects on marine mammals and marine turtles arising from the Offshore Project, based on the information gathered and the analysis and assessments undertaken
- Identifies any assumptions and limitations encountered in compiling the environmental information
- Highlights any necessary monitoring and/or mitigation measures which could prevent, minimise, reduce or offset the possible environmental effects identified in the EIA process.

12.2 Policy, Legislation and Guidance

6. **Chapter 3: Policy and Legislative Context** describes the wider policy and legislative context for the Offshore Project. The principal policy and legislation used to inform the assessment of potential effects on marine mammals and marine turtles for the Offshore Project are outlined in this section.

12.2.1 National Policy Statement

7. National Policy Statements (NPS) are statutory documents which set out the government's policy on specific types of Nationally Significant Infrastructure Projects (NSIP) and are published in accordance with the Planning Act 2008. Although the Offshore Project is not an NSIP, it is recognised that due to its size of 100MW and its location in English waters, certain NPS are considered relevant to the Offshore Project and decision-making and are referred to in this ES.

8. The assessment of potential effects upon marine mammals and marine turtles has been made with specific reference to the relevant NPS. These are the principal decision-making documents for NSIPs. Those relevant to the Offshore Project are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) now BEIS, 2011a)
- NPS for Renewable Energy Infrastructure (EN-3) (DECC, 2011b)
- NPS for Electricity Networks Infrastructure (EN-5) (DECC, 2011c)
- Draft EN-3 NPS for Renewable Energy Infrastructure (EN-3) (BEIS, 2021).

9. The specific assessment requirements for marine mammals and marine turtles, as detailed in the NPS (EN-3), are summarised in **Table 12.1** together with an indication of the section of the chapter where each is addressed.

10. It is noted that the NPS for Renewable Energy Infrastructure (EN-3) is in the process of being revised. A draft version was published for consultation in September 2021 (BEIS, 2021). A review of this draft version has been undertaken in the context of this ES chapter.

11. Minor wording changes within the draft version which do not materially influence the NPS (EN-3) requirements have not been reflected in **Table 12.1**.

Table 12.1 Summary of NPS Assessment Requirement Provisions Relevant to Marine Mammals and Marine Turtles

NPS Requirement	NPS Reference	Section Reference
NPS for Renewable Energy Infrastructure (EN-3)		
There are specific considerations from piling noise which apply to offshore wind energy infrastructure proposals with regard to marine mammals and marine turtles, including cetaceans and seals, which have statutory protection. Offshore piling may reach noise levels which are high enough to cause injury, or even death, to marine mammals and marine turtles. If piling associated with an offshore wind farm is likely to lead to the commission of an offence (which would include deliberately disturbing, killing or capturing a European Protected Species), an application may have to be made for a wildlife licence to allow the activity to take place.	Paragraphs 2.6.90-2.6.91 of the NPS EN-3 (July 2011). See updated wording in draft EN-3 paragraph 2.28.1 and 2.28.2 (BEIS, 2021) below.	**Section 12.4.3** provides an overview of the worst-case scenario for possible piling works. **Sections 12.7.1** and **12.7.3.5** provide an assessment of pile driving (including noise modelling results). It is anticipated that an application for a European Protected Species / Marine Wildlife licence will be submitted post-consent.
Where necessary, assessment of the effects on marine mammals should include details of: • Likely feeding areas • Known birthing areas / haul out sites • Nursery grounds • Known migration or commuting routes • Duration of the potentially disturbing activity including cumulative / in-combination effects with other plans or projects • Baseline noise levels • Predicted noise levels in relation to mortality, Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS)	Paragraph 2.6.92 of the NPS EN-3 (July 2011). See updated wording in draft EN-3 paragraph 2.28.3 (BEIS, 2021) below.	**Section 12.5** provides a description of the existing environment. **Section 12.7** details the assessment of effects during construction, including pile driving. **Section 12.7.3** provides the assessment of operational noise. Cumulative effects are assessed in **Section 12.8**, transboundary effects are assessed in **Section 12.11**, and effects on protected sites are assessed in the

NPS Requirement	NPS Reference	Section Reference
• Soft-start noise levels according to proposed hammer and pile design; and operational noise.		**Report to Inform Appropriate Assessment (RIAA)**.
The applicant should discuss any proposed piling activities with the relevant body. Where assessment shows that noise from offshore piling may reach noise levels likely to lead to an offence [as described above], the applicant should look at possible alternatives or appropriate mitigation before applying for a licence.	Paragraph 2.6.93 of the NPS EN-3 (July 2011). See updated wording in draft EN-3 paragraph 2.28.1 and 2.28.5 (BEIS, 2021) below.	**Section 12.7** details the assessment of effects during construction, including pile driving and mitigation measures. the Offshore Project has discussed proposed piling activities through the Evidence Plan Process (EPP) as outlined in **Section 12.5**.
The IPC (Infrastructure Planning Commission) [now the Planning Inspectorate and the SoS] should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed so as to reasonably minimise significant disturbance effects on marine mammals. Unless suitable noise mitigation measures can be imposed by requirements to any development consent the SoS may refuse the application. The conservation status of marine European Protected Species and seals are of relevance to the SoS. SoS should take into account the views of the relevant statutory advisors. Fixed submerged structures such as foundations are likely to pose little collision risk for marine mammals and the SoS is not likely to have to refuse to grant consent for a development on the grounds that offshore wind farm foundations pose a collision risk to marine mammals.	Paragraphs 2.6.94 to 2.6.96 of the NPS EN-3 (July 2011). See updated wording in draft EN-3 paragraph 2.28.9 and 2.28.10 (BEIS, 2021) below.	**Chapter 5: Project Description** describes the foundation options for the offshore substation platform (OSP) under consideration for the Offshore Project. **Section 12.4.3** describes the worst-case scenario for marine mammals and marine turtles.

NPS Requirement	NPS Reference	Section Reference
Monitoring of the surrounding area before and during the piling procedure can be undertaken. During construction, 24-hour working practices may be employed so that the overall construction programme and the potential for impacts to marine mammal communities are reduced in time. Soft start procedures during pile driving may be implemented. This enables marine mammals in the area disturbed by the sound levels to move away from the piling before significant adverse impacts are caused.	Paragraphs 2.6.97 to 2.6.99 of the NPS EN-3 (July 2011). See updated wording in draft EN-3 paragraph 2.28.6 and 2.28.7 (BEIS, 2021) below.	**Appendix 12.C: Draft MMMP** has been submitted with the ES. These plans will be developed in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs) and approved by the MMO post-consent and will identify any necessary monitoring requirements.
The conservation status of marine European Protected Species and seals are of relevance to the SoS.	Paragraph 2.6.95 of the NPS EN-3 (July 2011).	The conservation status of relevant marine mammal species is included in **Section 12.2.8**.
Monitoring of the surrounding area before and during the piling procedure can be undertaken.	Paragraph 2.6.97 of the NPS EN-3 (July 2011).	**Appendix 12.C: Draft MMMP** has been submitted with the ES which details the marine mammal monitoring requirements during piling.
During construction, 24-hour working practices may be employed so that the overall construction programme and the potential for impacts to marine mammal and marine turtle communities is reduced in time.	Paragraph 2.6.98 of the NPS EN-3 (July 2011).	Details on the construction programme are provided in **Chapter 5: Project Description**.
Draft EN-3 NPS for Renewable Energy Infrastructure (EN-3) (BEIS, 2021)		
Construction activities, including installing wind turbine foundations by pile driving, geophysical surveys, and clearing the site and cable route of unexploded ordinance (UXOs) may reach noise levels which are high enough to cause disturbance, injury, or even death to marine mammals and marine turtles. All marine mammals are protected under Part 3 of the Habitats Regulations.	Draft EN-3 paragraph 2.28.1 (BEIS, 2021).	**Section 12.7, 12.7.3** and **12.8** provides an assessment of the underwater noise levels and maximum impact ranges that could cause injury or disturbance to marine mammals and marine turtles from

NPS Requirement	NPS Reference	Section Reference
In addition, whales, dolphins and porpoises (collectively known as cetaceans) are legally protected species. Therefore, if construction and associated noise levels are likely to lead to an offence under Part 3 of the Habitats Regulations (which would include deliberately disturbing, injuring or killing), an application will have to be made for a wildlife licence[1] to allow the activity to take place.		UXO clearance, piling and other noise sources. A summary of the mitigation measures to reduce the potential effects of underwater noise is provided in **Section 12.4.4**. As outlined in **Section 12.15**, if required, a wildlife licence application will be submitted post-consent.
The development of offshore wind farms can also impact fish species, which can have indirect impacts on marine mammals and marine turtles if those fish are prey species. There is also the risk of collision with construction and maintenance vessels.	Draft EN-3 paragraph 2.28.2 (BEIS, 2021)	**Section 12.7**, **12.7.3** and **12.8** provides an assessment of the potential effects from any indirect effects as a result of impacts on prey species and the risk of collision with construction and maintenance vessels.
Applicant's assessment Where necessary, assessment of the effects on marine mammals and marine turtles should include details of: likely feeding areas and impacts on prey species and prey habitat; known birthing areas / haul out sites for breeding and pupping; • migration routes • protected areas (e.g. Special Areas of Conservation (SACs)	Draft EN-3 paragraph 2.28.3 (BEIS, 2021).	**Section 12.5**, provide a description of the existing environment, including likely feeding areas and prey, seal haul out sites, migration routes and protected areas. **Section 12.7** details the assessment of impacts for PTS, TTS and disturbance from underwater noise, including during

[1] https://www.gov.uk/guidance/understand-marine-wildlife-licences-and-report-an-incident

NPS Requirement	NPS Reference	Section Reference
• baseline noise levels • predicted construction and soft start noise levels in relation to mortality, PTS and TTS and disturbance • operational noise • duration and spatial extent of the impacting activities including cumulative / in-combination effects with other plans or projects • collision risk • barrier risk.		construction from pile driving and soft-start noise levels for the OSP. **Section 12.7.3** provides the assessment of operational noise. **Section 12.8** provides the CEA. **Section 12.7.3.5** and **12.7.5.4** details the assessment of collision risk and barrier risk.
The scope, effort and methods required for marine mammal and marine turtle surveys should be discussed with the relevant statutory nature conservation body.	Draft EN-3 paragraph 2.28.4 (BEIS, 2021).	The requirements of the marine mammal surveys were discussed with the relevant SNCBs as part of the EPP, as outlined in **Section 12.5**.
The Applicant should discuss any proposed noisy activities with the relevant body and must reference the JNCC underwater noise guidance (JNCC *et al.*, 2020) in relation to noisy activities (alone and in-combination with other plans or projects) within Habitat Regulation Assessment (HRA) sites. Where assessment shows that noise from construction and UXO clearance may reach noise levels likely to lead to noise thresholds being exceeded (as detailed in the JNCC guidance) or an offence as described in paragraph 2.28.1 above, the applicant should look at possible alternatives or appropriate mitigation (detailed below).	Draft EN-3 paragraph 2.28.5 (BEIS, 2021)	The Applicant has discussed noisy activities through the EPP as outlined in **Section 12.5**. Reference has been made to the Joint Nature Conservation Committee (JNCC) underwater noise guidance (JNCC *et al.*, 2020) in relation to noisy activities (alone and in-combination with other plans or projects) for the assessment of effects on the Bristol Channel Approaches SAC in the **RIAA**.

NPS Requirement	NPS Reference	Section Reference
Mitigation Monitoring of the surrounding area before and during the piling procedure can be undertaken by various methods including marine mammal observers and passive acoustic monitoring. Active displacement of marine mammals and marine turtles outside potential injury zones can be undertaken using equipment such as acoustic deterrent devices.	Draft EN-3 paragraph 2.28.6 (BEIS, 2021)	The proposed mitigation is outlined in **Section 12.4.4** and the proposed monitoring is outlined in **Section 12.14**.
Soft start procedures during pile driving may be implemented. This enables marine mammals in the area disturbed by the sound levels to move away from the piling before physical or auditory injury is caused.	Draft EN-3 paragraph 2.28.7 (BEIS, 2021)	Sot-start procedures are included in the embedded mitigation as outlined in **Section 12.4.4**.
Where noise impacts cannot be reduced to acceptable levels, other mitigation should be considered, including spatial/temporal restrictions on noisy activities, alternative foundation types, alternative installation methods and noise abatement technology. Review of up-to-date research should be undertaken and all potential mitigation options presented.	Draft EN-3 paragraph 2.28.8 (BEIS, 2021)	Mitigation to reduce the effects from underwater noise are provided in **Appendix 12.C: Draft MMMP** and **Appendix 12.D: In Principle SIP for the BCA SAC**. As outlined in **Section 12.4.4**, these documents and the mitigation measures required will be developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and MMO.
SoS decision making The SoS should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed to reasonably minimise significant impacts on marine mammals and marine turtles. Unless suitable noise mitigation measures can be	Draft EN-3 paragraph 2.28.9 (BEIS, 2021)	As outlined in **Section 12.4.3** and **Section 12.4.4**, selection of the types of foundations, construction methods and mitigation measures are designed to reasonably minimise significant effects on marine mammals.

NPS Requirement	NPS Reference	Section Reference
imposed by requirements to any development consent the SoS may refuse the application.		
The conservation status of cetaceans and seals are of relevance and the SoS should be satisfied that cumulative and in-combination impacts on marine mammals and marine turtles have been considered.	Draft EN-3 paragraph 2.28.10 (BEIS, 2021)	The conservation status of relevant marine mammal species is included in **Section 12.2.8**. The cumulative effects and in-combination effects on marine mammals have been assessed in **Section 12.8** of the ES and in the **RIAA**, respectively.

12.2.2 National Planning Policy Framework

12. The National Planning Policy Framework (NPPF) (Ministry of Housing, Communities and Local Government, updated July 2021) is the primary source of national planning guidance in England. Sections relevant to this aspect of the ES are summarised below in **Table 12.2**.

Table 12.2 Summary of NPPF Policy Relevant to Marine Mammals and Marine Turtles

Summary	How and where this is Considered in the ES
Noise resulting from a proposed activity or development in the marine area or in coastal and estuarine waters can have adverse effects on biodiversity. Anthropogenic sound has the potential to mask biologically relevant signals; it can lead to a variety of behavioural reactions, affect hearing organs and injure or even kill marine life.	Underwater noise impacts resulting from the Offshore Project have been considered within **Sections 12.7, 12.7.3** and **12.8.10.4**, and within **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.
To protect and enhance biodiversity and geodiversity, plans should identify, map and safeguard components of local wildlife-rich habitats and wider ecological networks, including the hierarchy of international, national and locally designated sites of importance for biodiversity[2]; wildlife corridors and stepping-stones that connect them; and areas identified by national and local partnerships for habitat management, enhancement, restoration or creation[3].	The existing environment of the Offshore Project has been considered within **Section 12.4** and **12.5,** alongside the **RIAA** for Designated Sites for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Area of Conservation (cSAC), Sites of Community Importance (SCI), SAC and Special Protected Areas (SPA) and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017. An assessment for other designated sites (e.g. Sites of Specific Scientific Interest (SSSIs) have been included in **Sections 12.7**, **12.8** and **12.9** where relevant.
To protect and enhance biodiversity and geodiversity, plans should promote the conservation, restoration and enhancement of priority habitats, ecological networks and the protection and recovery of priority species; and	The existing environment of the Offshore Project has been considered within **Section 12.4** and **12.5**, alongside the **RIAA** for designated sites.

[2] Circular 06/2005 provides further guidance in respect of statutory obligations for biodiversity and geological conservation and their impact within the planning system.
[3] Where areas that are part of the Nature Recovery Network are identified in plans, it may be appropriate to specify the types of development that may be suitable within them.

Summary	How and where this is Considered in the ES
identify and pursue opportunities for securing measurable net gains for biodiversity.	

12.2.3 National and Regional Marine Policies

13. In addition to the NPS and NPPF, there are several pieces of legislation, policy and guidance applicable to the assessment of marine mammals and marine turtles. These include:

- The Marine Policy Statement (MPS) (HM Government, 2011)
- The Marine Strategy Regulations (MSR) SI 2010/1627 (Defra, 2010)
- The South West Inshore and South West Offshore Marine Plans (HM Government, 2021).

14. Full details are provided in **Chapter 3: Policy and Legislative Context**.

12.2.4 National and International Legislation for Marine Mammals and Marine Turtles

15. **Table 12.3** provides an overview of national and international legislation in relation to marine mammals and marine turtles. These include:

- The Conservation of Seals Act 1970 (HM Government, 1970)
- The Conservation of Seals Order 1999 (HM Government, 1999)
- Wildlife and Countryside Act 1981 (HM Government, 1981)
- Conservation of Habitats and Species Regulations 2017 (HM Government, 2017)
- Conservation of Offshore Marine Habitats and Species Regulations 2017 (HM Government, 2017).

Table 12.3 Summary Table for National and International Legislations Relevant for Marine Mammals

Legislation	Level of Protection	Species Included	Details
Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS)	International	Odontocetes	Formulated in 1992, this agreement has been signed by eight European countries bordering the Baltic and North Seas (including the English Channel) and includes the UK. Under the Agreement, provision is made for the protection of specific areas, monitoring, research, information exchange, pollution control and increasing public awareness of small cetaceans.
The Berne Convention 1979	International	All cetaceans, grey seal and harbour seal All marine turtle species	The Convention conveys special protection to those species that are vulnerable or endangered. Appendix II (strictly protected fauna): 19 species of cetacean. Appendix III (protected fauna): all remaining cetaceans, grey and harbour seal. Although an international convention, it is implemented within the UK through the Wildlife and Countryside Act 1981 (with any aspects not implemented via that route brought in by the Habitats Directive).
The Bonn Convention 1979	International	All cetaceans All marine turtle species	Protects migratory wild animals across all, or part of their natural range, through international co-operation, and relates particularly to those species in danger of extinction. One of the measures identified is the adoption of legally binding agreements, including ASCOBANS.
Oslo and Paris Convention for the Protection of the Marine Environment 1992 (OSPAR)	International	Bowhead whale *Balaena mysticetus*, northern right whale *Eubalaena glacialis*, blue whale *Balaenoptera musculus*, and harbour porpoise	OSPAR has established a list of threatened and/or declining species in the North East Atlantic. These species have been targeted as part of further work on the conservation and protection of marine biodiversity under Annex V of the OSPAR Convention. The list seeks to complement, but not duplicate, the work under the EC Habitats and Birds directives and measures under the Berne Convention and the Bonn Convention.

Legislation	Level of Protection	Species Included	Details
International Convention for the Regulation of Whaling 1956	International	All cetacean species	This Convention established the International Whaling Commission (IWC) who regulates the direct exploitation and conservation of large whales (in particular sperm and large baleen whales) as a resource and the impact of human activities on cetaceans. The regulation considered scientific matters related to small cetaceans, in particular the enforcing of a moratorium on commercial whaling which came into force in 1986.
Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1975	International	All cetacean species All marine turtle species	Prohibits the international trade in species listed in Annex 1 (including sperm whales, northern right whales, and baleen whales) and allows for the controlled trade of all other cetacean species.
Convention on Biological Diversity (CBD) 1993	International	All marine mammal species	Requires signatories to identify processes and activities that are likely to have impacts on the conservation of and sustainable use of biological diversity, inducing the introduction of appropriate procedures requiring an EIA and mitigation procedures.
The Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017	National	All cetaceans, grey and harbour seal All marine turtle species	'The Habitats Regulations 2017'. Provisions of The Habitats Regulations are described further in **Chapter 12: Marine Mammal and Marine Turtle Ecology**. It should be noted that the Habitats Regulations apply within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles (nm).
The Wildlife and Countryside Act	National	All cetaceans	Schedule five: all cetaceans are fully protected within UK territorial waters. This protects them from killing or injury, sale, destruction of

Legislation	Level of Protection	Species Included	Details
1981 (as amended)		All marine turtle species	a particular habitat (which they use for protection or shelter) and disturbance. Schedule six: Short-beaked common dolphin, bottlenose dolphin and harbour porpoise; prevents these species being used as a decoy to attract other animals. This schedule also prohibits the use of vehicles to take or drive them, prevents nets, traps or electrical devices from being set in such a way that would injure them and prevents the use of nets or sounds to trap or snare them.
The Countryside and Rights of Way Act (CRoW) 2000	National	All cetaceans	Under the CRoW Act 2000, it is an offence to intentionally or recklessly disturb any wild animal included under Schedule 5 of the Wildlife and Countryside Act.
Conservation of Seals Act 1970 (as amended)	National	Grey and harbour seal	As of 1st March 2021, a person commits an offence if they intentionally or recklessly kill, injure or take a seal. The legislative changes in England and Wales, amends the Conservation of Seals Act 1970, prohibiting the intentional or reckless killing, injuring or taking of seals and removing the provision to grant licences for the purposes of protection, promotion or development of commercial fisheries or aquaculture activities. These changes were enacted to ensure compliance with the US Marine Mammal Protection Act Import Provision Rule.

12.2.5 Guidance Documents for Marine Mammals and Marine Turtles

16. The principal guidance documents used to inform the assessment of potential effects on marine mammals and marine turtles include, but are not limited to:

- The Protection of Marine European Protected Species (EPS) from Injury and Disturbance: Draft Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area (JNCC *et al.*, 2010)
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (Chartered Institute of Ecology and Environmental Management (CIEEM), 2019)
- Environmental Impact Assessment for offshore renewable energy projects – guide (British Standards Institution (BSI), 2015)
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report (Sea Mammal Research Unit Ltd (SMRU Ltd) on behalf of The Crown Estate, 2010)
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Centre for the Environment and Fisheries and Aquaculture Science (Cefas), 2011)
- Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (JNCC, Department of Agriculture, Environment and Rural Affairs (DAERA) and Natural England, 2020)
- A review of noise abatement systems for offshore wind farm construction noise, and the potential for their application in Scottish Waters (Verfuss *et al.*, 2019)
- Reducing Underwater Noise (NIRAS, SMRU Consulting, and The Crown Estate, 2019)
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010a)
- Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC, 2010b).

12.2.6 Protected Species and Marine Wildlife Licence Guidance

17. All cetacean species are listed as EPS under The Conservation of Habitats and Species Regulations 2017, and the Conservation of Offshore Marine Habitats and Species Regulations 2017 ('the Regulations') and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Under these Regulations, it is an offence to:

- Deliberately capture, injure or kill any cetacean species
- To deliberately disturb them
- To damage or destroy a breeding site or resting place.

18. The JNCC, Natural England and the Countryside Council for Wales (CCW) (JNCC *et al.,* 2010) have produced draft guidance concerning the Regulations on the deliberate disturbance of marine EPS, which provides an interpretation of the regulations in greater detail, including for pile driving operations (JNCC, 2010a), seismic surveys (JNCC, 2017) and the use of explosives (JNCC, 2010b).

19. The draft guidance provides the following interpretations of deliberate injury and disturbance offences under both Habitats Regulations and Offshore Regulations (now the Habitats Regulations, 2017), as detailed in the paragraphs below:

"*Deliberate actions are to be understood as actions by a person who knows, in light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action;*

Certain activities that produce loud sounds in areas where EPS could be present have the potential to result in an injury offence, unless appropriate mitigation measures are implemented to prevent the exposure of animals to sound levels capable of causing injury".

20. For the purposes of marine users, the draft guidance states that a disturbance which can cause offence should be interpreted as:

"*Disturbance which is significant in that it is likely to be detrimental to the animals of an EPS or significantly affect their local abundance or distribution*".

21. The draft guidelines further states that a disturbance offence is more likely where an activity causes persistent noise in an area for long periods of time and highlights that sporadic *"trivial disturbance"* should not be considered as a disturbance offence under Article 12.

22. Any action that could increase the risk of a long-term decline of the population, increase the risk of a reduction of the range of the species, and/or increase the risk of a reduction of the size of the habitat of the species can be regarded as a disturbance under the Regulations. For a disturbance to be considered non-trivial, the disturbance to marine EPS would need to be likely to at least increase the risk of a certain negative impact on the species at Favourable Conservation Status (FCS).

23. JNCC *et al*. (2010) state that:

"*In any population with a positive rate of growth, or a population remaining stable at what is assumed to be the environmental carrying capacity, a certain number of animals can potentially be removed as a consequence of anthropogenic activities (e.g. through killing, injury or permanent loss of reproductive ability), in addition to natural mortality, without causing the population to decrease in numbers, or preventing recovery, if the population is depleted. Beyond a certain threshold however, there could be a detrimental effect on the population*".

24. Grey seals are protected in the UK under the Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017, as well as Conservation of Seals Act 1970.

25. All marine turtles recorded in the UK and Ireland are entitled to a range of legal protection. They are listed on Appendix I of CITES, Appendix I and II of the Bonn Convention and Appendix II of the Bern Convention. All species are protected by the Wildlife and Countryside Act 1981 (as amended), Conservation of Habitats and Species Regulations 2010 in England and Wales, and are an EPS.

26. The United Kingdom Turtle Code (Marine Conservation Society, 2011) has been developed to provide advice for all sea users on how to deal with marine turtle encounters and all sea users are strongly encouraged to report sightings.

12.2.7 Marine Wildlife Licence Requirements

27. If required, a Marine Wildlife Licence application will be submitted post-consent. At that point in time, the Offshore Project design envelope (PDE) will have been further refined through detailed design and procurement activities and further detail will be available on the techniques selected for construction, as well as the mitigation measures that will be in place following the development of MMMPs for piling and UXO clearance.

28. Under the Habitats Regulations 2017, a marine wildlife licence is required if the risk of injury or disturbance to cetacean species, from any potential effect (i.e. underwater noise, collision risk) is assessed as likely, following the application of mitigation. If a licence is required, an application must be submitted, the assessment of which comprises three tests, namely:

- Whether the activity falls within one of the purposes specified in Regulation 55 of the Habitats Regulations.

- Only the purpose of "preserving public health or public safety or other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment" is of relevance to marine mammals in this context.

- That there are no satisfactory alternatives to the activity proposed (that would not incur the risk of offence)
- That the licensing of the activity will not result in a negative impact on the species'/ population's FCS.

29. A marine wildlife licence would consider all cetacean species and marine turtles at potential risk of injury or disturbance. It is likely that the Offshore Project would require a licence for disturbance to cetacean species, as a result of the piling activities.

30. There is no legislation that requires seals to be included under a marine wildlife licence; disturbance is not an offence under the Conservation of Seals Act 1970, and in the case of injury to seals, the MMO is only able to grant licences under very specific circumstances as listed under Section 10(1) of the Conservation of Seals Act 1970, which would not apply in the case that a marine wildlife licence was required for the construction of the Offshore Project.

31. Under the definitions of 'deliberate disturbance' in the Habitats Regulations, chronic exposure and / or displacement of animals could be regarded as a disturbance offence. Therefore, if these risks cannot be avoided, then the Applicant is likely to be required to apply for a marine wildlife licence from the MMO in order to be exempt from the offence.

12.2.8 Conservation Status of Marine Mammals and Marine Turtles

32. **Table 12.4** provides the current conservation status of marine mammal and marine turtle species occurring in UK and adjacent waters, based on the most recent 2013-2018 reporting by JNCC in 2019.

Table 12.4 Conservation Status Assessment of Marine Mammals and Marine Turtle Species in Annex IV of the Habitats Directive Occurring in UK and Adjacent Waters (JNCC, 2019a)

Species	Favourable Conservation Status Assessment
Cetaceans	
Harbour porpoise, *Phocoena phocoena*	Unknown

Species	Favourable Conservation Status Assessment
Bottlenose dolphin, *Tursiops truncatus*	Unknown
Common dolphin, *Delphinus delphis*	Unknown
Striped dolphin, *Stenella coeruleoalba*	Unknown
Minke whale, *Balaenoptera acutorostrata*	Unknown
Pinnipeds	
Grey seal, *Halichoerus grypus*	Favourable
Marine turtles	
Leatherback turtle, *Dermochelys coriacea*	Unknown

33. The International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species[4] provides assessments of the conservation status of animals evaluated at a global scale using the IUCN Red List Categories and Criteria, with the aim of determining their relative risk of extinction. Assessments are updated periodically to reflect new information. Where sufficient information exists, the majority of marine mammal species occurring in UK waters fall into the lowest category of 'least concern' (**Table 12.5**).

Table 12.5 Global IUCN Red List of Threatened Species Assessments for Marine Mammal Species Relevant to the Offshore Project

Species	IUCN Red List Status	Year Assessed
Harbour porpoise	Least Concern	2020
Bottlenose dolphin	Least Concern	2018
Common dolphin	Least Concern	2020
Striped dolphin	Least Concern	2018
Minke whale	Least Concern	2018
Grey seal	Least Concern	2016
Leatherback turtle	Vulnerable	2013

[4] https://www.iucnredlist.org/

12.3 Assessment Methodology

34. **Chapter 6: EIA Methodology** provides a summary of the general impact assessment methodology applied to the Offshore Project. The following sections confirm the methodology used to assess the potential effects on marine mammals and marine turtles.

35. The approach to determining the significance of an impact follows a systematic process for all impacts. This involves identifying, qualifying and, where possible, quantifying the sensitivity, value and magnitude of all ecological receptors which have been scoped into this assessment. Using this information, a significance of each potential impact has been determined using a matrix approach.

36. A matrix approach is used to guide the assessment of effects following best practice, EIA guidance, JNCC *et al*. (2010) guidance and the approach previously agreed with stakeholders for other recent offshore windfarms (including Sheringham and Dudgeon extension projects, Norfolk Vanguard, Norfolk Boreas and East Anglia ONE North, TWO and THREE).

37. In order to enable and facilitate a consistency of approach, a matrix of definitions will be employed to structure the expertise and evidence led assessment of effects. Receptor sensitivity for an individual from each marine mammal and marine turtle species have been defined within the ES, following the definitions set out in **Sections 12.3.1** and **12.3.2**.

12.3.1 Definitions

12.3.1.1 Sensitivity of Receptor

38. For each effect, the assessment identifies receptors sensitive to that effect and implements a systematic approach to understanding the impact pathways and the level of effect on the receptors. The definitions of sensitivity and magnitude for the marine mammal and marine turtle assessments are provided in **Table 12.6** and **Table 12.8** respectively.

39. The sensitivity of a receptor is determined through its ability to accommodate change and on its ability to recover if it is negatively affected (**Table 12.6**). The sensitivity level of marine mammals and marine turtles to each type of impact is justified within the impact assessment and is dependent on the following factors:

- Adaptability – The degree to which a receptor can avoid or adapt to an effect
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect

- Recoverability – The temporal scale over and extent to which a receptor will recover following an effect
- Value – A measure of the receptor importance and rarity (as reflected in the species conservation status (**Section 12.2.8**) and legislative importance (**Section 12.2**).

40. The sensitivity to potential impacts of lethality, physical injury, auditory injury or hearing impairment, as well as behavioural disturbance or auditory masking are considered for each species, using available evidence, including published data sources. **Table 12.6** defines the levels of sensitivity used in the assessments.

Table 12.6 Definition of Sensitivity for a Marine Mammal and Marine Turtle Receptor

Sensitivity	Definition
High	Individual receptor has very limited capacity to avoid, adapt to, accommodate, or recover from the anticipated effect.
Medium	Individual receptor has limited capacity to avoid, adapt to, accommodate, or recover from the anticipated effect.
Low	Individual receptor has some tolerance to adapt, accommodate, or recover from the anticipated effect.
Negligible	Individual receptor is generally tolerant to and can accommodate or recover from the anticipated effect.

41. The 'value' of the receptor forms an important component within the assessment, for instance, if the receptor is a protected species. It is important to understand that high value and high sensitivity are not necessarily linked within a particular impact. A receptor could be of high value (e.g. an Annex II species) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis.

42. All marine mammal species are protected by a number of national and international legislation. All cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin, and grey seal are also afforded protection through the designation of Protected Sites. As such, all species of marine mammal can be considered to be of high value. Marine turtles are also protected under international and national policy, and are listed as an EPS, and therefore are internationally important, and are considered to be of high value.

43. **Table 12.7** provides definitions for the value afforded to a receptor based on its legislative importance. The value is considered, where relevant, in the assessments.

Table 12.7 Definitions of the Different Value Levels for Marine Mammals and Marine Turtles

Value	Definition
High	Internationally or nationally important: Internationally protected species that are listed as a qualifying interest feature of an internationally protected site (i.e. Annex II protected species designated feature of a designated site) and protected species (including EPS) that are not qualifying features of a designated site.
Medium	Regionally important or internationally rare: Protected species that are not qualifying features of a designated site but are recognised as a Biodiversity Action Plan (BAP) priority species either alone or under a grouped action plan, and are listed on the local action plan relating to the marine mammal Study Area.
Low	Locally important or nationally rare: Protected species that are not qualifying features of a designated site and are occasionally recorded within the Study Area in low numbers compared to other regions.
Negligible	Not considered to be particularly important or rare: Species that are not qualifying features of a designated site and are never or infrequently recorded within the Study Area in very low numbers compared to other regions.

12.3.1.2 Magnitude of Effect

44. The magnitude of the potential impacts is based on the intensity or degree of impact to the baseline conditions and is categorised into four levels of magnitude: high, medium, low or negligible, as defined in **Table 12.8**.

45. Determining the magnitude of an impact considers several factors, including:

- Type of activity: will the effects be permanent or temporary
- Duration and frequency of the activity
- Extent of the activity
- Timing and location of the activity.

46. The thresholds for defining the magnitude of effect that could occur from a particular impact has been determined based on current scientific understanding of marine mammal and marine turtle population biology, and JNCC *et al.* (2010) draft guidance on disturbance to EPS species.

47. There are currently no agreed thresholds to determine magnitude of effect for marine mammals. The JNCC *et al.* (2010) EPS draft guidance suggests definitions for a 'significant group' of individuals or proportion of the population for EPS species.

As such this guidance has been considered in defining the thresholds for magnitude of effects (**Table 12.8**).

48. The JNCC *et al.* (2010), draft guidance provides some indication on how many animals may be 'removed' from a population without causing detrimental effects to the population at Conservation Status.

49. The number of animals that can be 'removed' from a population through injury or disturbance varies between species but is largely dependent on the growth rate of the population. Populations with low growth rates can sustain the removal of a smaller proportion of the population than populations with a larger growth rates.

50. The JNCC *et al.* (2010) draft guidance also provides limited consideration of temporary effects, with guidance reflecting consideration of displacement.

51. Temporary effects are considered to be of medium magnitude at greater than 5% of the reference population. JNCC *et al.* (2010) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth could be halted. In assigning 5% to a temporary effect in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

52. Permanent effects with a greater than 1% of the reference population being affected within a single year are considered to be high in magnitude in this assessment. This is based on Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) and Department for Environment, Food and Rural Affairs (Defra) advice (Defra, 2003; ASCOBANS, 2015) relating to impacts from fisheries by-catch (i.e. a permanent effect) on harbour porpoise. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to ASCOBANS, with an intermediate precautionary objective of reducing the effect to less than 1% of the population (Defra, 2003; ASCOBANS, 2015).

Table 12.8 Definition of Magnitude for a Marine Mammal and Marine Turtle Receptor

Magnitude	Definition
High	Fundamental, permanent / irreversible changes to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 1% of the reference population are anticipated to be exposed to the effect. OR

Magnitude	Definition
	Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the Offshore Project). Assessment indicates that more than 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 10% of the reference population are anticipated to be exposed to the effect.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.01% and 1% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the Offshore Project). Assessment indicates that between 1% and 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 5% and 10% of the reference population anticipated to be exposed to effect.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.001% and 0.01% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the Offshore Project). Assessment indicates that between 0.01% and 1% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor.

Magnitude	Definition
	Assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to effect.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that less than 0.001% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more (but not permanent, e.g. limited to lifetime of the Offshore Project). Assessment indicates that less than 0.01% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (limited to the construction phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that less than 1% of the reference population anticipated to be exposed to effect.

12.3.2 Effect Significance

53. In basic terms, the potential significance of an effect is a function of the sensitivity of the receptor and the magnitude of the effect (see **Chapter 6: EIA Methodology** for further details). The determination of significance is guided by the use of an effect significance matrix, as shown in **Table 12.9**. Definitions of each level of significance are provided in **Table 12.10**.

54. Potential effects identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations. Appropriate mitigation has been identified, where possible, in consultation with the regulatory authorities and relevant stakeholders. The aim of mitigation measures is to avoid or reduce the overall effect in order to determine a residual effect upon a given receptor.

Table 12.9 Effect Significance Matrix

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Negligible	Negligible	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate

		Negative Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 12.10 Definition of Effect Significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No effect, therefore no change in receptor condition.

12.3.3 Cumulative Effect Assessment Methodology

55. The CEA considers other plans, projects and activities that may have an effect cumulatively with the Offshore Project. As part of this process, the assessment considers which of the residual effects assessed for the Offshore Project alone has the potential to contribute to a cumulative effect, the data and information available to inform the cumulative effect assessment and the resulting confidence in any assessment that is undertaken. **Chapter 6: EIA Methodology** provides further details of the general framework and approach to the CEA.

56. For the marine mammal and marine turtle assessment, the stages of project development have been adopted as 'tiers' of project development status within the CEA. These tiers are based on guidance issued by JNCC and Natural England in September (2013), as follows:

- Tier 1: built and operational projects
- Tier 2: projects under construction
- Tier 3: projects that have been consented (but construction has not yet commenced)
- Tier 4: projects that have an application submitted to the appropriate regulatory body that have not yet been determined

- Tier 5: projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects)
- Tier 6: projects that have been identified in relevant strategic plans or programmes.

57. These tiers are used as they are considered more appropriate in comparison to the tiers in The Planning Inspectorate (2019a) Advice Note 17 for the types of projects and plans considered in this assessment, in particular for the offshore windfarm stages.

58. The types of plans and projects to be taken into consideration are:

- Other offshore windfarms
- Marine Renewable Energy developments (wave and tidal)
- Geophysical surveys
- Aggregate extraction and dredging
- Licenced disposal sites
- Construction of sub-sea cables and pipelines
- Oil and gas development and decommissioning, including seismic surveys
- Other offshore industries, including gas storage, offshore mines, and carbon capture projects
- Construction of coastal developments, including ports, harbours, and coastal defence schemes
- UXO clearance.

59. Commercial fishing activity and shipping are not considered in the CEA. Further information and justification are provided in **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**.

60. The CEA is a two-part process in which an initial long list of potential projects and activities are identified. The potential to interact with the Offshore Project is determined based on the mechanism of interaction and spatial extent of the reference population for each marine mammal and marine turtle species. Following a tiered approach, the long list of projects is then refined based on the potential for cumulative effects and level of information available to enable further assessment.

61. The plans and projects screened into the CEA are:

- Located in the marine mammal MU population reference area (defined for individual species in the assessment sections)

   - For marine turtle species, the CEA study area (**Figure 12.29**) was used to determine other projects to be screened for cumulative assessment.
- Offshore projects and activities, if there is the potential for cumulative effects during the construction, operational or decommissioning of the Offshore Project
- Offshore windfarms, if the construction and/or piling period could overlap with the proposed construction and/or piling period of the Offshore Project, based on best available information on when the offshore wind farms are likely to be constructed and piling could be taking place.

62. The CEA considers projects, plans and activities which have sufficient information available to undertake the assessment. Insufficient information will preclude a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances. The CEA is based on the publicly available information at the time of writing, however, given the fast moving nature of offshore development, the Offshore Project specific detail is likely to change between submission of the application, and undertaking activities for the Offshore Project. Therefore, a precautionary worst-case approach was taken to identifying the potential projects that could take place at the same time as the Offshore Project.

63. The Offshore Project tiers considered in the CEA for marine mammals are outlined in **Table 12.11** and the CEA screening is provided in **Appendix 12.B: Marine Mammal and Marine Turtle CEA Report**.

Table 12.11 Tiers in Relation to Project Category which have been Screened into the CEA

Project Category	UK	Other
Other offshore windfarms	Tier 1, 2, 3, 4, 5	Tier 1, 2, 3, 4, 5
Other marine renewables	Tier 1, 2, 3, 4, 5	Tier 1, 2, 3
Aggregate extraction and dredging	Tier 1, 2, 3, 4	Screened out
Licenced disposal sites	Tier 1, 2, 3, 4	Screened out
Construction of sub-sea cables and pipelines	Tier 1, 2, 3, 4, 5	Screened out
Oil and Gas development and decommissioning	Tier 1, 2, 3, 4	Screened out
Other offshore industries	Tier 1, 2, 3, 4	Screened out
Construction of coastal developments	Tier 1, 2, 3, 4, 5	Screened out

12.3.4 Transboundary Effect Assessment Methodology

64. The transboundary assessment (**Section 12.11**) considers the potential for transboundary effects to occur on marine mammal and marine turtle species. The highly mobile nature of marine mammals and marine turtles included within the assessments means that there is the potential for transboundary effects since species might arise from areas beyond UK waters.

65. **Chapter 6: EIA Methodology** provides further details of the general framework and approach to the assessment of transboundary effects.

66. For marine mammals, the potential for transboundary effects has been addressed by considering the reference populations (MUs) and potential linkages to other countries (for example, as identified through seal telemetry studies) (IAMMWG, 2022). For marine turtles the potential for transboundary effects has been based on the CEA study area, as shown in **Figure 12.29**.

67. The assessment of effects on transboundary Designated Sites is presented in the **RIAA**.

12.3.5 Inter-Relationships Methodology

68. This assessment considers the potential for there to be inter-relationships between effects, whereby effects may act together to affect a single receptor, or where an effect on one receptor, may in turn indirectly affect another receptor (e.g. an effect on prey fish species may in turn affect food availability for marine mammals).

12.3.6 Interactions Methodology

69. The assessment considers if the potential effects for marine mammals have the potential to interact with each other and could give rise to synergistic effects due to that interaction (e.g. effects due to underwater noise from piling and their interaction with barrier effects caused by underwater noise).

12.3.7 Assumptions and Limitations

70. Due to the large amount of available data and information that has been reviewed for marine mammals within the region, including the site-specific surveys, there is a good understanding of the existing environment.

71. There are, however, some limitations to data collected by marine mammal and marine turtle surveys, primarily due to the highly mobile nature of marine mammals and marine turtles and therefore the potential variability in usage of the site. Each

survey provides only a 'snapshot'. The majority of the surveys, such as the Small Cetaceans in the European Atlantic and North Sea (SCANS), are typically carried out in summer months which can result in seasonal gaps. However, the site-specific aerial surveys were conducted every month during the two-year survey period (APEM Ltd, 2022). Therefore, taking into account the site-specific survey and given the number surveys and data collected from other surveys, for different months, seasons and years, there is good coverage to provide information on the species likely to present in the area.

72. There are acknowledged limitations in the detectability of marine mammals and marine turtles from aerial surveys, such as not being to detect those individuals that are submerged. These limitations are addressed by estimating a correction factor, which is used to account for variability in detecting harbour porpoise at different times of the year and at different times of the day during the site-specific aerial surveys in order to determine estimated absolute density estimates from the site-specific aerial surveys (APEM, 2022). Correction factors have not been applied to the survey data for other marine mammal species due to the limited information available on dive profiles (and therefore the proportion of time each species spends at the surface).

73. As a precautionary approach, density estimates for each marine mammal species used in the assessments are based on the highest for the area, see **Section 12.6.9**.

74. An overview of the confidence of the data and information underpinning the assessment will be presented, where possible. Confidence is classed as High, Medium or Low depending on the type of data (quantitative, qualitative or lacking) as well as the source of information (e.g. peer reviewed publications, grey literature) and its applicability to the assessment.

12.3.8 Approach to Underwater Noise Assessment

75. Several approaches have been used to model the noise sources that are likely to be present during construction of the Offshore Project. For all noise making activities (except UXO and impact piling), the modelling approach is based on directly measured data from Subacoustech Environmental underwater noise measurement database. To model noise from UXO clearance, an approach based on equations from Soloway and Dahl (2014) has been used. For impact piling, Subacoustech's INSPIRE underwater noise model has been used.

76. The National Physical Laboratory (NPL) Good Practice Guide 133 for underwater noise measurements (Robinson *et al.*, 2014) indicated that under certain

circumstances, a simple modelling approach, such as those considered for sources other than impact piling, may be considered acceptable. As the sources are either quiet when compared to impact piling (e.g., drilling and cable laying) or where detailed modelling would imply unjustified accuracy (e.g., where data is limited, such as with UXO clearance). The method of modelling that has been presented here is considered sufficient and there would be little benefit in undertaking a more detailed modelling approach. The limitations of this approach are noted, including the lack of frequency or bathymetric dependence, but are acceptable due to the relatively low noise levels produced by the non-impulsive noise sources. For further information see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.

12.3.9 Baseline Data Sources

77. A desk study was undertaken to obtain information on marine mammals and marine turtles. Data was acquired within the Study Area through a detailed desktop review of existing studies and datasets. Agreement was reached with all consultees that the data collected and the sources used to define the baseline characterisation for marine mammals and marine turtles are fit for the purpose of the EIA, this was discussed and confirmed at the following expert topic group (ETG) meetings:

- Marine Ecology ETG 1 – 5th May 2022
- Marine Mammal ETG 2 – 14th November 2022.

12.3.9.1 Site Specific Surveys

78. In order to provide site specific and up to date information on which to base the impact assessment, site-specific aerial surveys were conducted for marine mammals and seabirds (APEM Ltd, 2022). APEM Ltd collected high resolution aerial digital still imagery for marine megafauna (combined with ornithology surveys) over the Windfarm Site, including a 4km buffer, with a total survey area of 336km^2. The aerial surveys were conducted over a 24 month period between July 2020 and June 2022. The surveys were conducted monthly, and in total, 24 months of data has been collected.

79. The aerial surveys were conducted with a grid based design, with 1.4km spaced transects across the Windfarm Site and buffer every month, with a total of nine transects (**Figure 12.1**). The surveys are flown along the transect pattern at a height of approximately 395m above sea level.

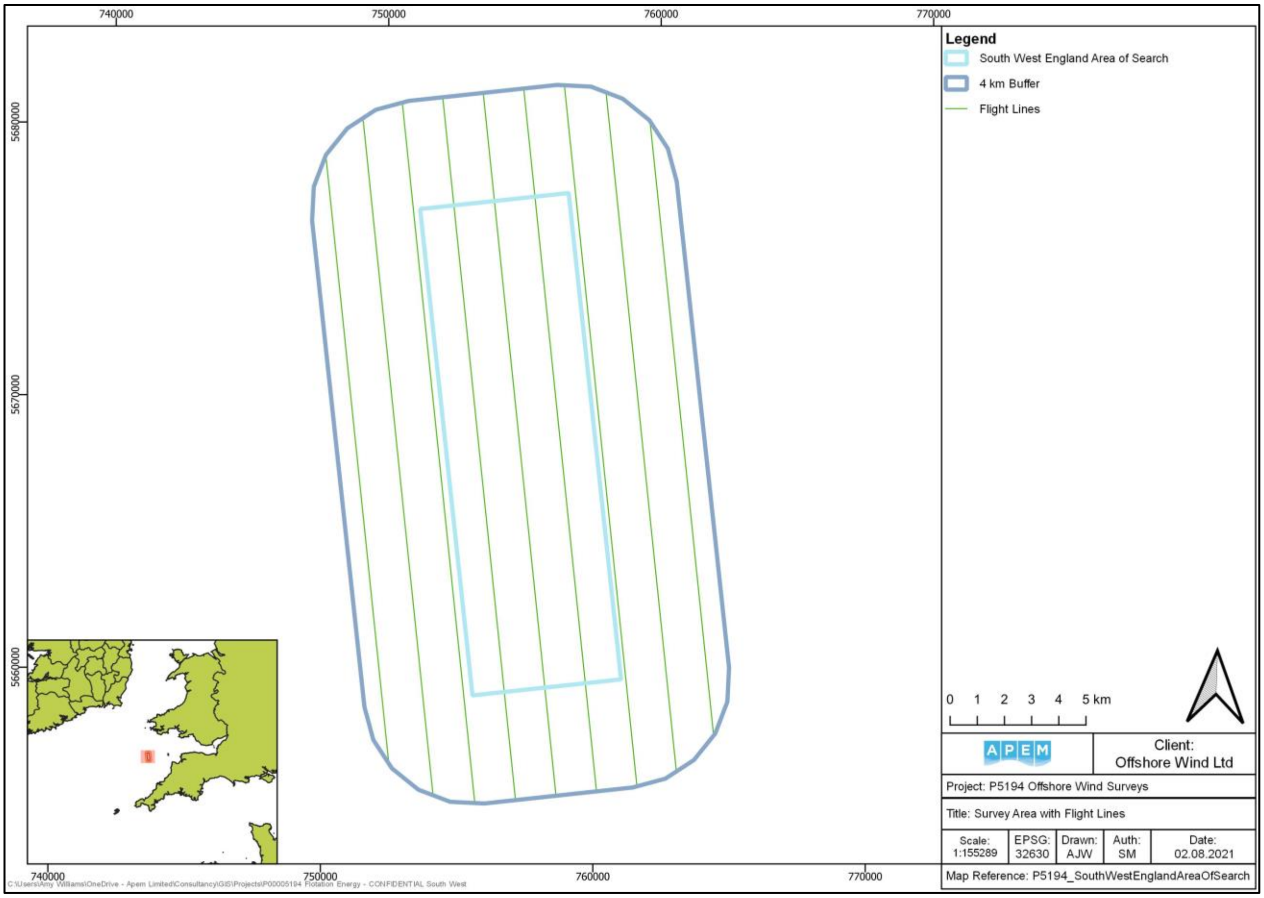


Figure 12.1 Transect Lines of the Aerial Digital Still Imagery of the Offshore Project and 4 km Buffer

80. The surveys were undertaken using a specially designed twin-engine aircraft to capture digital still imagery at 1,300ft, with a 1.5cm ground sampling distance. The surveys achieved approximately 40% coverage of the survey area in each flight, with analysis of 10% of the data.

81. Data analysis follows a two-stage process in which video footage is reviewed (with a 20% random sample used for audit) then the detected objects are identified to species or species group level (again with 20% selected at random for audit). The audit of both stages requires 90% agreement to be achieved (see APEM Ltd, 2022 for further details).

12.3.9.2 Other Available Sources

82. Other sources that have been used to inform the assessment are listed in **Table 12.12**.

Table 12.12 Other Available Data and Information Sources

Data Set	Spatial Coverage	Year	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond *et al.*, 2021).	North Sea and European Atlantic waters	Summer 2016	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2016, including the proposed offshore development area.
MUs for cetaceans in UK waters (Inter-Agency Marine Mammal Working Group (IAMMWG), 2022).	UK waters	2021	Provides information on cetacean MUs for the proposed offshore development area.
Offshore Energy Strategic Environmental Assessments (OESEA) (including relevant appendices and technical reports) (OESEA 3 (Department of Energy and Climate Change (DECC) (now BEIS), 2016; OESEA 4 (BEIS, 2022)).	UK waters	2016 2022	Provides information marine mammals in UK waters
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov, 2015).	UK waters	1994-2011	Data was used to determine UK harbour porpoise SAC sites. Provides information on harbour porpoise in UK waters.
Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (Paxton *et al.*, 2016).	UK waters	1994-2011	Provides information on cetaceans in UK waters.
Distribution and abundance maps for cetacean species around Europe (Waggitt *et al.* (2019).	North-east Atlantic	1980-2018	Provides information on cetacean species in the North-east Atlantic and UK waters

Data Set	Spatial Coverage	Year	Notes
Habitat-based predictions of at-sea distribution for grey seals in the British Isles (Carter *et al.*, 2022).	British Isles	1991-2019	Provides information on relative density (i.e. percentage of at-sea population) for seal species.
Seal telemetry data (e.g. Russell and McConnell, 2014; Russell, 2016a; Carter *et al.,* 2020; Carter *et al.,* 2022; Vincent *et al.*, 2017).	British Isles	1988-2010; 2015	Provides information on movements and distribution of seal species.
Special Committee on Seals (SCOS) annual reporting of scientific advice on matters related to the management of seal populations (SCOS, 2020; SCOS, 2021).	UK and Ireland	2019 & 2020	Provides information on seal species.
British and Irish Marine Turtle Strandings & Sighting Annual Report 2019 (Penrose *et al.,* 2021)	UK and Ireland	2021	Number of marine turtle sightings around the UK and Ireland in 2021.
Long-term insights into marine turtle sightings, strandings and captures around the UK and Ireland (1910–2018) (Botterell *et al.*, 2020)	UK and Ireland	1910 – 2018	Review of marine turtle stranding's and sightings around the UK and Ireland from 1910-2018.
Leatherback turtles satellite tagged in european waters (Doyle *et al.*, 2008)	Celtic and Irish Sea	2003-2005 (June to October)	Aerial surveys of leatherback turtles.

12.4 Scope

12.4.1 Marine Mammal and Marine Turtle Species

83. Site characterisation has been undertaken using site specific data for the Offshore Project, as well as existing data from other offshore wind farms in the area and other available information for the region (See Scoping Report and **Section 12.5** for further information). The key species and therefore the focus of the assessments are:

- Harbour porpoise
  - Present throughout the year, although there may be variations in seasonal occurrence
- Bottlenose dolphin
  - Historically not common in the area, with limited data. However, with a recent increase in sightings along the coast, the species has been included on a precautionary basis
- Striped dolphin
  - Seasonal occurrence in low numbers
- Common dolphin
  - Present throughout the year, although there may be variations in seasonal occurrence
- Minke whale
  - Seasonal occurrence in low numbers
- Grey seal
  - Present throughout the year
- Leatherback turtle
  - Seasonal occurrence in low numbers.

12.4.2 Study Area

84. The study areas for each marine mammal and marine turtle species have been defined on the basis that marine mammals and marine turtles are highly mobile and transitory in nature. Therefore, it is necessary to examine species occurrence not only within the Offshore Project area, but also over the wider area. Details of the location of the Offshore Project and the offshore components are set out within **Chapter 5: Project Description**.

85. The study area for each marine mammal species is based on their relevant Management Units (MU), current knowledge and understanding of the biology of each species. The MU for each species is provided in **Section 12.5** and displayed

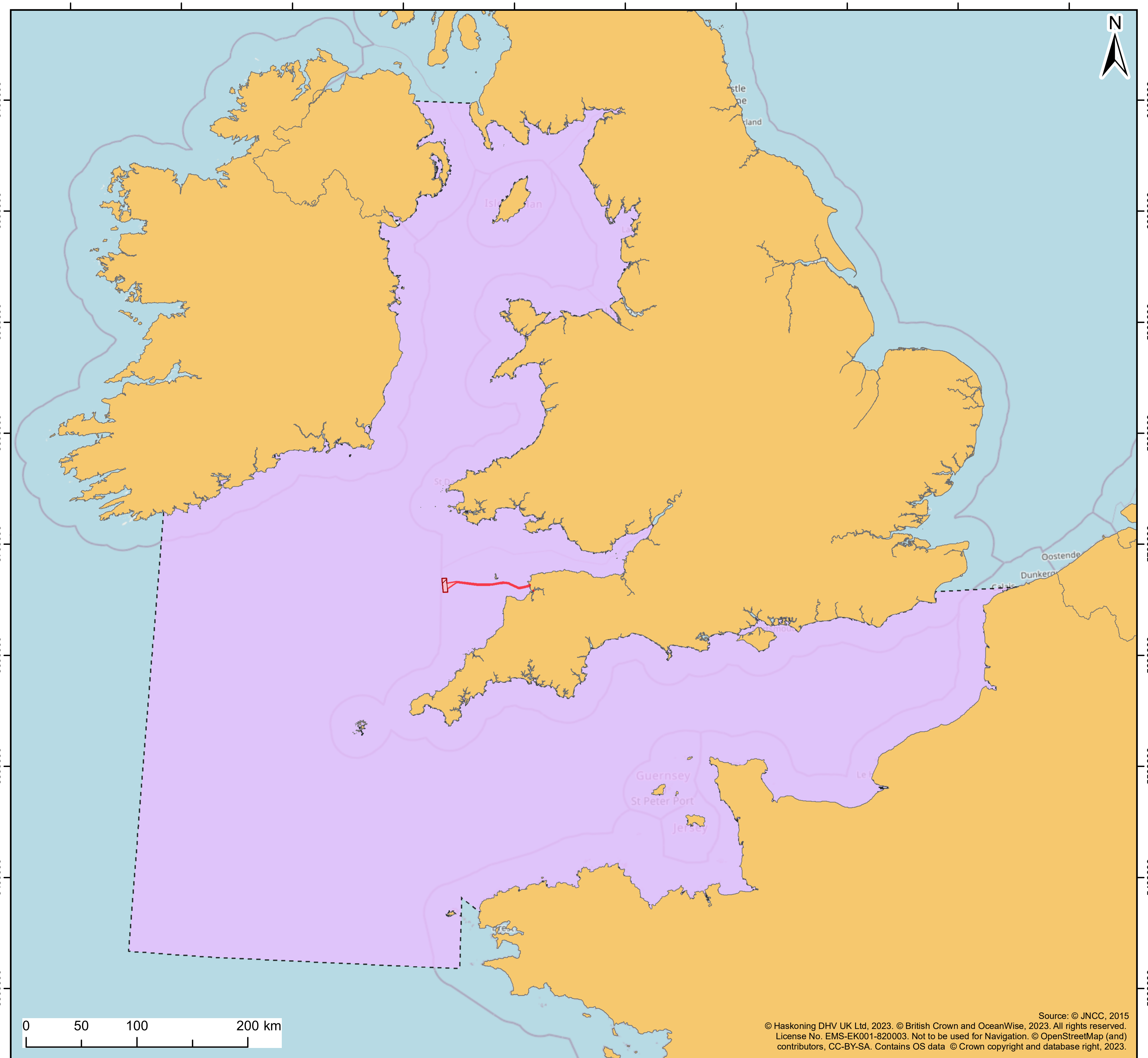
in **Figure 12.2**. For marine turtles, the study area is based on the CEA study area (**Figure 12.29**) to account for the mobile nature of marine turtles.

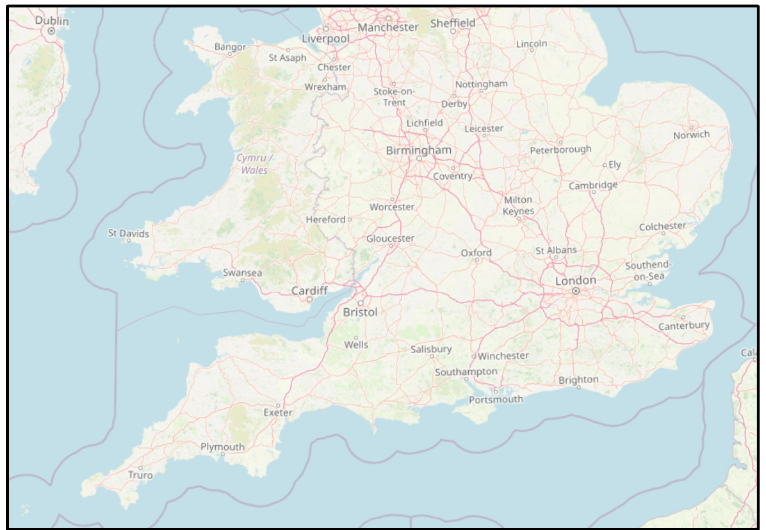
86. The status and activity of marine mammal and marine turtle species known to occur within or adjacent to the Offshore Project are considered in the context of regional population dynamics at the scale of the CIS depending on the data available for each species and the extent of the agreed reference population.

87. the Offshore Project is located approximately 52km offshore (at the closest point to shore), respectively. Water depths at the Windfarm Site range from 60m below Lowest Astronomical Tide (LAT) to 80m.

88. There is the potential for seals from haul out sites to move along the coast and offshore to forage in and around the proposed offshore sites. Key haul out sites for both seal species within the vicinity of the Offshore Project includes:

- Lundy Island (at closest point is located 44km from the Windfarm Site and 2.6km from the Export Cable Corridor (ECC))
- Near Boscastle, along the north Cornwall coastline (approximately 40km from the Offshore Project).





Legend:

- Windfarm Site
- Offshore Development Area
- Cumulatative Effect Assessment Study

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Marine Mammal and Marine Turtle Study Area

Figure: 12.2 Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0476

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	03/03/2023	AB	LA	A3	1:3,500,000
P01	19/01/2023	AB	LA	A3	1:3,500,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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12.4.3 Worst Case Scenario

89. The final design of the Offshore Project will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. To provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach to the ES, referred to as the PDE, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine: PDE (v3, 2018). The PDE for a project outlines the realistic worst-case scenario for each individual effect, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 6: EIA Methodology**.

90. The potential effects on marine mammals are summarised in **Table 12.13**, with the realistic worst-case scenarios for the marine mammal and marine turtle species assessment are summarised in **Table 12.14**.

Table 12.13 Summary of Effects Relating to Marine Mammals and Marine Turtles

Potential Effect	Construction	Operation	Decommissioning
Underwater noise during foundation installation	✓	x	x
Underwater noise during UXO clearance	✓	x	x
Underwater noise from other activities (for example rock placement and cable laying)	✓	✓	✓
Underwater noise and presence of vessels	✓	✓	✓
Underwater noise from operational wind turbines	x	✓	x
Barrier effects from underwater noise	✓	✓	✓
Collision risk with vessels	✓	✓	✓
Disturbance at seal haul out sites	✓	✓	✓
Entanglement	✓	✓	✓
Electromagnetic fields (EMF) direct and indirect effects	✓	✓	✓

Potential Effect	Construction	Operation	Decommissioning
Changes to prey availability (including from habitat loss and Electromagnetic Fields)	✓	✓	✓
Changes to water quality	✓	✓	✓
Barrier effects from physical presence of windfarm	✓	✓	✓
Cumulative effects from underwater noise	✓	✓	✓
Cumulative effects from collision risk and entanglement	✓	✓	✓
Cumulative changes to prey availability (including habitat loss)	✓	✓	✓
Transboundary effects	✓	✓	✓
Inter-relationships	✓	✓	✓
Interactions	✓	✓	✓
Key: ✓ **Impact scoped in** × **Impact scoped out**			

91. These are based on the Offshore Project parameters described in **Chapter 5: Project Description**, which provides further details regarding specific activities and their durations.

92. In addition to the design parameters set out in **Table 12.14**, consideration is also given to:

- How the Offshore Project will be built as described in **Chapter 5: Project Description**
- A number of further development options which either depend on pre-investment or anticipatory investment, or that relate to the final design of the wind farm
- Whether OSPs are required in the Offshore Project (i.e. if no OSP jacket piling is required, the worst-case for foundation installation would be mooring pin piles).

93. In order to ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst-case scenario for each topic has been assessed. Further details are provided in **Chapter 5: Project Description**.

94. Piled foundations for the OSP (jackets piles) are considered the worst-case for marine mammal and marine turtle species as a result of underwater noise levels. (see **Chapter 5: Project Description**).

95. For underwater noise effects from piling, two scenarios have been considered in the assessments:

- Single piling – A scenario where only one pile is installed within a 24-hour period
- Sequential piling – A scenario where one pile is installed after another pile in the same 24-hour period (e.g. up to four pin piles in the same 24 hour period).

96. In relation to the different offshore design scenarios for the Offshore Project (i.e. one OSP or no OSPs), the worst-case has been included in **Table 12.14** and assessed in the impact assessment in **Section 12.7**, **12.7.3**, and **12.8**, where relevant.

Table 12.14 Realistic Worst-Case Scenarios

Potential Effect	Parameters	Rationale
Construction		
Impact 1: Underwater noise during foundation installation (piling)	Installation of up to eight Wind Turbine Generators (WTGs) and up to one OSP.	
	Options for WTG moorings; • Drag embedment anchors (up to eight per WTG (64 total)) • Mooring pin piles (up to six per WTG (48 pin piles total)) • Suction piles (up to six per WTG (48 pin piles total).	Hammer piled foundations (mooring pin piles) represent the worst-case scenario for underwater noise.
	Options for OSP piled foundations: • Jacket with up to four piles.	Hammer piled foundations (OSP jacket piles) represent the worst-case scenario for underwater noise.
	Maximum hammer energy for mooring pin piles: up to 800kJ. Maximum hammer energy for OSP piles: up to 2,500kJ.	The maximum hammer energy will not be required for all piles and would not be required for the entire duration to install a pile.
	Maximum pile diameter for mooring pin piles: up to 2.0m. Maximum pile diameter for OSP piles: up to 4.0m.	This is the worst-case, with the greatest potential underwater noise impact ranges for installation of OSP piles.
	Duration of mooring pin pile installation: two hours and 13 minutes per pin pile. Duration of OSP foundation installation: four hours and 30 minutes per OSP pile.	Total piling time includes soft-start and ramp-up, and provides allowance for issues such as low blow rate, refusal, etc.
	Total mooring piling time: Up to 13 hours and 18 minutes per WTG (with six pin piles per WTG), and up to 106 hours and 24	

Potential Effect	Parameters	Rationale
	minutes for all eight WTGs (or a total of up to 4.5 days of active piling). Total OSP piling time: Up to 18 hours per OSP (with four piles) (or a total of up to 1 day of active piling).	
	Maximum number of piling vessels (at any one time): one	
	Maximum number of mooring pin piles to be installed in a 24-hour period: eight. Maximum number of OSP piles to be installed in a 24-hour period: four.	
	Duration of piling period: six months	This is the maximum duration of all offshore activities to install the OSP. However, active piling will only be a relatively small duration within this overall period.
	Activation of Acoustic Deterrent Device (ADD) Indicative durations: 31 minutes per mooring pin-piles, or 62 minutes for jacket piles.	Indicative only.
Impact 2: Underwater noise during UXO clearance	Any requirements for UXO clearance currently unknown, including locations, number, types and sizes of UXO. Risk Assessment determined potential worst-case is UXO with a Net Explosive Quantity (NEQ) of 309.4kg (based on the known presence of devices in the area) (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**). Underwater modelling and assessments based high-order detonation of UXO with NEQ of 309.4kg (including donor charge). Low-order clearance would be the first and preferred method for UXO that require clearance.	Indicative only. A detailed UXO survey would be completed prior to construction. The exact type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage.

Potential Effect	Parameters	Rationale
	Underwater modelling and assessments include low-order deflagration with shaped charge of 3.1kg NEQ. As a worst case, assessments are based on high-order detonation without mitigation.	
Impact 3: Underwater noise from other activities such as seabed preparations, cable laying and rock placement	Seabed clearance methods: Pre-lay grapnel run, boulder grab, plough, sand wave levelling (pre-sweeping), dredging.	Dredging is considered to be the worst-case scenario in terms of underwater noise levels.
	Cable installation methods: Jetting / ploughing / trenching / mechanical cutting.	Assumed equal amounts of jetting and mechanical cutting.
	Windfarm Site: 50km^2.	Maximum windfarm area.
	Export cable corridor: 70 – 93.6km^2.	
	Duration of offshore construction: 16 months. Duration of offshore export cable installation: 2 to 6 months.	
Impact 4 & 6: Interactions and collision risk with vessels, and underwater noise and disturbance from vessels	Vessel movements: • Maximum number of construction vessels on site at any one time: up to five vessels. • Construction vessel movements: up to 101 movements over the construction period.	Construction port(s) will not be confirmed until nearer the start of construction.
Impact 5: Barrier effects caused by underwater noise	Maximum impact range from underwater noise assessments (worst-case parameters described above). • Piling (TTS) – 54km (**Table 12.50**) • UXO (TTS) – 85km (**Table 12.63**)	The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier effect.
Impact 7: Disturbance at seal haul out sites	Distance to the Windfarm Site and vessel routes to seal haul out sites identified within **Section 12.7.7** for grey seal, respectively.	Construction port(s) will not be confirmed until nearer the start of construction.

Potential Effect	Parameters	Rationale
Impact 8: Entanglement	• Max 48 mooring lines (six per WTG) • Max 10 inter-array cables • Mooring lines made up of anchor chain, mooring cables or polyester mooring line • Mooring lines extend out to between 600m (catenary system) from the WTG.	
Impact 9: Electromagnetic fields direct and indirect effects	EMF from export cable options, inter-array cables and dynamic cables from turbines to seabed in water column, based on potential direct effects of magnetic and electric fields. • Max 10 inter-array cables (max. of 8 per WTG) • Max 2 export cables.	EMF assessment for the Offshore Project (**Chapter 11: Fish and Shellfish Ecology**).
Impact 10: Barrier effects (physical presence)	Windfarm Site is located 52.5km from the coast. See further detail as outlined for Operational Impact 8.	The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier impact.
Impact 11: Changes to prey availability (temporary habitat loss / disturbance; permanent habitat loss; increased suspended sediments (SSC) and sediment re-deposition; re-mobilisation of contaminants from sea bed sediment; underwater noise;	Impacts to prey species and habitat as described in **Chapter 10: Benthic and Intertidal Ecology** and **Chapter 11: Fish and Shellfish Ecology**.	
	Total seabed disturbance within Windfarm Site, worst-case scenario total temporary disturbance of eight turbines footprint: • The area of active benthic footprint for anchoring systems for catenary turbines is 2,984m^2 per turbine, total area 23,872m^2 • Total drag embedment anchor footprint is 6,400m^2 • Max Inter-array cable (IAC) footprint on seabed: 480,000m^2 (assumes 8 turbines). For the OSP max footprint (4 piles) = 1256.64m^2 for the export cables:	The worst-case scenario for maximum area of temporary habitat loss / disturbance of seabed from offshore cable installation, seabed preparation, jack-up vessels, drag embedment anchors, and Horizontal Directional Drilling (HDD) exit points.

Potential Effect	Parameters	Rationale
EMF; and entanglement)	• Cable burial would disturb the subtidal = 4,680,000m^2 • Total maximum volume of sediment disturbed = 1,684,800m^3.	
	Export cable burial for two cables would displace a volume of 1,684,800m^3 assuming 3m wide, 3m deep excavation for each cable. Inter-array cable burial would displace a volume of 216,000m^3 also assuming 3m wide, 3m deep excavation (based on max length of IAC = 29,760km). 1256.64m^2 footprint for the OSP.	The worst-case for increased SSCs and sediment re-deposition from seabed preparation and cable trenching.
	Remobilisation of contaminated sediments: As described for increased SSCs and sediment re-deposition.	
	Underwater noise parameters as outlined for construction noise-related effects above and **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.	As above for underwater noise.
Impact 12: Indirect effects due to changes in water quality	Impacts to water quality as described in **Chapter 9: Marine Water and Sediment Quality**. See worst-case for temporary increases in SSC and re-mobilisation of contaminated sediments as described for Impact 1 and 2 within **Chapter 9: Marine Water and Sediment Quality**.	
Operation and maintenance		
Impact 1: Underwater noise from operational wind turbines	Turbine parameters (e.g. size and number) as outlined above and underwater noise parameters described in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**. Operational life: 25 years Turbine spacing:	Underwater noise modelling for operational turbines.

Potential Effect	Parameters	Rationale
	• Minimum in row spacing of between 1,100m and 1,310m (depending on MW of WTG) Minimum inter row spacing of between 2,200m and 2,620m (depending on MW of WTG).	
Impact 2: Underwater noise from other activities such as cable repairs and rock placement	Estimated timeframe for any cable repair, replacement or reburial work: • One cable repair or replacement every 20 years • One cable reburial every ten years.	
Impact 3 and 5: Interactions and collision risk with vessels, and underwater noise and disturbance from vessels	Vessel movements: • Maximum number of vessels on site at any one time: 5 • Operation and maintenance vessel trips to port per year: approximately 40 • Maximum impact range from operation and maintenance phase underwater noise assessment (as above).	The maximum spatial area of potential effect, and duration of impacts, are considered to cause the worst-case noise effects.
Impact 4: Barrier effects from underwater noise from operational wind turbines	Maximum impact range from underwater noise assessments (worst-case parameters described above). • Operational WTGs (TTS) – 0.01km for each WTG (**Table 12.84**)	The maximum spatial area of potential effect, and duration of effects, are considered to cause the worst-case barrier effect.
Impact 6: Disturbance at seal haul out sites	See construction effects for distance to seal haul out sites.	
Impact 7: Entanglement	See above in Construction, Impact 8.	
Impact 8: Barrier effects due to the physical presence of the windfarm	See turbine spacing under operation and maintenance Impact 1 above. Footprint for total WTGs: 19,392m^2 for up to eight WTGs;	

Potential Effect	Parameters	Rationale
	• Anchor length (10m) x anchor width (10m) x maximum number of anchors per WTG (six) = 600m^2 per WTG • Mooring line radius (600m) x chain width (0.5m) x maximum number of anchors (six) = 1,800m^2 per WTG. Footprint for OSP: 1,256.64m^2	
Impact 9: Electromagnetic fields direct and indirect effects	See above in Construction, Impact 9.	
Impact 10: Changes to prey availability (temporary habitat loss / disturbance; permanent habitat loss; increased SSCs and sediment re-deposition; re-mobilisation of contaminants from sea bed sediment; underwater noise; and Electromagnetic Fields; entanglement)	Impacts to prey species and habitat as described in **Chapter 10: Benthic and Intertidal Ecology** and **Chapter 11: Fish and Shellfish Ecology**.	
	If 8 turbines with catenary mooring systems are used the maximum area of physical disturbance and temporary habitat loss of seabed habitat has been quantified based on the following: • The area of active benthic footprint for anchoring systems for catenary turbines is 2,984m^2 per turbine, total area 23,872m^2 • Total drag embedment anchor footprint is 6,400m^2 • Max IAC footprint on seabed: 480,000m^2 (assumes 8 turbines). For the OSP max footprint (4 piles) = 1256.64m^2 For the export cables: • Total length of cable = 93,600m per cable Maximum width of disturbance = 25m (jetting/ploughing) • Cable burial (single cable) would disturb the subtidal = 4,680,000m^2 (plan area for two cables)	In most places, burial of the inter array cables will be less than the 3m maximum and 0.5m minimum depth. Installation of all the moorings/anchors will take up to 53 days. Assuming the maximum length of array cable is installed, the duration of installation is predicted to be up to 70 days Based on four suction caissons at 20m diameter each.

Potential Effect	Parameters	Rationale
	• Total maximum volume of sediment disturbed = 1,684,800m^3.	
	Temporary increases in SSC and any deterioration in water quality through the resuspension of contaminated sediment due to maintenance activities could result from periodic jack-up vessel deployment, and cable repair, replacement and reburial activities – same as temporary habitat loss / disturbance.	The worst-case scenario based on maximum area of temporary habitat loss / disturbance of sea bed (as above).
	Underwater noise parameters as outlined for operation noise-related effects above and **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.	As above for underwater noise.
Impact 11: Changes to water quality	Impacts to water quality (as described in **Chapter 9: Marine Water and Sediment Quality**). Temporary increases in SSC and any deterioration in water quality through the resuspension of contaminated sediment due to maintenance activities could result from periodic jack-up vessel deployment, and cable repair, replacement and reburial activities – same as temporary habitat loss / disturbance for prey above.	
Decommissioning		
Impact 1: Underwater noise from removing foundations and cables **Impact 2: Underwater noise and disturbance from vessels** **Impact 3: Barrier effects caused by underwater noise**	No final decision has yet been made regarding the final decommissioning policy for the offshore project infrastructure. It is also recognised that legislation and industry best practice change over time. However, the following infrastructure is likely be removed, reused or recycled where practicable: • OSP including topsides and steel jacket foundations • Offshore cables and cable protection may be removed or left in situ depending on available information at the time of decommissioning.	Assumed to be no worse than during construction. Decommissioning arrangements will be detailed in a Decommissioning Programme, which will be drawn up and agreed with BEIS prior to construction.

Potential Effect	Parameters	Rationale
Impact 4: Interaction and collision risk with vessels	The following infrastructure is likely to be decommissioned in situ depending on available information at the time of decommissioning: • OSP scour protection • Offshore cables may be removed or left in situ • Crossings and cable protection. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. For the purposes of the worst-case scenario, it is anticipated that the effects will be no greater than those identified for the construction phase, as no piling will be required.	
Impact 5: Disturbance at seal haul out sites		
Impact 6: Entanglement		
Impact 7: Electromagnetic fields direct and indirect effects		
Impact 8: changes to prey availability (temporary habitat loss / disturbance; increased SSCs and sediment re-deposition; re-mobilisation of contaminants from seabed sediment; underwater noise)		
Impact 9: Changes to water quality		
Cumulative		
Impact 1: Disturbance from underwater noise	Duration of offshore construction of up to 16 months, which could take place at any time from 2025 to 2027, and relative areas of MUs to determine long list of projects and activities.	

Potential Effect	Parameters	Rationale
	Disturbance effect ranges based on worst case, including underwater noise modelling for the Offshore Project for similar activities (as outlined above). Precautionary approach to determine projects and all potential noise sources which could have cumulative effects. Precautionary approach to determine density estimates and reference populations for all marine mammal species.	
Impact 2: Collision risk with vessels	Potential increased collision risk to marine mammals from projects and activities identified in the CEA, compared to current number of vessel movements.	
Impact 3: Entanglement	As outlined above for entanglement during operation and maintenance, based on current information.	
Impact 4: Physical barrier effects	As outlined above for potential barrier effects from underwater noise during construction or physical presence during operation and maintenance, based on current information.	

12.4.4 Summary of Mitigation

12.4.4.1 Mitigation Embedded in the Design

97. This section outlines the embedded mitigation relevant to the marine mammal and marine turtle assessment, which has been incorporated into the design of the Offshore Project (**Table 12.15**). Where other mitigation measures are proposed, as outlined in **Section 12.4.4.2**, these are also detailed in the relevant impact assessments (**Sections 12.7, 12.7.3** and **12.8**).

98. Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels.

99. For the purposes of the EIA, two types of mitigation are defined:

- Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIS
- Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by the Applicant as the EIA process progresses.

Table 12.15 Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Design of the Offshore Project
Entanglement monitoring	
Monitoring of entanglement for asset integrity	Monitoring of all dynamic cables, mooring lines and WTGs will be undertaken throughout the operation and maintenance phase of the Offshore Project to ensure there is no risk to the infrastructure of caught debris in the mooring lines and cables. This will likely be done by use of a Remotely Operated Vehicle (ROV). In the case of any fishing gear / debris caught in the Offshore Projects infrastructure, it will be removed. See **Section 12.8.7.4** for further detail.
UXO Clearance	
Hierarchy of UXO clearance methods	The hierarchy of UXO clearance techniques, in order of preference, are; • Avoid (through micro-siting) • Move UXO without clearing it (if safe to do so)

Parameter	Mitigation Measures Embedded into the Design of the Offshore Project
	• Remove the UXO without clearing it (if safe to do so) • Low-order deflagration if above options not suitable / unsafe • High-order clearance, if low-order deflagration not possible, or in the unlikely event that low-order deflagration was unsuccessful.
Electromagnetic fields	
Reduce potential effect of EMF	Cables will be buried to a target depth of 0.5-3.0m. This is a similar range to the DECC Guidelines (2011) which advise a 0.6m-1.5m depth to reduce the potential for effects relating to EMF. Cables will be specified to reduce EMF emissions as per industry standards and best practice such as the relevant International Electrotechnical Commission (IEC) specifications.

12.4.4.2 Other Mitigation Measures

100. In addition to the embedded mitigation measures as outlined above, the Applicant has also committed to the mitigation measures outlined in **Table 12.16**. With regard to piling activities, it is worth noting that while impact piling may be required to install both the OSP and anchors, it would be for smaller foundations, and for a significantly smaller number of piles, than for fixed foundation offshore wind farms. It is also worth noting that there is potential that impact piling will not be required.

Table 12.16 Additional Mitigation Measures

Parameter	Additional Mitigation Measures
Underwater Noise	
Soft-start and ramp-up	Each piling event would commence with a soft-start at a lower hammer energy followed, by a gradual ramp-up for at least 20 minutes to the maximum hammer energy required (the maximum hammer energy is only likely to be required at a few of the piling installation locations). The soft-start and ramp-up allows mobile species to move away from the area before the maximum hammer energy with the greatest noise impact area is reached. The soft-start and ramp-up procedure, along with other mitigation measures for piling, will be detailed in the MMMP for Piling.
UXO	A draft MMMP (**Appendix 12.C: Draft MMMP**) will be drawn up for UXO clearance, which will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals and marine turtles as a result

Parameter	Additional Mitigation Measures
	of UXO clearance. Low noise alternatives to high order detonations will be prioritised when developing protocols to clear UXOs.
Water Quality	
Pollution prevention	As outlined in **Chapter 9: Marine Sediment and Water Quality**, the Applicant is committed to the use of best practice techniques and due diligence regarding the potential for pollution throughout all construction, operation and maintenance, and decommissioning activities.
MMMP for Piling Activities	
MMMP for Piling Activities	The MMMP for piling will be developed in the pre-construction period and based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will be developed in consultation with the relevant SNCBs and the MMO, detailing the proposed mitigation measures to reduce the risk of any physical or PTS to marine mammals and marine turtles during all piling operations. This will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the mitigation zone and any additional mitigation measures required in order to minimise potential effects of any physical or PTS, for example, the activation of ADD (e.g. for 10 minutes) prior to the soft-start. Bubble curtains (and other noise at source reducing technologies) will be considered, however, it is unlikely they will be feasible for the Offshore Project given the specific environmental parameters of the site (notably the water depth).
MMMP for UXO Clearance	
MMMP for UXO	A detailed MMMP will be prepared for UXO clearance during the pre-construction phase. The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals and marine turtles as a result of UXO clearance. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with the MMO and relevant SNCBs. The MMMP for UXO clearance will include details of all the required mitigation measures to minimise the potential risk of PTS as a result of underwater noise during UXO clearance, for example, this

Parameter	Additional Mitigation Measures
	would consider the options, suitability and effectiveness of mitigation measures such as, but not limited to: • Low-order clearance techniques, such as deflagration • All UXO clearance to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less) • Establishment of a monitoring area with minimum of 1km radius. The observation of the monitoring area will be by dedicated and trained marine mammal observers (MMObs) during daylight hours and suitable visibility • The activation of ADD • The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO • Other UXO clearance techniques, such as avoidance of UXO; or relocation of UXO. If more than one high-order detonation is required, other measures such as the use of scare charges; or multiple detonations, if UXO are located in close proximity, will also be considered in consultation with the MMO and SNCBs. UXO clearance is not included in the ES application, as currently not enough detailed information is available. Therefore, UXO clearance will be assessed through a separate Marine Licence (ML) application post consent, as agreed with the MMO and Natural England during the marine mammal ETG 2 (**Table 12.17**).
Vessel collision risk and disturbance at seal haul out sites	
Best practice to reduce vessel collision risk and disturbance at seal haul out sites	Vessel movements, where possible, will follow set vessel routes and hence areas where marine mammals and marine turtles are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will follow best practice guidance to reduce any risk of collisions with marine mammals and marine turtles, such as following the Cornwall Marine and Coastal Code for Vessels[5]. All vessels will transit to and from the Windfarm Site at less than 10 knots to further reduce the potential for collision risk.

[5] https://www.cornwallwildlifetrust.org.uk/sites/default/files/2019-03/Cornwall%20Marine%20and%20Coastal%20Code%20Guidelines.pdf

Parameter	Additional Mitigation Measures
	No vessel will transit within 1km of any known seal haul out site at any time.
Site Integrity Plan (SIP)	
Site Integrity Plan (SIP) for the Bristol Channel Approaches SAC (Appendix 12.D: In Principle SIP for the BCA SAC)	In addition to the MMMPs for piling and UXO clearance, a SIP for the Bristol Channel Approaches SAC (solely designated for harbour porpoise) will be developed. The SIP will set out the approach to deliver any Project mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the Bristol Channel Approaches SAC conservation objectives. The SIP is an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the Bristol Channel Approaches SAC. The SIP will be developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and the MMO.

12.5 Consultation

101. Consultation has been a key part of the development of the Offshore Project. Consultation regarding marine mammals and marine turtles has been conducted throughout the EIA. An overview of the Offshore Project consultation process is presented within **Chapter 7: Consultation**.

102. A summary of the key issues raised during consultation specific to marine mammals and marine turtles is outlined below in **Table 12.17**, together with how these issues have been considered in the production of this ES.

Table 12.17 Consultation Responses

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
Natural England	14/01/2022, Discretionary Advice Service (DAS) response	Natural England is supportive of the approach to scope the risk of entanglement to marine mammals in to further assessment. We are in agreement with the statement that the entanglement risk of marine megafauna with floating wind systems is relatively unknown and for that reason, monitoring should be undertaken to test any assumptions made in the EIA, to help fill a current knowledge gap and to inform future FLOW projects. We look forward to working with the Applicant to develop this monitoring and would be supportive of an adaptive approach.	The risk of entanglement is assessed in **Section 12.8.6**.
Natural England	14/01/2022, DAS response	A more recent literature review should be undertaken to inform the assessment as there has been a large increase in the amount of FLOW installed since the 2013 paper that is cited here, was published.	A review of the current information on the risk of entanglement is assessed in **Section 12.8.6**.
Cefas (Underwater Noise (UWN))	14/03/2022, Scoping Opinion	Question 1 To the best of your knowledge is the description of the environment and potential impacts accurate? In terms of the project infrastructure (outlined in Table 1.4, EIA Scoping Report), underwater noise will be produced during construction, operation and decommissioning of the proposed floating offshore windfarm. Construction activities such as dredging, anchoring, and mooring will produce varying levels of underwater noise depending on the equipment used and/or technique applied. While during operation, underwater noise is expected to be produced by the wind turbine generators, associated machinery and by service and maintenance vessels. The applicant emphasised that noise produced during construction and operation will be scoped into the future EIA.	See **Table 12.13** for the scoped in effects.
Cefas (UWN)	14/03/2022, Scoping Opinion	The scoping report provides high level information which will be expanded upon during a programme of consultation with technical stakeholders through the EIA process, as such some	Techniques have been confirmed in **Chapter 5: Project**

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		technical detail about construction is missing. A greater understanding of the methodology intended is needed to review the effects of underwater noise. In paragraphs 82-84 of the EIA Scoping Report, all three designs for floating windfarm structures (tension leg platform, semi-submersible and spar buoy) are outlined. Given the advantages and disadvantages of each type, it was suggested that the White Cross windfarm is likely to use the semi-submersible type but, no indication was given to the type of anchoring that will be adopted (Table 1.9 EIA Scoping Report). Piling will have a much greater noise level than gravity based or drag embedment anchors (Sclavounos, 2008)[6] therefore understanding the methodology will help review potential effects of noise.	**Description**, and further effects discussed in **Section 12.7.1** and **12.7.2.6** for noise from piling and other construction activities.
Cefas (UWN)	14/03/2022, Scoping Opinion	Following on from the previous comment, the timing and duration of works (such as piling and vessel operations) will also influence noise exposure levels. Within the EIA this information should be provided, using a worst-case scenario if details are not finalised.	Worst-case scenarios provided in **Section 12.4.3**.
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 2 Has the appropriate evidence base been used? If not, please explain why and what you would expect to see and any additional work. To the best of my knowledge, appropriate evidence has been used throughout the scoping report. For example, the applicant has included an extensive list of datasets to provide baseline data on resident and migratory fishes (Table 2.11) and marine mammals (Table 2.15) in the study area. Furthermore, appropriate published thresholds and criteria will be applied to determine potential effects of noise (National Marine Fisheries	A full baseline review is provided in **Section 12.5**. Underwater noise modelling has been undertaken for the National Marine Fisheries Service (NMFS) (2018) guidance, and the

[6] Sclavounos, P.D., 2008. Floating Offshore Wind Turbines. Mar. Technol. Soc. J. 42, 39–43. https://doi.org/10.4031/002533208786829151

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		Service, 2018; Popper et al., 2014)[7]. The evidence used is also consistent with that submitted for operations of a similar nature.	Southall *et al.* (2019) paper.
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 3 Do you agree with the conclusions reached? I agree with the applicant's conclusion to scope in the potential impact of underwater noise during construction for fishes and marine mammals, and operation for marine mammals. However, as per comment 12, I do not agree that operational noise can be scoped out for fishes.	An assessment of the effect of underwater noise has been undertaken for both construction (**Section 12.7**) and during operation (**Section 12.7.3**).
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 4 Please tell us about further data sources that could be reviewed as part of the site characterisation for each topic? Site selection is at an early stage and will continue throughout the project development phase however, environmental, technical, and commercial constraints have been considered for site location (Section 1.6.2 Site Selection). As such, I do not have any further data sources that could be reviewed beyond the already included datasets.	A full baseline review is provided in **Section 12.5**.
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 5 Tell us about any other relevant potential impacts for each topic? The applicant has included the relevant potential impacts for fishes and marine mammals.	An assessment of the potential effects has been undertaken for construction (**Section 12.7**), operation (**Section 12.7.3**), and

[7] National Marine Fisheries Service, 2018. 2018 Revision to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 2.0) - Underwater Thresholds for Onset of Permanent and Temporary Threshold Shifts; Popper, A.N., Hawkins, A.D., Fay, R.R., Mann, D.A., Bartol, S., Carlson, T.J., Coombs, S., Ellison, W.T., Gentry, R.L., Halvorsen, M.B., Lokkeborg, S., Rogers, P.H., Southall, B.L., Zeddies, D.G., Tavolga, W.N., 2014. Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014. Springer.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
			decommissioning (**Section 12.9**).
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 7 Have the relevant potential cumulative impacts and transboundary impacts been identified? If not, please provide details. For both fishes and marine mammals, cumulative and transboundary assessments are planned for the EIA. The applicant has highlighted several offshore wind farms and aggregate projects in consenting or early construction stages within the Celtic Sea and Bristol Channel (paragraph 150 EIA Scoping Report). Importantly, the applicant acknowledges that only projects which are reasonably well described will be included in the cumulative impact assessment.	Further information in **Sections 12.8** and **12.11**.
Cefas (UWN)	14/03/2022, Scoping Opinion	At this stage I am unable to comment fully on this aspect as I do not have full awareness of other projects (including the timings of works) that may overlap with the construction, operation and decommissioning at White Cross. Furthermore, cumulative and transboundary effects are very difficult to assess, and EIA based cumulative effect assessments (CEAs) led by developers of individual projects have clear shortcomings (when compared to CEAs prepared on a regional or strategic level (Willsteed *et al*., 2017)[8].	Further information in **Sections 12.8** and **12.11**.
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 9 Do you agree that the proposed approach to assessing each impact is appropriate? If not, please provide details.	Noted

[8] Willsteed, E., Gill, A.B., Birchenough, S.N.R., Jude, S., 2017. Assessing the cumulative environmental effects of marine renewable energy developments. Establishing common ground. Sci. Total Environ. 577, 19–32.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		Yes, I agree that the proposed approach to assessing the effect of underwater noise on fishes and marine mammals is appropriate and has considered a range of evidence.	
Cefas (UWN)	14/03/2022, Scoping Opinion	Question 10 Is there any further guidance relating to each topic that we should be aware of? If so, please provide details. No further comments to note at this stage.	Noted
Cefas (UWN)	14/03/2022, Scoping Opinion	Summary Underwater noise will be produced during construction, operation, and decommissioning activities at White Cross floating offshore wind farm. This scoping report has identified potential significant effects of underwater noise on sensitive receptors including fishes and marine mammals. A variety of fishes have been identified as having potential spawning and/or nursery grounds within the vicinity of the proposed site location and have a variety of different hearing sensitivities, therefore it is expected they will have differing responses to underwater noise. From desk-based research and aerial surveys over 12 months have identified several marine mammal species present within or in the vicinity of the proposed site location. Using published criteria and thresholds together with underwater noise propagation modelling, the effect of noise on fishes and marine mammals will be quantified. Overall, I agree with the conclusions of the scoping report and propose operational noise also be scoped in for fishes.	Noted
North Devon Council	05/04/2022, Scoping Opinion	HRA Screening Report The HRA screening report appears comprehensive and provides an appropriate screening of all potential receptor sites and species.	Noted

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	Wildlife Licensing The Environmental Impact Assessment has noted records of the following species in the work area: grey seals (*Halichoerus grypus*) and other unidentified seal species; minke whales (*Balaenoptera acutorostrata*); common dolphins (*Delphinus delphis*) and other unidentified dolphin species and harbour porpoises (*Phocoena phocoena*) and other unidentified dolphin/porpoise species. The assessment also notes the potential presence of leatherback turtles (*Dermochelys coriacea*).	**Section 12.4.1** outlines the marine mammal and marine turtle species to be assessed further.
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	Seals are protected from injury, but not disturbance, under the Conservation of Seals Act 1970, except within a Site of Special Scientific Interest (SSSI) where they are listed as a special feature. From 0-12 nautical miles seals are protected from prohibited methods of killing or capturing under regulation 45 of the Conservation of Habitats and Species Regulations 2017 (CHSR). From 12-200 nautical miles seals are protected from prohibited methods of killing or capturing under regulation 47 of the Conservation of Offshore Marine Habitats and Species Regulations 2017 (COHSR). Please see the MMO's webpage guidance with details of offences for seals here[9].	Policy and protections of seals are detailed in **Section 12.2**.
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	Cetaceans are protected from injury, disturbance and damage or obstruction to places of breeding or resting under the CHSR and the Wildlife and Countryside Act 1981 (as amended) (WCA) from 0-12 nautical miles, and from injury, disturbance and damage or obstruction to places of breeding or resting from 12-200 nautical miles under regulations 45 and 47 of COHSR.	Policy and protections of cetacean species are detailed in **Section 12.2**.

[9] https://www.gov.uk/government/publications/protected-marine-species/seals

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		Please see the MMO's webpage guidance with details of offences for cetaceans here[10].	
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	Turtles are protected from injury, disturbance and damage or obstruction to places of breeding or resting under regulations 43 and 45 of CHSR, sections 9(4)(b), (c) and 9(5) of WCA from 0 to 12 nautical miles and under regulations 45 and 47 of COHSR from 12 to 200 nautical miles. Please see the MMO's webpage guidance with details of offences for turtles here[11].	Policy and protections of marine turtles are detailed in **Section 12.2**.
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	The assessment notes that there is potential for increased injury and mortality risk from vessel collisions to marine mammals during the construction, operation and decommissioning phases of the project due to increased vessel activity. There is also a perceived potential for injury or mortality due to entanglement in the mooring systems of the floating turbines during operation.	Assessments for the potential for vessel collision risk are provided in **Sections 12.7.5.4**, **12.8.6**, and **12.8.2.4**.
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	Risk of disturbance due to underwater noise is also considered to be a possibility, with construction, unexploded ordnance (UXO) clearance, foundation installation, vessel noise, operational noise and movement of floating turbine moorings on the seabed as significant factors. Maintenance activities, such as cable re-burial and rock placement and operation and maintenance vessel activity are also factors, as is the increased levels of underwater noise that might occur during decommissioning.	Assessments for disturbance from underwater noise are provided in **Sections 12.7.1**, **12.7.1.5**, **12.7.2.6**, **12.8.1**, **12.8.1**, and **12.8.10.4**.
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	Physical and auditory barrier effects as a form of disturbance are also considered, with the potential for barring marine mammals from migration to feeding and breeding areas. Similarly, there is thought to be a risk of changes in water	Assessments for barrier effects, any indirect effects due to changes in prey and water

[10] https://www.gov.uk/government/publications/protected-marine-species/cetaceans-dolphins-porpoises-and-whales
[11] https://www.gov.uk/government/publications/protected-marine-species/marine-turtles

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		quality and cumulative changes to prey habitats causing disturbance. It was also noted that there is potential for disturbance due to increased vessel and human activity near seal haul out sites, particularly during sensitive periods, such as breeding or moult seasons. The applicant should identify if any SSSI including seals as a listed feature may be impacted from disturbance. If this is the case, the applicant should contact Natural England, who are responsible for SSSI assent.	quality, and cumulative effects are provided in **Sections 12.7.3.5**, **12.7.6.4**, and **12.7.12**, **12.7.6.4**, **12.8.6**, **12.8.10.4**, and **12.8.6**. Assessments for the potential for disturbance to seals within SSSIs is provided in **Section 12.7.7**.
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	While the assessment notes that site specific mitigation measures will be undertaken to assess impacts – including underwater noise modelling and a Marine Mammal Mitigation Protocol to reduce risk of physical injury and mortality - based on the information provided, and the significant level of marine development being undertaken, MCT are minded to consider that a wildlife licence is likely required for this application for disturbance and injury offences relating to the identified protected species. It is the applicant's responsibility to identify which activities and species are likely to require a wildlife licence to avoid an offence.	**Section 12.15** provides a summary of the potential for the Offshore Project to require an EPS Licence (Marine Wildlife Licence).
MMO Marine Conservation Team	17/03/2022, Scoping Opinion	We would advise that any statutory nature conservation body (SNCB) and specialist advice is taken into account when considering this application and note that the applicant is reminded that they are responsible for satisfying themselves that their activities will not result in an offence. If the applicant deems their activities may cause an offence, it is their responsibility to consider the need for a wildlife licence. If any concerns regarding protected species are brought to the	See above.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		attention of the Marine Licensing Team from SNCBs, please re-consult us.	
Natural Resource Wales (NRW)	15/03/2022, Scoping Opinion	At this stage, given that the project is wholly within English waters, NRW Advisory are inclined to defer advice to Natural England (and JNCC if and where applicable). NRW Advisory would, however, be grateful where relevant, if we can continue to be consulted with regards the project due to the potential for cross-border issues arising at a later date – for example in respect to mobile species and cumulative / in-combination impacts. This will become increasingly pertinent with the advent of Floating Offshore Wind Projects within Welsh waters of the Celtic Sea. NRW Advisory have already been in contact with Natural England and JNCC to this effect.	Noted
NRW	15/03/2022, Scoping Opinion	In the meantime, we would note the use of Marine Mammal Management Units (MMMU) in Welsh waters, and I attach NRW's Position Statement on the use of MMMU's for screening and assessment in Habitats Regulations Assessments for SACs with marine mammal features.	See **Section 12.4** and **12.5** discussing MUs. NRWs position statement has been taken into account in the HRA Screening for designated sites.
Natural England	17/03/2022, Scoping Opinion	<u>Cumulative and in-combination effects</u> The ES should fully consider the implications of the whole development proposal. This should include an assessment of all supporting infrastructure. An impact assessment should identify, describe, and evaluate the effects that are likely to result from the project in combination with other projects and activities that are being, have been or will be carried out. The following types of projects should be included in such an assessment (subject to available information): • existing completed projects	See **Section 12.8** for further information on the cumulative and in-combination effects.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		• approved but uncompleted projects • ongoing activities • plans or projects for which an application has been made and which are under consideration by the consenting authorities • plans and projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient information is available to assess the likelihood of cumulative and in-combination effect. There are two additional projects that Natural England is aware of and consider should be included in the scoping report for cumulative and in-combination effects: • The X-links interconnector project with landfall at Cornborough • Mixed use / Residential development at Yelland Quay which is currently at appeal.	
Natural England	17/03/2022, Scoping Opinion	Designated nature conservation sites / International and European sites In accordance with your EIA scoping report, the development site is within or may impact on the following European/internationally designated nature conservation sites: • Braunton Burrows Special Area of Conservation (SAC) • Culm Grassland SAC • Tintagel Marsland Clovelly Coast SAC • Bristol Channel Approaches/Dynesfeydd Mor Hafren SAC • Lundy SAC • Tamar Estuaries Complex SPA • Isles of Scilly SPA.	A full HRA Screening and assessment of adverse effects on the relevant designated sites for marine mammals is provided in the HRA.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
MMO formal response	30/05/2022, Scoping Opinion	Baseline Scenario The ES should include a description of the baseline scenario with and without implementation of the development 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.	Please see **Section 12.5** detailing the baseline for each screened in species, including a review of the 'do nothing' scenario in **Section 12.6.10**.
MMO formal response	30/05/2022, Scoping Opinion	Transboundary Effects Schedule 4, Part 5 of the Regulations requires a description of the likely significant transboundary effects to be provided within an ES. The MMO notes that Applicant has scoped in: • marine mammals, • offshore ornithology, • commercial fisheries, • shipping and navigation • marine archaeology–direct impacts for potential transboundary effects. The MMO advises that the ES should detail the likely significant effects of which EEA States would be affected in respect of each the matters scoped into the ES.	A transboundary assessment is provided in **Section 12.11.**
MMO formal response	30/05/2022, Scoping Opinion	Mitigation and monitoring The ES should identify and describe any mitigation relied upon for the purposes of the assessment, and any proposed monitoring of significant adverse effects and how the results of such monitoring would be utilised to inform any necessary remedial actions. The likely efficacy of the mitigation proposed should also be explained with reference to residual effects.	Mitigation and monitoring for each potential effect is discussed within the potential effects section for construction, operation and

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		Considerations on how proposed monitoring will be secured is also advised.	decommissioning (**Sections 12.7**, **12.7.3** and **12.9**)
MMO formal response	30/05/2022, Scoping Opinion	Cumulative and In-combination At this stage, cumulative assessment methods are not developed sufficiently to understand the full scope of cumulative assessment. The MMO advise further detail is provided as to how cumulative assessment is to be undertaken. A full consideration of the implications of the whole scheme must be included in the ES and all supporting infrastructure must be included within the assessment. The ES should include an assessment of all projects (or aspects within projects) which, in cumulation with the Proposed Development, are likely to give rise to significant effects.	Further details provided in **Section 12.8**.
MMO formal response	30/05/2022, Scoping Opinion	An impact assessment should identify, describe, and evaluate the effects that are likely to result from the project in combination with other projects and activities that are being, have been or will be carried out. The following types of projects should be included in such an assessment (subject to available information): • existing completed projects; • approved but uncompleted projects; • ongoing activities; • plans or projects for which an application has been made and which are under consideration by the consenting authorities; and • plans and projects which are reasonably foreseeable, i.e. projects for which an application has not yet been submitted, but which are likely to progress before completion of the development and for which sufficient	Further details provided in **Section 12.8.**

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		information is available to assess the likelihood of cumulative and in-combination effects.	
MMO formal response	30/05/2022, Scoping Opinion	There are two additional projects to those outlined within the Scoping Report that the MMO is aware of at present and consider should be included for cumulative and in-combination effects: • The X-links interconnector project with landfall at Cornborough • Mixed use / Residential development at Yelland Quay which is currently at appeal.	Further details provided in **Section 12.8**.
MMO formal response – 30/05/2022	30/05/2022, Scoping Opinion	Further consideration should also be given to the potential cumulative impacts resulting from future offshore energy infrastructure projects. The Scoping Report makes no reference to the potential growth of the offshore wind sector in the Celtic Sea or strategic connections for power transmission cables. Opportunities to future-proof landfall sites and onshore cable routes by providing built in additional capacity should be considered in order to avoid multiple projects drilling and trenching through designated landscapes and habitats.	Further details provided in **Section 12.8**.
MMO formal response	30/05/2022, Scoping Opinion	Section 1.9.2 of the Scoping Report sets out the Applicant's proposed approach to assessment of cumulative effects within the ES, and the MMO notes that the scope of the assessment will be established on an aspect-by-aspect basis in consultation with relevant consultation bodies. The ES should also describe the extent of the Study Area(s) that have been used for the assessment of cumulative effects, which should be determined based on a consideration of impact pathways for each aspect.	Further details provided in **Section 12.8**.
MMO formal response	30/05/2022, Scoping Opinion	Conservation of Habitats and Species Regulations 2017	A full HRA Screening and assessment of adverse effects on the relevant designated

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		In accordance with the Scoping Report, the development site is within or may impact on the following European/Internationally designated nature conservation sites: • Braunton Burrows SAC • Culm Grassland SAC • Tintagel Marsland Clovelly Coast SAC • Bristol Channel Approaches/Dynesfeydd Mor Hafren SAC • Lundy SAC • Tamar Estuaries Complex SPA • Isles of Scilly SPA.	sites for marine mammals is provided in the **RIAA** and **Chapter 13: Offshore Ornithology**.
MMO formal response	30/05/2022, Scoping Opinion	Wildlife Licensing The Scoping Report has noted records of the following species in the work area: grey seals (*Halichoerus grypus*) and other unidentified seal species; minke whales (*Balaenoptera acutorostrata*); common dolphins (*Delphinus delphis*) and harbour porpoises (*Phocoena phocoena*) and other unidentified dolphin/porpoise species. The assessment also notes the potential presence of leatherback turtles (*Dermochelys coriacea*).	Scoped in species discussed in **Section 12.4**.
MMO formal response	30/05/2022, Scoping Opinion	While the assessment notes that site specific mitigation measures will be undertaken to assess impacts, including underwater noise modelling and a Marine Mammal Mitigation Protocol to reduce risk of physical injury and mortality, based on the information provided, and the significant level of marine development being undertaken, the MMO consider that a wildlife licence is likely to be required for this application for disturbance and injury offences relating to the identified protected species. It is the Applicant's responsibility to identify which activities and species are likely to require a wildlife licence to avoid an offence.	**Section 12.15** provides a summary of the potential for the Offshore Project to require an EPS Licence (Marine Wildlife Licence).

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
MMO formal response	30/05/2022, Scoping Opinion	The Applicant is responsible for satisfying themselves that their activities will not result in an offence. If the Applicant deems their activities may cause an offence, it is their responsibility to consider the need for a wildlife licence.	See above.
MMO formal response	30/05/2022, Scoping Opinion	Underwater noise during UXO clearance – operation and decommissioning. The MMO agrees that this can be scoped out as UXO operations are not expected to take place during operation and decommissioning.	See **Table 12.13**.
MMO formal response	30/05/2022, Scoping Opinion	Underwater noise during foundation installation – operation, decommissioning The MMO agrees that this can be scoped out as there will not be any foundations installed during the operational or decommissioning phases.	See **Table 12.13**.
MMO formal response	30/05/2022, Scoping Opinion	Underwater noise from operational wind turbines – construction and decommissioning The MMO agrees that this can be scoped out as there will not be any operational wind turbines during the construction and decommissioning phases.	See **Table 12.13**.
MMO formal response	30/05/2022, Scoping Opinion	Entanglement – construction, decommissioning The Applicant states "Depending on the method used, there is the perceived potential for entanglement in the mooring systems for floating offshore wind turbines. To date, there have been no recorded instances of marine mammal entanglement from mooring systems of renewable devices (Sparling et al., 2013; Isaacman and Daborn, 2011), or for anchored FPSO vessels in the oil and gas industry (Bejamins et al., 2014) with similar mooring lines as proposed for floating turbine structures."	An assessment for the potential entanglement during the construction and decommissioning phases has been provided in **Sections 12.8.9.4** and **12.8.8** respectively.

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		The MMO does not agree that entanglement to WTG mooring systems can be scoped out during construction and decommissioning as the risk will be present during the construction period and decommissioning period whilst turbine are being transported to site and in place prior to becoming operational and also whilst they are being decommissioned.	
MMO formal response	30/05/2022, Scoping Opinion	Barrier effects from physical presence of wind farm - construction The MMO disagrees that the barrier effects from the construction of the wind farm can be scoped out. The construction activities will be ongoing over a long period of time and so should be assessed within the ES. The MMO notes that the potential for any acoustic barrier effects as a result of underwater noise during construction is included as part of the underwater noise assessment.	This has been scoped in, see **Section 12.7.3.5**.
MMO formal response	30/05/2022, Scoping Opinion	Seals The MMO notes physical and auditory barrier effects as a form of disturbance are considered, with the potential for barring marine mammals from migration to feeding and breeding areas. Similarly, there is thought to be a risk of changes in water quality and cumulative changes to prey habitats causing disturbance. It was also noted that there is potential for disturbance due to increased vessel and human activity near seal haul out sites, particularly during sensitive periods, such as breeding or moult seasons.	This is discussed within **Sections 12.7**, **12.7.3** and **12.8.10.4**.
MMO formal response	30/05/2022, Scoping Opinion	UWN The scoping report provides high level information which will be expanded upon during a programme of consultation with technical stakeholders through the EIA process, as such some technical detail about construction is missing. A greater	See **Chapter 5: Project Description** for further information. Noise modelling for the construction methods

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
		understanding of the methodology intended is needed to review the effects of underwater noise. In paragraphs 82-84 of the EIA Scoping Report, all three designs for floating windfarm structures (tension leg platform, semi-submersible and spar buoy) are outlined. Given the advantages and disadvantages of each type, it was suggested that the Proposed Development is likely to use the semi-submersible type but, no indication is given to the type of anchoring that will be adopted (Table 1.9 EIA Scoping Report). Piling anchors will have a much greater noise level than gravity based or drag embedment anchors (Sclavounos, 2008) therefore understanding the methodology will help review potential effects of noise.	mentioned in further detail in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report.**
MMO formal response	30/05/2022, Scoping Opinion	The timing and duration of works (such as piling and vessel operations) will also influence noise exposure levels. Within the EIA this information should be provided, using a worst-case scenario if details are not finalised.	The duration of all potential disturbance effect is provided within the relevant assessments in **Section 12.7**.
Natural England	14/11/2022, Marine Mammal ETG response	It is recommended not to scope out any species, such as striped dolphins and harbour seals due to the large number of unidentified species from the APEM surveys.	Striped dolphins are assessed throughout the chapter and the population is discussed in **Section 12.6.4**. Harbour seal stayed scoped out due to the low numbers of unidentified seals recorded during the APEM surveys (n = 15).

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
Devon and Cornwall Wildlife Trusts	14/11/2022, Marine Mammal ETG response	It is recommended to consider the seal linkages between SSSI sites, significant haul out sites in north Cornwall, and juvenile seal movement (Carter *et al.*, (2017) looks at movement in Celtic seas)).	Existing environment for grey seals is discussed in **Section 12.6.6**.
Natural England, Cefas, Devon and Cornwall Wildlife Trusts, and MMO	14/11/2022, Marine Mammal ETG response	It is recommended to consider the entire English Channel for bottlenose dolphin due to their linkages to the Kent area. The Coastal West Channel MU for bottlenose dolphin is currently being revised by IAMMWG to extend the boundary further East towards Kent, and also further north towards Padstow. It is recommended to include this updated boundary in the assessments. JNCC can potentially provide the project team with a figure of this new boundary, depending on when it's finalised.	Boundaries used for bottlenose dolphin are shown in **Section 12.6.2** from IAMMWG (2022).
Natural England	14/11/2022, Marine Mammal ETG response	It is recommended to reconsider the thought of harbour porpoise being excluded from nearby disturbance and Natural England would want to see monitoring in place otherwise. It is also recommended to reconsider using less ADDs, particularly as within EPS licences the project will need to show they are doing as much as possible to avoid injury.	Harbour porpoises are included for nearby disturbance as discussed in **Sections 12.7** to **12.9**. **Appendix 12.C: Draft MMMP** and **Appendix 12.D: In Principle SIP for the BCA SAC** layout the draft MMMP and SIP.
Natural England	14/11/2022, Marine Mammal ETG response	If a management measure is used within the assessment to conclude no effect on some of the SACs, then the management measure would need to be secured.	The **RIAA** discusses effects on SACs and the management measures discussed are present within **Appendix 12.C: Draft MMMP** and **Appendix 12.D: In**

Consultee	Date, Document, Forum	Comment	Where addressed in the ES
			Principle SIP for the BCA SAC, along with the embedded mitigation within this chapter (**Section 12.4.4**)
Natural England	14/11/2022, Marine Mammal ETG response	It is recommended to take note for assessments that if there is any distance between piling locations that might occur within any 24-hour period, this would then cover a larger area to assess. Data from the marine noise registry has been looking at noise activity that has overlapped with the Bristol Channel Approaches SAC in the past between 215 and 2020. It should be published soon and would be beneficial to include in the assessments once published. The need for a SIP would depend on the in-combination assessment in the HRA.	This is discussed in the **RIAA** and the SIP has been produced, see **Appendix 12.D: In Principle SIP for the BCA SAC**.
Natural England	14/11/2022, Marine Mammal ETG response	There is a high amount of bycatch of grey seal in this region so in theory this population is declining as a result. How would this be taken into account in the assessment? As the projects magnitude is based on removal of 1% but in theory this removal of 1% is already occurring.	This is discussed in **Section 12.7.8** and **12.8.7** regarding entanglement and bycatch, alongside **Chapter 14: Commercial Fisheries**.

12.6 Existing Environment

104. This section describes the existing environment in relation to marine mammals and marine turtles associated with the Offshore Project. It has been informed by a review of the sources listed in **Section 12.3.9**. As outlined in **Section 12.4.1**, the key marine mammal and marine turtle species are:

- Harbour porpoise
- Bottlenose dolphin
- Common dolphin
- Striped dolphin
- Minke whale
- Grey seal
- Leatherback turtle.

105. This section provides detailed information for each of the species, including details from the site-specific surveys (**Section 12.3.9.1**), density estimates, abundance estimates, distribution, diet and seal haul out sites, that are relevant for the assessments.

12.6.1 Harbour Porpoise

12.6.1.1 Distributions

106. Harbour porpoise is a globally distributed species and can be found throughout the UK, albeit typically in shallow waters. Due to their global distribution, this species is listed as least concern on the IUCN red list. However, harbour porpoises are listed in Annex II of the EU Habitats Directive, requiring the designation of SACs as a component of their conservation. The closest of these designations is the Bristol Channel Approaches / Dynesfeydd Môr Hafren SAC, which is adjacent to the Windfarm Site and has the ECC running through.

107. In the last 30 years UK harbour porpoise populations have shown a southerly directional trend, with their concentrations gradually moving from the Northern Isles of Scotland to the more southerly areas of the North Sea and English channel (JNCC, 2022). The Bristol channel / Dynesfeydd Môr Hafren SAC is designated as such due to the presence of harbour porpoise which is an Annex II species (JNCC, 2019b).

108. Harbour porpoise within the eastern North Atlantic are generally considered to be part of a continuous biological population that extends from the French coastline of the Bay of Biscay to northern Norway and Iceland (Tolley and Rosel, 2006; Fontaine *et al.,* 2007, 2014; IAMMWG, 2022). However, for conservation and management

purposes, it is necessary to consider this population within smaller MUs. MUs provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (IAMMWG, 2022).

109. IAMMWG defined three MUs for harbour porpoise: North Sea; West Scotland; and the Celtic and Irish Sea (CIS). The Offshore Project area is located in the CIS MU (**Figure 12.2**).

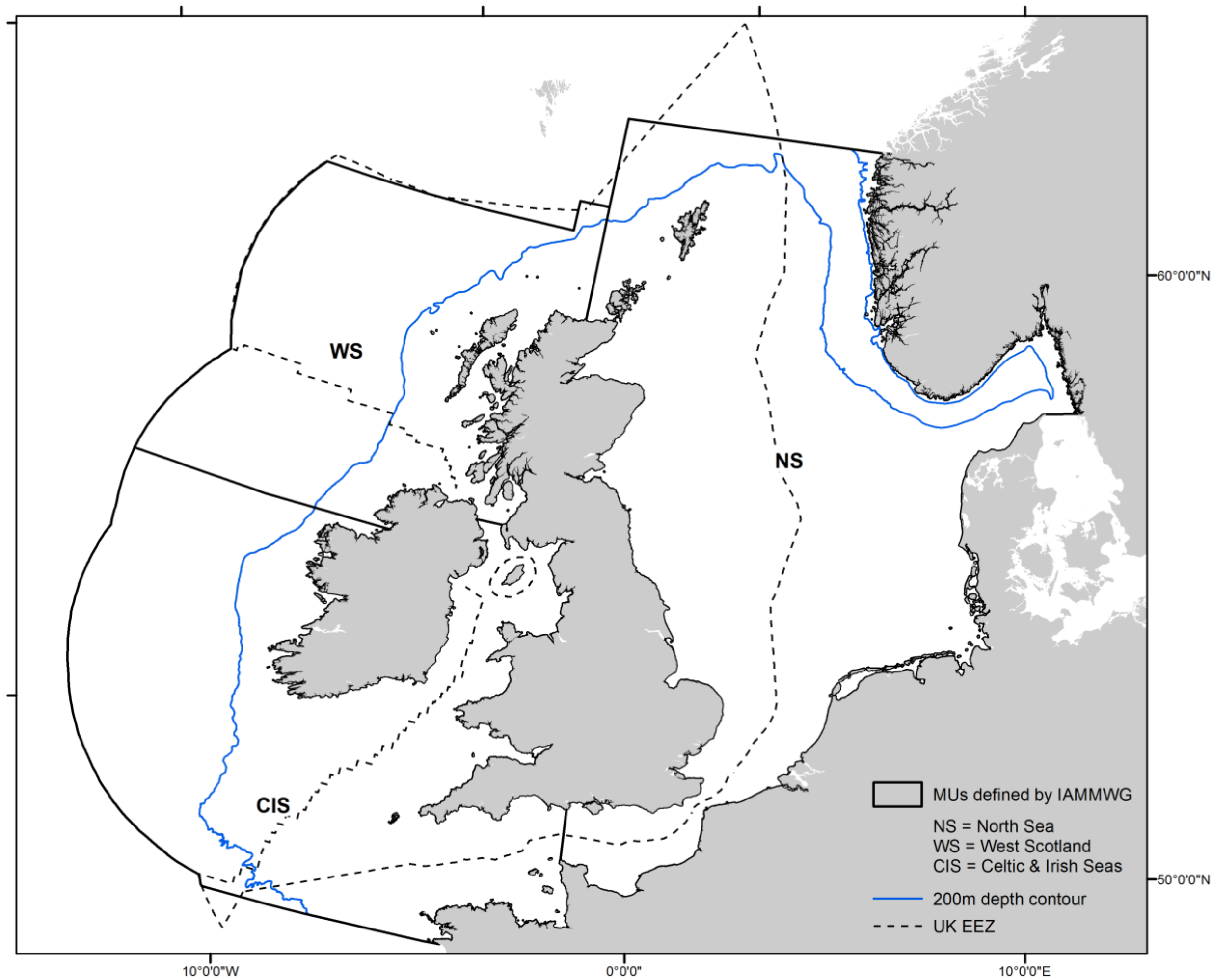

Figure 12.3 Harbour porpoise MUs, noting that this species is largely confined to the continental shelf (i.e., waters <200m depth) (IAMMWG, 2022)

110. Since 2015, there have been three MU abundance estimates for harbour porpoise, two of the estimates are based off data from SCANS II (Hammond *et al.*, 2006) and Cetacean Offshore Distribution and Abundance (CODA) (Hammond *et al.*, 2009), with an updated estimate from SCANS III (Hammond *et al.*, 2021) and ObSERVE (Rogan *et al.*, 2018). The three estimates were presented in IAMMWG (2015a;

2015b; 2022), and the results are shown in **Table 12.18**. The harbour porpoise population has declined between the 2015 and the 2022 population estimate (for further information, see **Section 12.6.10**).

Table 12.18 Harbour Porpoise and Management Unit Abundance Estimates

Management Unit	Abundance Estimate (IAMMWG, 2015a)	Abundance Estimate (IAMMWG, 2015b)	Abundance Estimate (IAMMWG, 2022)
CIS	104,695 (0.32)	98,807 (0.30)	62,517 (0.13)

111. Harbour porpoises have been recorded in Welsh waters since 1990 and are the most widespread and common species in these waters (Baines and Evans, 2012). The species is present throughout the year, yet not evenly distributed within the Irish Sea, with hotspots in close proximity to the Windfarm Site being Cardigan Bay, the west Pembrokeshire islands (including Skomer and Ramsey), Strumble Head, and in the Bristol Channel off the coast of Wales (Baines and Evans, 2012).

112. Baines and Evans (2012), reported on the long-term (1990 – 2009) sighting rates of harbour porpoises from both vessel and aerial surveys. The conclusion of the report showed an expected widespread distribution of the species throughout the Welsh MU, with the highest densities in the coastal waters of south Wales. The study also touched upon there being a seasonal variation occurring in relation to the species being more present in the summer months (July to September) and moving out of the area from January to March.

12.6.1.2 Density Estimates

113. Heinänen and Skov (2015) identified an area of persistently high harbour porpoise density in the summer period off the south and west coast of Wales, north Anglesey, and off the south coast of Devon. Relevant for the Offshore Project, persistently high densities of harbour porpoise in winter were identified off the north coast of Cornwall and Devon, to the west of Lundy; an area which includes the Offshore Project.

114. Persistently high densities of harbour porpoise within the CIS MU are determined by water depth, surface sediments, current speed, and eddy potential. The number of vessels also has a significant effect on the presence of harbour porpoise in the summer period, with a vessel activity level of more than 15,000 vessels per year, or 50 vessels a day coinciding with a significant reduction in harbour porpoise presence.

115. A series of large scale surveys for cetaceans in European Atlantic waters was initiated in summer 1994, in the North Sea and adjacent waters (SCANS, 1995;

Hammond *et al.,* 2002) and continued in summer 2005 in all shelf waters (SCANS-II 2008; Hammond *et al.,* 2013).

116. The SCANS III survey, undertaken in 2016 (Hammond *et al*., 2021) used both aerial and boat-based surveys, covering the North Sea, Irish and Celtic Seas, English Channel, Bay of Biscay, and north-west continental coastal waters and offshore areas. the Offshore Project is located within SCANS-III survey block D (**Figure 12.4**; Hammond *et al*., 2021).

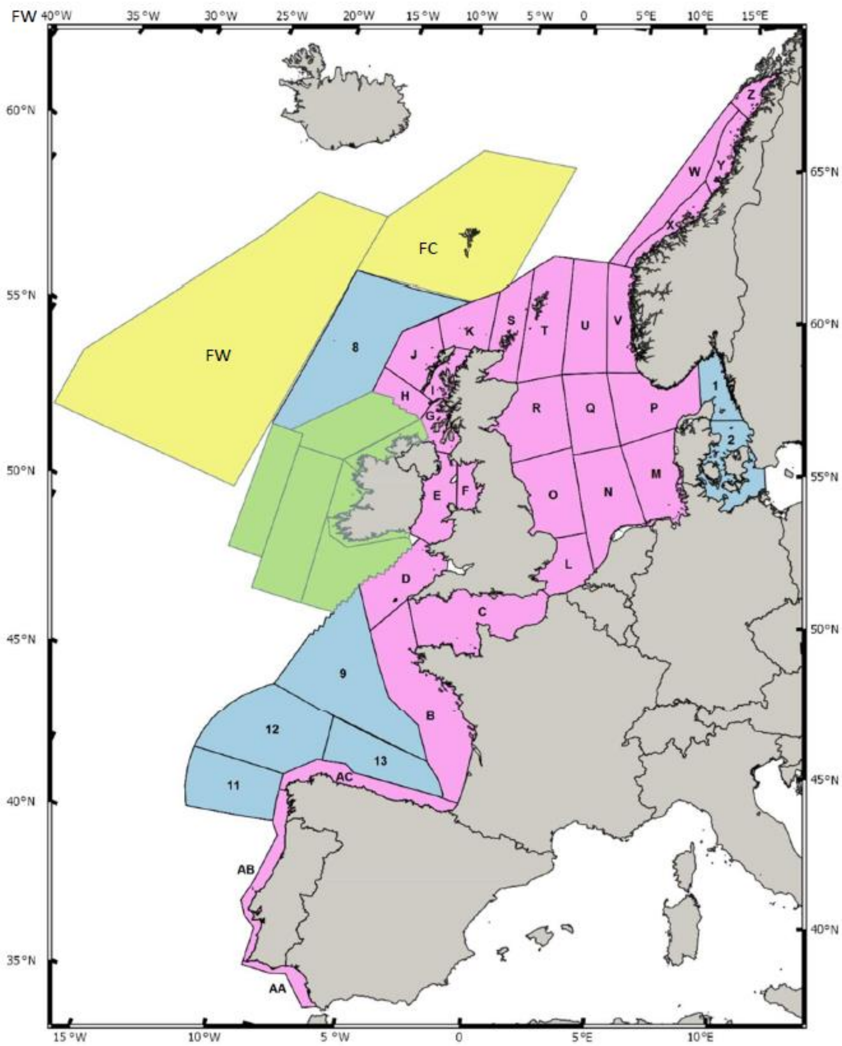

Figure 12.4 SCANS-III Survey Area (Pink Blocks were Surveyed by Air; Blue Blocks were Surveyed by Ship; Green Blocks were Surveyed by the Irish ObSERVE Project; Yellow Survey Blocks were Surveyed by the Faroe Islands as part of the North Atlantic Sightings Survey in 2015 (see Pike et al. 2019)). Taken from Hammond et al. (2021).

117. The SCANS-III survey showed harbour porpoise sightings within the Bristol Channel, as well as in more offshore waters. Results from the survey showed that block D

(which covered the Southern Celtic/Irish Seas) had an estimate abundance of 5,734 individuals (95% CI: 1,697 – 12,452), with density estimates coming out at 0.118 porpoise/km^2 (CV: 0.489) (**Figure 12.5**).

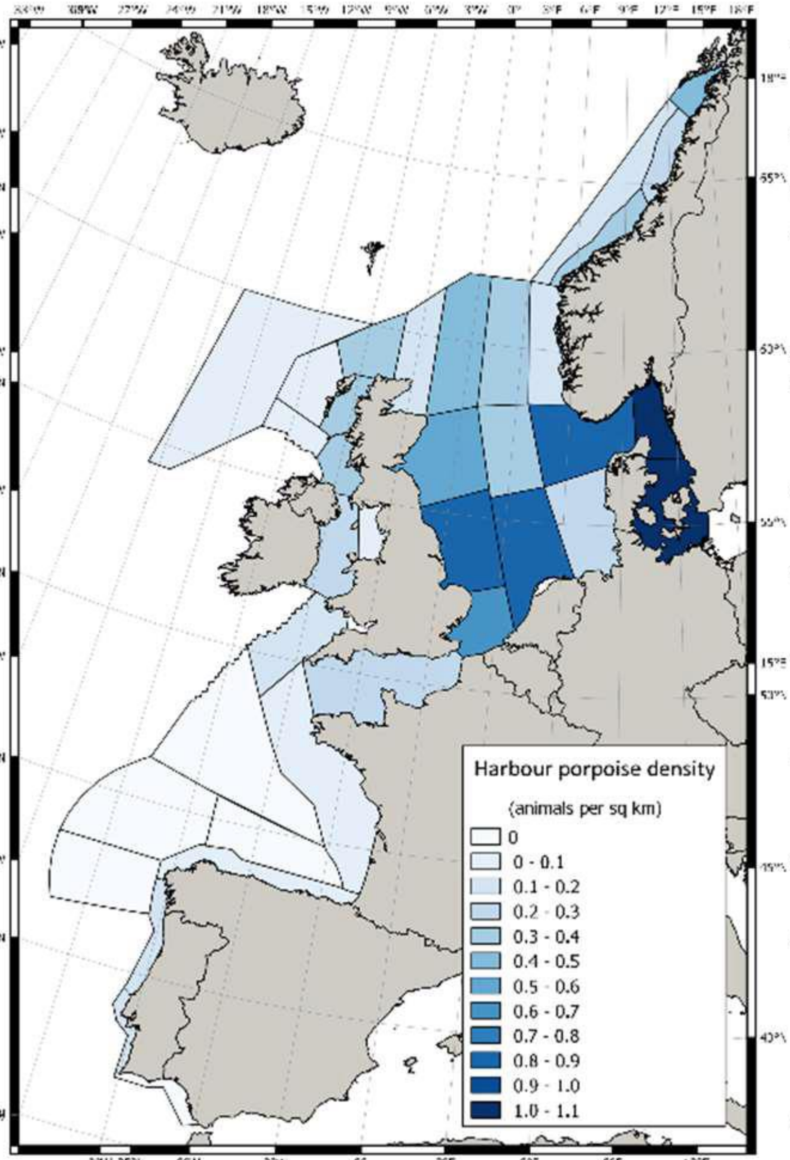

Figure 12.5 Harbour Porpoise Density Estimates from the SCANS III Survey (Hammond et al., 2021)

118. Distribution and abundance maps were developed by Waggitt *et al.* (2019) for cetacean species around Europe. For harbour porpoise, the distribution maps show a moderate harbour porpoise density within the Irish Sea, and off the north coasts of Devon and Cornwall for both January and July (**Figure 12.6**, Waggitt *et al.,* 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of 0.191

individuals per km^2 for the Windfarm Site (with a peak of 0.258 per km^2 in August), and 0.389 per km^2 for the ECC (with a peak of 0.433 per km^2 in March).

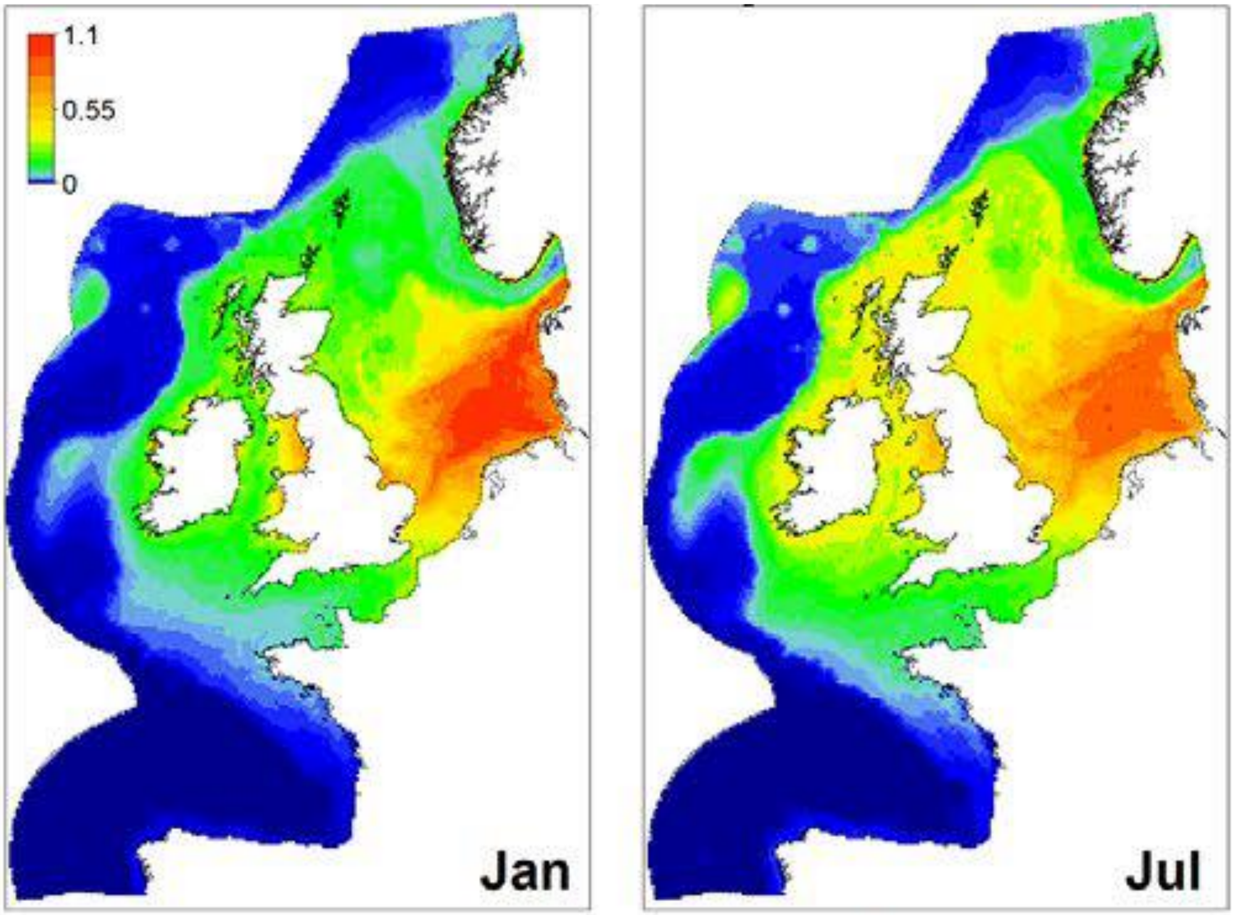

Figure 12.6 Spatial Variation in Predicted Densities (Individuals per km of Harbour Porpoise in January and July in the North-East Atlantic). Values are provided at 10 km Resolution. Source: Waggitt et al., 2019.

12.6.1.3 Site-Specific Survey Data

119. Data from the Offshore Project's site-specific surveys (APEM, 2022) have also been used to generate abundance and density for the sites within a 4km buffer. Harbour porpoises were recorded in July, September and October 2020, May, July and September 2021, and April to June 2022. The peak raw count of nine in May 2021 resulted in an abundance estimate of 65 (CI: 22-116; precision: 0.33) for the Survey Area, and a density estimate of 0.19/km^2 (**Table 12.19**).

Table 12.19 Raw Counts, Abundance and Density Estimates (Individuals per km^2) of Harbour Porpoises in a) Survey Area b) Southwest England Site and c) 4 km Buffer Zone (Peak Estimates in Bold)

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
a) Survey Area						
Jul-20	2	16	2	39	0.71	0.05
Sep-20	4	31	4	86	0.50	0.09
Oct-20	1	8	1	23	1.00	0.02
May-21	9	65	22	116	0.33	0.19
Jul-21	1	8	1	23	1.00	0.02
Sep-21	4	30	4	90	0.50	0.09
Apr-22	1	8	1	23	1.00	0.02
May-22	1	8	1	23	1.00	0.02
Jun-22	1	7	1	22	1.00	0.02
b) Southwest England Site						
Jul-20	1	9	1	26	1.00	0.09
Oct-20	1	8	1	25	1.00	0.08
May-21	5	40	8	890	0.45	0.40
Sep-21	3	25	3	74	0.58	0.25
Apr-22	1	8	1	25	1.00	0.08
c) 4 km Buffer Zone						
Jul-20	1	7	1	22	1.00	0.03
Sep-20	4	30	4	83	0.50	0.13
May-21	4	28	7	56	0.50	0.12
Jul-21	1	8	1	23	1.00	0.02
Sep-21	1	7	1	22	1.00	0.03
May-22	1	7	1	22	1.00	0.03
Jun-22	1	7	1	21	1.00	0.03

120. To produce annual and seasonal density estimates, the maximum density of each month was taken for the harbour porpoise data. The average of the winter months, summer months, and annual density has then been calculated based on the maximum density for each month. **Table 12.20** shows the density estimates for the individuals identified as harbour porpoise only, and **Table 12.21** shows the

density estimates for the data including harbour porpoise, and individuals recorded as either porpoise or dolphin. As a worst-case, it has been assumed that all of the individuals recorded as porpoise or dolphin species are harbour porpoise.

Table 12.20 Maximum Harbour Porpoise Density Estimate Calculated for Each Month, with Summer, Winter and Annual Density Estimate for the Whole Survey Area plus 4km Buffer

Survey Month / Period	Individuals per km^2
January	-
February	-
March	-
April	0.02
May	0.19
June	0.02
July	0.05
August	-
September	0.09
October	0.02
November	-
December	-
Annual average	0.065
Summer average (April to September)	0.074
Winter average (October to March)	0.020

Table 12.21 Maximum Harbour Porpoise (and Dolphin / Porpoise) Density Estimate Calculated for each Month, with Summer, Winter and Annual Density Estimate for the Whole Survey Area plus 4km Buffer

Survey Month / Period	Individuals per km^2
January	0.04
February	0.07
March	0.07
April	1
May	1
June	1
July	2
August	0.23
September	0.28

Survey Month / Period	Individuals per km²
October	0.25
November	-
December	-
Annual average	0.594
Summer average (April to September)	0.918
Winter average (October to March)	0.108

12.6.1.4 Diet

121. The distribution and occurrence of harbour porpoise, as well as other marine mammal species is most likely to be related the availability and distribution of their prey species. For example, sandeels (*Ammodytidae species*), which are known prey for harbour porpoise, exhibit a strong association with key surface sediments (Gilles *et al.,* 2016; Clarke *et al.,* 1998).

122. Harbour porpoise are generalist feeders, and their diet reflects available prey in an area. Therefore, their diet varies geographically, seasonally and annually, reflecting changes in available food resources and differences in diet between sexes or age classes may also exist. The diet of the harbour porpoise consists of a wide variety of fish, including pelagic schooling fish, as well as demersal and benthic species, especially Gadoids, Clupeids and sandeels (Berrow and Rogan 1995; Kastelein *et al.,* 1997; Börjesson *et al.,* 2003; Santos and Pierce 2003; Santos *et al.,* 2004). Harbour porpoise are a very active species with high metabolic cost of living; they are considered an opportunistic feeder and energy balance is maintained by feeding regularly (2.5 - 5kg per day in adults) on a diet largely based on high energy density prey (BEIS, 2022b).

123. Harbour porpoise tend to concentrate their movements in small focal regions (Johnston *et al.,* 2005), which often approximate to particular topographic and oceanographic features and are associated with prey aggregations (Raum-Suryan and Harvey 1998; Johnston *et al.,* 2005; Keiper *et al.,* 2005; Tynan *et al.,* 2005). Consequently, habitat use is highly correlated with prey density rather than any particular habitat type.

124. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet its daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.,* 1997).

12.6.2 Bottlenose Dolphin

12.6.2.1 Distributions

125. Bottlenose dolphins are a worldwide species and are classified as a priority species under the UK Post 2010 Biodiversity Framework. They are listed as a Least Concern species on the IUCN red list but are also listed under Annex II of the EU Habitats Directive and as such, SACs must be assigned to aid in the protection of this species.

126. There are currently two bottlenose dolphin SACs in the Irish Sea, including the Lleyn Peninsula and the Sarnau SAC and the Cardigan Bay SAC. While the Offshore Project is not within the Irish Sea MU, given the ranging patterns of bottlenose dolphins it is important to consider the potential for connectivity between the Windfarm Site and these SACs.

127. IAMMWG defined four offshore MUs for bottlenose dolphin (Greater North Sea; Offshore Waters; OCWS; and the Irish Sea), and a number of coastal MUs, including the Coastal West Channel MU. the Offshore Project area is located in the Offshore Channel and Southwest England (OCSW) MU (**Figure 12.7**).

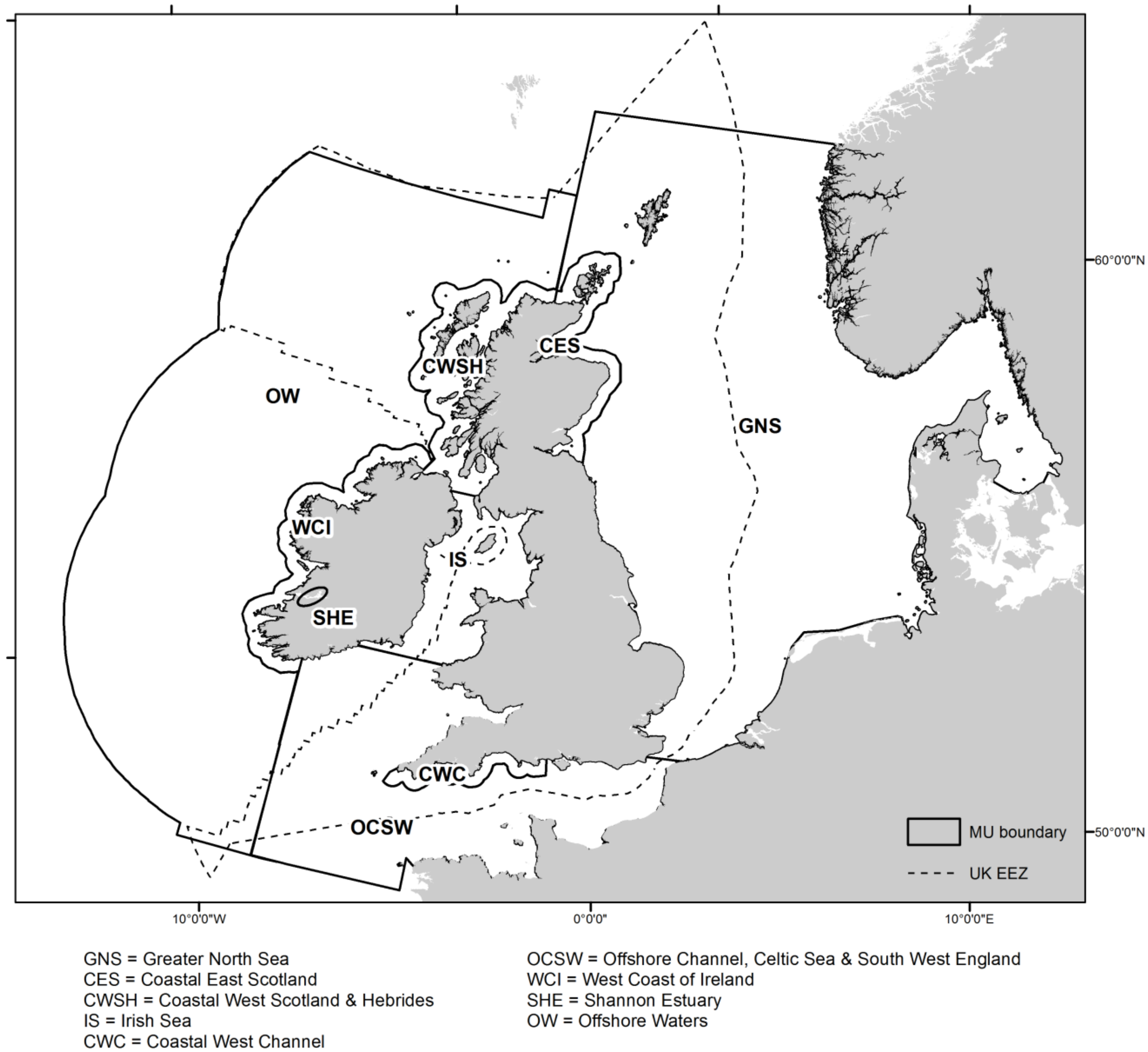

Figure 12.7 Bottlenose Dolphin MUs (IAMMWG, 2022)

128. Since 2015, there have been two OCSW MU abundance estimates for bottlenose dolphin, the 2015 estimate is based off data from SCANS II (Hammond *et al.*, 2013), with an updated estimate from SCANS III (Hammond *et al.*, 2021) and ObSERVE (Rogan *et al.*, 2018). The three estimates were presented in IAMMWG (2015a; 2015b; 2022), and the results are shown in **Table 12.22**. The bottlenose population has increased between the 2015 and the 2022 population estimate (for further information, see **Section 12.6.10**).

Table 12.22 Bottlenose Dolphin and Management Unit Abundance Estimates

Management Unit	Abundance Estimate (IAMMWG, 2015a)	Abundance Estimate (IAMMWG, 2022)
OCSW	4,856 (0.60)	10,947 (0.25)

12.6.2.2 Density Estimates

129. The SCANS III survey (Hammond *et al*., 2021) showed a small number of bottlenose dolphin sightings within the Irish Sea, off the north-west coast of Cornwall and the west coast of Wales, as well as in more offshore waters. Results from the survey showed that block D (which covered the Southern Celtic/Irish Seas) had an estimated abundance of 2,938 individuals (95% CI: 914 – 5,867), with density estimates of 0.0605 bottlenose dolphin/km^2 (CV: 0.447) (**Figure 12.8**).

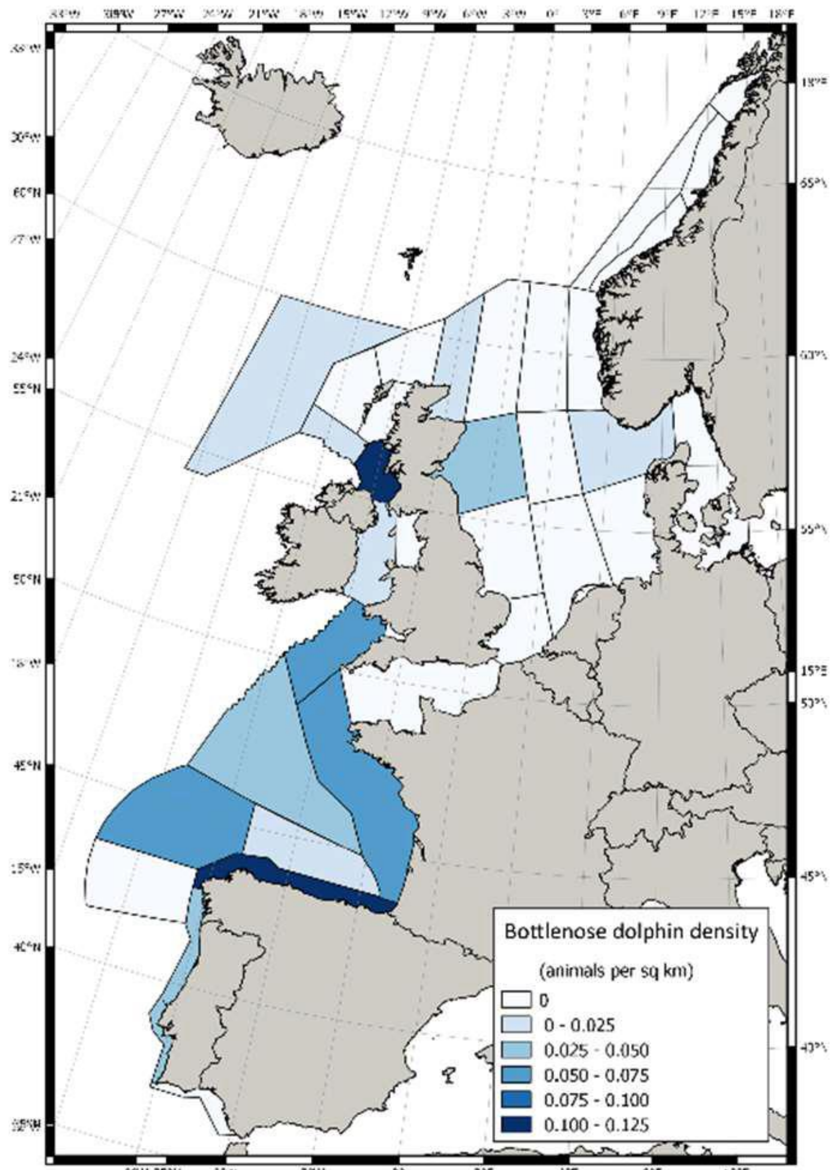

Figure 12.8 Bottlenose Density Estimates from the SCANS III Survey (Hammond et al., 2021)

130. For bottlenose dolphin, the European distribution maps (Waggitt *et al.,* 2019) show a relatively low bottlenose dolphin density within the Irish Sea, and off the north coasts of Devon and Cornwall for both January and July (**Figure 12.9**; Waggitt *et al.,* 2019). It should be noted however that these distribution maps include the offshore populations of bottlenose dolphin only, and do not include data for the resident coastal bottlenose dolphin populations.

131. Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of 0.013

individuals per km^2 for the Windfarm Site (with a peak of 0.017 per km^2 in August), and 0.0069 per km^2 for the ECC (with a peak of 0.0096 per km^2 in August).

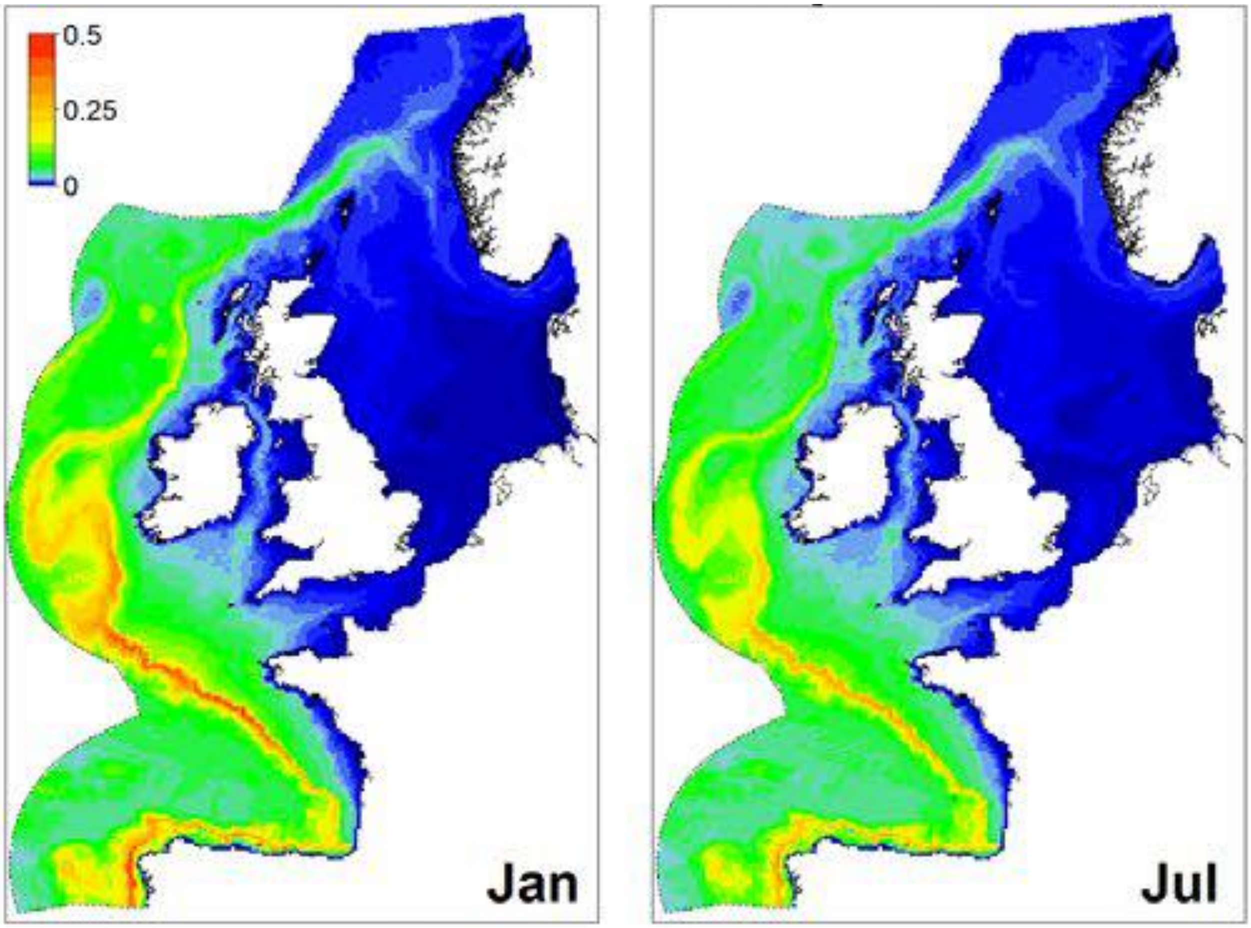

Figure 12.9 Spatial Variation in Predicted Densities (individuals per km of Bottlenose Dolphin in January and July in the North-East Atlantic), including the Offshore Populations only. Values are provided at 10km Resolution. Source: Waggitt et al., 2019.

12.6.2.3 Site-Specific Survey Data

132. During the site specific surveys conducted by APEM (2022), there were no specific sightings of bottlenose dolphins. However, there were a number of dolphin sightings which have the potential to be bottlenose dolphins (**Table 12.23**). Within the survey area, peak numbers of dolphins were recorded in May 2021, with an estimated abundance of 269 and density of 0.8 dolphins per km^2. For the Southwest England survey area, a peak density of 1.88 per km^2 was estimated for May 2021.

133. While the data for dolphin species has been included here, it is highly unlikely that the individuals recorded within the site-specific surveys as dolphin species were anything other than common dolphin, as common dolphin were the only dolphin

species reported to species level. Therefore, for bottlenose dolphin, the assessments will be undertaken based on the worst-case density estimate as found within the above described desk-based sources. This is still considered to be precautionary and an over-estimation, as no bottlenose dolphins were recorded within the site-specific surveys.

Table 12.23 Raw Counts, Abundance and Density Estimates (Individuals per km^2) of Dolphin Species that could not be Identified to Species Level in: a) Survey Area b) Southwest England Site and c) 4 km Buffer Zone (Peak Estimates in Bold)

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
a) Survey Area						
Jul-20	16	124	16	294	0.25	0.37
Aug-20	27	205	68	387	0.19	0.61
Sep-20	5	39	5	110	0.45	0.12
Nov-20	7	55	7	165	0.38	0.16
Dec-20	6	48	6	120	0.41	0.14
Feb-21	11	84	15	177	0.30	0.25
Mar-21	8	61	8	245	0.35	0.18
Apr-21	6	46	6	138	0.41	0.14
May-21	37	269	146	415	0.16	0.80
April-22	9	69	9	152	0.33	0.21
b) Southwest England Site						
Jul-20	2	17	2	43	0.71	0.17
Aug-20	8	67	8	175	0.35	0.68
Sep-20	4	35	4	105	0.50	0.35
Nov-20	7	62	7	185	0.38	0.63
Dec-20	3	27	3	80	0.58	0.27
Feb-21	5	43	5	122	0.45	0.43
May-21	23	186	65	332	0.21	1.88
April-22	4	34	4	102	0.5	0.34
c) 4 km Buffer Zone						
Jul-20	14	104	14	283	0.27	0.44
Aug-20	19	139	37	292	0.23	0.59
Sep-20	1	8	1	23	1.00	0.03
Dec-20	3	23	3	69	0.58	0.10

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
Feb-21	6	44	6	102	0.41	0.19
Mar-21	8	59	8	176	0.35	0.25
Apr-21	6	44	6	132	0.41	0.19
May-21	14	98	35	175	0.27	0.41
April-22	5	37	5	88	0.45	0.16

134. While no bottlenose dolphin were recorded within the site-specific surveys, to produce annual and seasonal density estimates, the maximum density of each month was taken for both the dolphin species and dolphin / porpoise data, as a very precautionary worst-case. The average of the winter months, summer months, and annual density has then been calculated based on the maximum density for each month. **Table 12.24** shows the density estimates for the data for individuals recorded as either porpoise or dolphin, or dolphin species.

Table 12.24 Maximum Dolphin (Dolphin Species and dolphin / porpoise) Density Estimate Calculated for Each Month, with Summer, Winter and Annual Density Estimate for the Whole Survey Area plus 4km Buffer

Survey Month / Period	Individuals per km^2
January	2
February	3.29
March	0.25
April	0.39
May	1.1
June	-
July	0.51
August	0.84
September	2.31
October	12
November	0.16
December	0.14
Annual average	2.090
Summer average (April to September)	1.030
Winter average (October to March)	2.973

12.6.2.4 Diet

135. Bottlenose dolphin are opportunistic feeders and take a wide variety of fish and invertebrate species. Benthic and pelagic fish (both solitary and schooling species), including haddock *Melanogrammus aeglefinus*, saithe *Pollachius virens*, pollock *Pollachius pollachius*, cod *adus morhua*, whiting *Merlangius merlangus*, hake *Merluccius merluccius*, blue whiting *Micromesistius poutassou*, bass *Dicentrarchus labrax*, mullet *Mugilidae*, mackerel *Scombridae*, salmon *Salmo salar*, sea trout *Salmo trutta trutta*, flounder *Platichthys flesus*, sprat *Sprattus sprattus* and sandeels, as well as octopus and other cephalopods have all been recorded in the diet of bottlenose dolphin (Santos *et al.,* 2001; Santos *et al.,* 2004; Reid *et al.,* 2003).

136. Diet analysis suggests that bottlenose dolphin are selective opportunists and although they may have preference for a type of prey, their diet seems to be determined largely by prey availability. Research in Australia has shown that when presented with a choice, they will preferentially feed on certain types of prey, particularly those with a high fat content (Corkeron *et al.,* 1990).

137. Analysis of the stomach contents of ten bottlenose dolphin in Scottish waters, from 1990 to 1999, reveals that the main prey are cod (29.6% by weight), saithe (23.6% by weight), and whiting (23.4% by weight), although other species including salmon (5.8% by weight), haddock (5.4% by weight) and cephalopods (2.5% by weight) were also identified in lower number (Santos *et al.,* 2001). In Irish waters, haddock, saithe and pollock are the dominant prey species ingested, followed by whiting, blue whiting, Atlantic mackerel and horse mackerel; cephalopods are also important (Hernandez-Milian *et al.,* 2015).

12.6.3 Common Dolphin

12.6.3.1 Distributions

138. In UK waters, common dolphins occur primarily in the Celtic Sea, with some reports of this species in the North Sea. The species is listed as Least Concern on the IUCN red list.

139. IAMMWG defined a single MU for this species; the Celtic and Greater North Seas (CGNS) MU (**Figure 12.10**). Since 2015, there have been two MU abundance estimates for common dolphin, the first of these was based off data from SCANS II (Hammond *et al.*, 2013), with an updated estimate from SCANS III (Hammond *et al.*, 2021) and ObSERVE (Rogan *et al.*, 2018). The two estimates are shown in **Table 12.25**. The common dolphin population has increased between the 2015 and the 2022 population estimate (for further information see **Section 12.6.10**).

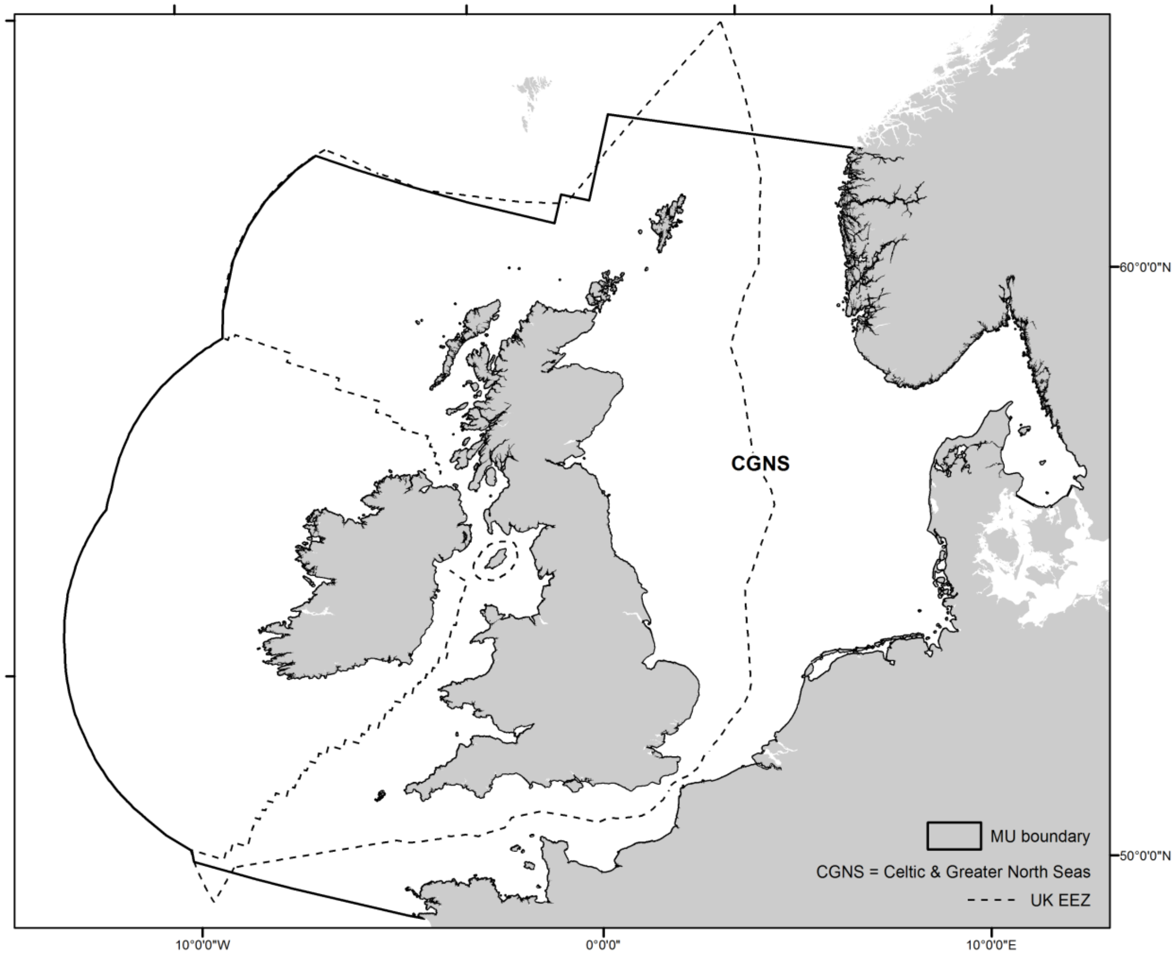

Figure 12.10 Common Dolphin MU (IAMMWG, 2022)

Table 12.25 Common Dolphin Management Unit Abundance Estimates

Management Unit	Abundance Estimate (IAMMWG, 2015a)	Abundance Estimate (IAMMWG, 2022)
CGNS	56,556 (0.28)	102,656 (0.29)

12.6.3.2 Density Estimates

140. The SCANS III survey (Hammond *et al.*, 2021) showed a small number of common dolphin sightings within the Bristol Channel, off the north-west coast of Cornwall and the west coast of Wales, as well as in more offshore waters. Results from the survey showed that block D had an estimated abundance of 18,187 individuals (95% CI: 4,394 – 33,077), with density estimates of 0.3743 common dolphin/km^2 (CV: 0.413) (**Figure 12.11**).

141. Within SCANS-III survey block D, there were also a significant number of dolphins that were either common or striped dolphins, with an estimated abundance of 31,800 (95% CI: 15,661 – 60,584), and estimated density of 0.6545 individuals per km^2. To ensure a precautionary approach is taken for the assessments, where relevant, the highest of these density estimates will be used to inform the assessments.

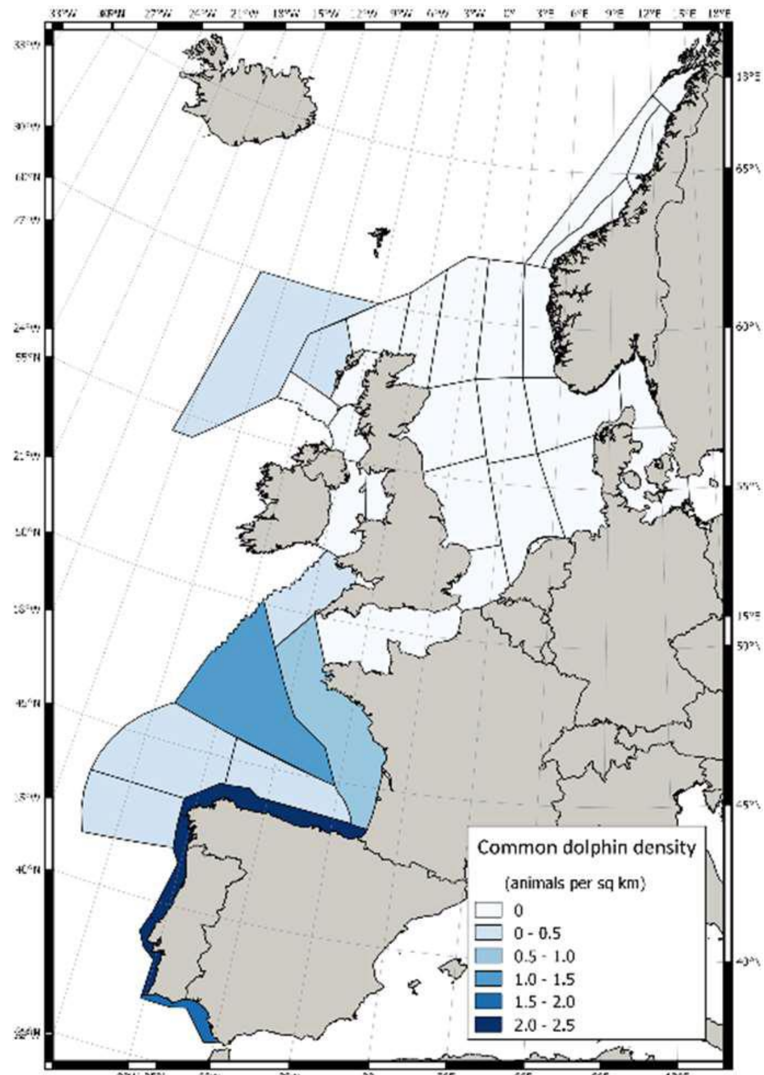

Figure 12.11 Common Dolphin Density Estimates from the SCANS III Survey (Hammond et al., 2021)

142. For common dolphin, the European distribution maps (Waggitt *et al.,* 2019) show a moderate common dolphin density within the Irish Sea, and off the north coasts of Devon and Cornwall for both January and July (**Figure 12.12**, Waggitt *et al.,* 2019). Examination of this data, including all 10 km grids that overlap with the Offshore

Development Area, indicates an average annual density estimate of 0.185 individuals per km^2 for the Windfarm Site (with a peak of 0.280 per km^2 in August), and 0.128 per km^2 for the ECC (with a peak of 0.193 per km^2 in August).

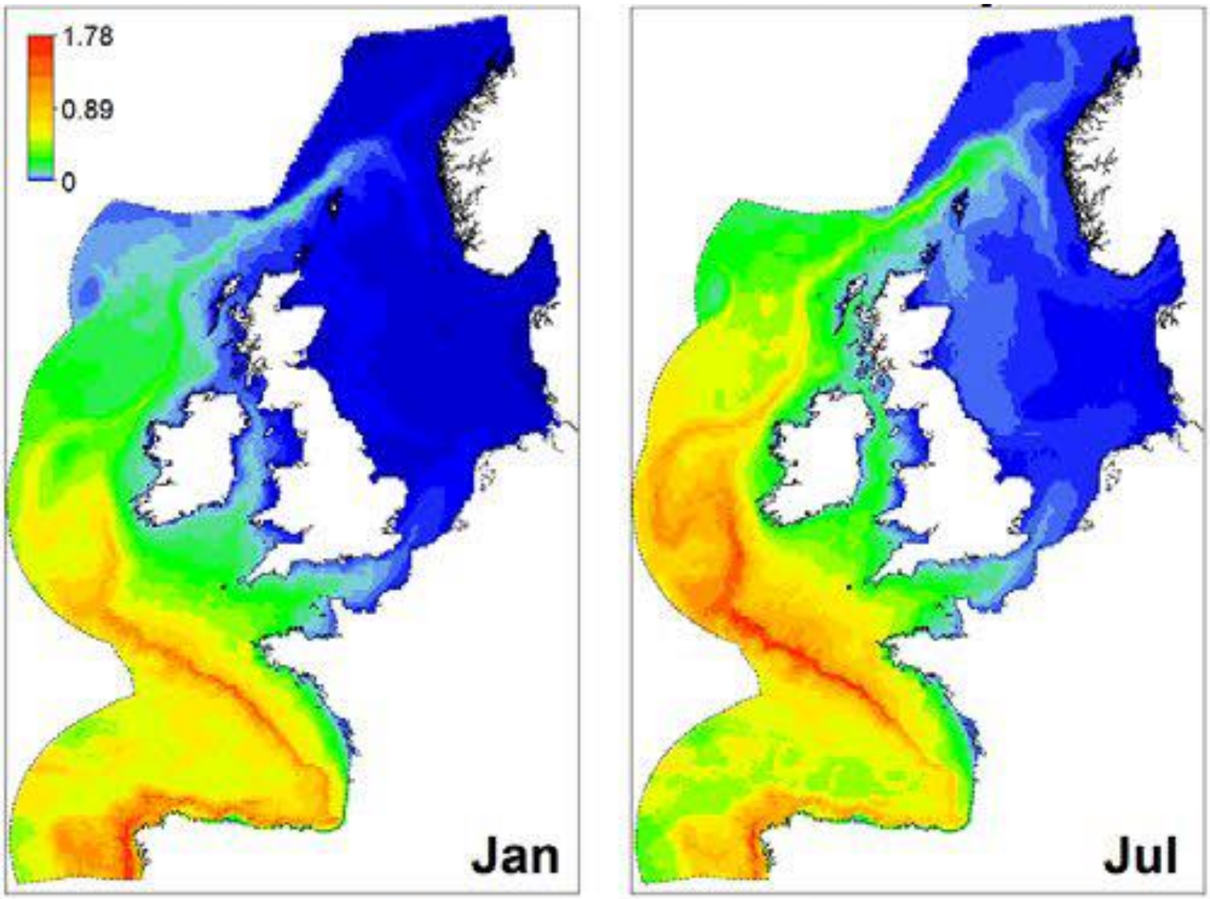

Figure 12.12 Spatial Variation in Predicted Densities (individuals per km of Common Dolphin in January and July in the North-East Atlantic). Values are provided at 10 km Resolution. Source: Waggitt et al., 2019.

12.6.3.3 Site-Specific Survey Data

143. Data from the Offshore Project's site-specific surveys (APEM, 2022) have also been used to generate abundance and density for the sites within a 4km buffer. Common dolphins were recorded in July, August, September, November and December 2020, January, April, May and September 2021, and January, February, April and May 2022. The peak raw count of 285 in May 2021 resulted in an abundance estimate of 2,074 for the Survey Area (**Table 12.26**). This peak of common dolphin presence in May 2021 coincided with a peak in other species, and therefore was likely due to feeding frenzy.

144. In the Southwest England Site, common dolphins were recorded in August, September and November 2020 as well as in May 2021, January, February and April 2022. The peak raw count of 94 in May 2021 resulted in an abundance estimate of 761 (**Table 12.26**).

145. In the 4km Buffer Zone, they were present in July, August, September, November and December 2020, as well as January, April, May and September 2021, and January, February, April and May 2022. The peak raw count of 191 in May 2021 resulted in an abundance estimate of 1,334 (**Table 12.26**).

Table 12.26 Raw Counts, Abundance and Density Estimates (Individuals per km^2) of Common Dolphin in: a) Survey Area b) Southwest England Site and c) 4 km Buffer Zone (Peak Estimates in Bold)

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
a) Survey Area						
Jul-20	4	31	4	77	0.50	0.09
Aug-20	33	250	99	432	0.17	0.74
Sep-20	12	94	12	236	0.29	0.28
Nov-20	20	158	24	339	0.22	0.47
Dec-20	1	8	1	24	1.00	0.02
Jan-21	1	8	1	24	1.00	0.02
Apr-21	4	31	4	69	0.50	0.09
May-21	285	2,074	1,499	2,729	0.06	6.16
Sep-21	1	8	1	23	1.00	0.02
Jan-22	19	147	39	294	0.23	0.44
Feb-22	20	154	20	370	0.22	0.46
Apr-22	24	183	76	297	0.20	0.54
May-22	37	281	53	577	0.16	0.84
b) Southwest England Site						
Aug-20	16	134	16	300	0.25	1.35
Sep-20	7	61	7	244	0.38	0.62
Nov-20	4	35	4	141	0.50	0.35
May-21	94	761	437	1,117	0.10	7.69
Jan-22	8	70	8	209	0.35	0.71
Feb-22	2	17	2	52	0.71	0.17

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
Apr-22	2	17	2	42	0.71	0.17
c) 4 km Buffer Zone						
Jul-20	4	30	4	82	0.50	0.13
Aug-20	17	124	37	234	0.24	0.52
Sep-20	5	38	5	90	0.45	0.16
Nov-20	16	121	16	287	0.25	0.51
Dec-20	1	8	1	31	1.00	0.03
Jan-21	1	8	1	23	1.00	0.03
Apr-21	4	29	4	66	0.50	0.12
May-21	191	1,334	887	1,795	0.07	5.62
Sep-21	1	7	1	22	1.00	0.03
Jan-22	11	81	11	185	0.30	0.34
Feb-22	18	133	18	354	0.24	0.56
Apr-22	22	161	66	285	0.21	0.68
May-22	37	268	58	550	0.16	1.13

146. To produce annual and seasonal density estimates, the maximum density of each month was taken for the common dolphin data. The average of the winter months, summer months, and annual density has then been calculated based on the maximum density for each month. **Table 12.27** shows the density estimates for the individuals identified as common dolphin only, and **Table 12.28** shows the density estimates for the data including common dolphin, and individuals recorded as either porpoise or dolphin, or dolphin species. As a worst-case, it has been assumed that all of the individuals recorded as porpoise or dolphin species are common dolphin. These densities are therefore likely to be an overestimation and over-precautionary.

Table 12.27 Maximum Common Dolphin Density Estimate Calculated for Each Month, with Summer, Winter and Annual Density Estimate for the Whole Survey Area plus 4km Buffer

Survey month / period	Individuals per km^2
January	0.44
February	0.46
March	-

Survey month / period	Individuals per km^2
April	0.54
May	6.16
June	-
July	0.09
August	0.74
September	0.28
October	-
November	0.47
December	0.02
Annual average	**1.022**
Summer average (April to September)	**1.562**
Winter average (October to March)	**0.348**

Table 12.28 Maximum Common Dolphin (plus Dolphin Species and Dolphin / Porpoise) Density Estimate Calculated for Each Month, with Summer, Winter and Annual Density Estimate for the Whole Survey Area plus 4km Buffer

Survey month / period	Individuals per km^2
January	0.48
February	11.04
March	8.07
April	0.75
May	7.26
June	-
July	0.6
August	1.58
September	0.59
October	11
November	0.63
December	0.16
Annual average	**3.833**
Summer average (April to September)	**2.156**
Winter average (October to March)	**5.230**

12.6.3.4 Diet

147. Common dolphin feed on a variety of prey species of squid and fish, such as herring, mackerel and other pelagic schooling fish. Common dolphin co-operate to herd schools of fish and catch more easily.

148. A study over two decades of the diet of common dolphin from 514 stranded or by-caught common dolphin in Galicia in NW Spain determined that the most common prey items were sardine, blue whiting and hake (Santos *et al.,* 2013). A study on the stomach contents of 76 individuals stranded on the Irish coast over 14 years identified largely fish species dominating the diet of offshore and inshore dolphins with some cephalopods and crustaceans.

149. In the Celtic Sea and western Channel, the common dolphin predominately feeds on horse mackerel *Trachurus trachurus*, sardines and mackerel. Common dolphins bycaught in Irish and French tuna driftnets on and beyond the continental shelf slope in summer were predominately feeding nocturnally on meso-pelagic fishes such as myctophids and squids (BEIS, 2022b).

12.6.4 Striped Dolphin

12.6.4.1 Distributions

150. The striped dolphin is a widely distributed species, found primarily in tropical and warm-temperate waters of the Atlantic, Pacific, and Indian Oceans, alongside the adjacent seas such as the Mediterranean. The species do not tend to go above 50ºN latitude, although they have been spotted as far north as southern Greenland, Iceland and the Faroe Islands (ICES, 2021).

151. An increase in the number of striped dolphin strandings (and occasional sightings) have been recorded around the UK since 1988 (Macleod *et al.*, 2009). The species now resides year-round around the British Isles and in the Bay of Biscay (MacLeod *et al.*, 2009).

152. Striped dolphins are the third most abundant cetacean within the SCANS III survey area, albeit towards the west of Europe instead of UK waters (**Figure 12.13**). Overall estimated abundance for the survey area covered by Hammond *et al.* (2021), shown in **Figure 12.13**, is 441,455 striped dolphins (95% CI: 245,974-792,290). It's important to note that the SCANS III survey recorded 183,559 dolphins (95% CI: 123,703-272,378) as either common or striped, which complicates the population estimates (Hammond *et al.*, 2021).

153. The abundance estimate for the aerial survey blocks (shown in pink in **Figure 12.13**) is 19,253 (95% CI: 6,774-36,849) for striped dolphins, and 107,255 (95% CI: 73,394-157,707) for unidentified common or striped dolphin. In the absence of a population estimate for striped dolphin, the assessments are based against the striped dolphin abundance estimate for the aerial survey blocks, of 19,253.

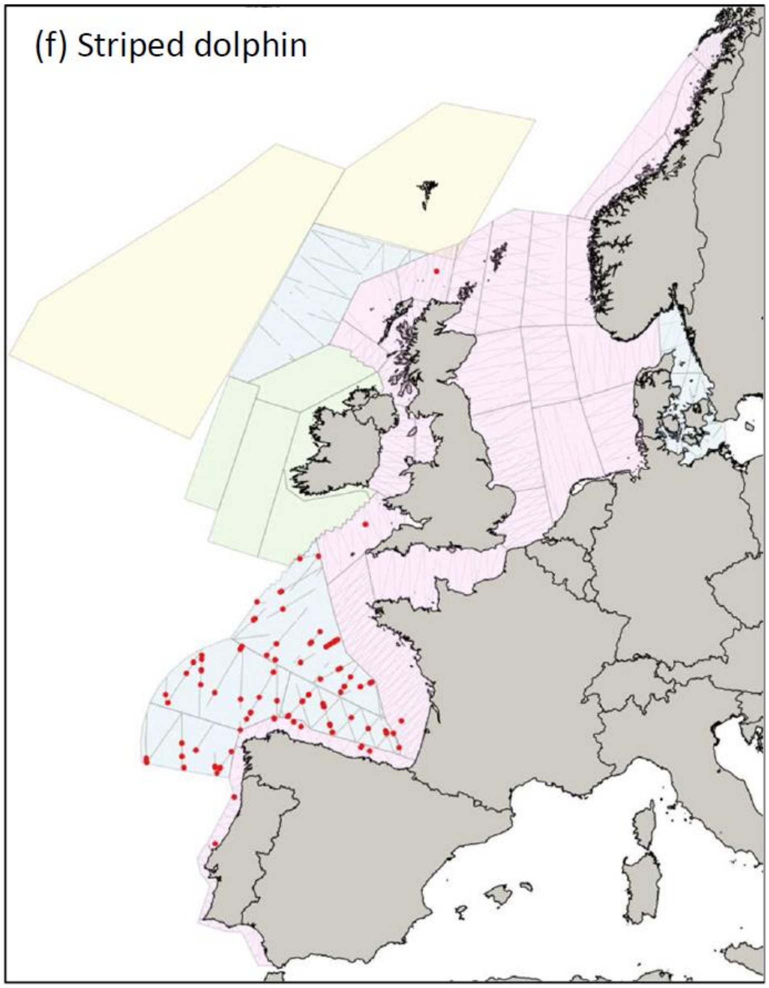

Figure 12.13 Striped Dolphin Sightings from the SCANS III Survey (Hammond et al., 2017; 2021)

12.6.4.2 Density Estimates

154. The SCANS III survey (Hammond *et al.*, 2021) indicate rare presence of striped dolphin sightings within the Bristol Channel. Results from the survey showed that block D had an estimated abundance of 262 individuals (95% CI: 0 – 883), with density estimates of 0.0054 striped dolphin/km^2 (CV: 0.915) (**Figure 12.14**). Within SCANS-III survey block D, there were also a significant number of dolphins that were either common or striped dolphins, with an estimated abundance of 31,800 (95% CI: 15,661 – 60,584), and estimated density of 0.6545 individuals per km^2.

To ensure a precautionary approach is taken for the assessments, where relevant, the highest of these density estimates will be used to inform the assessments.

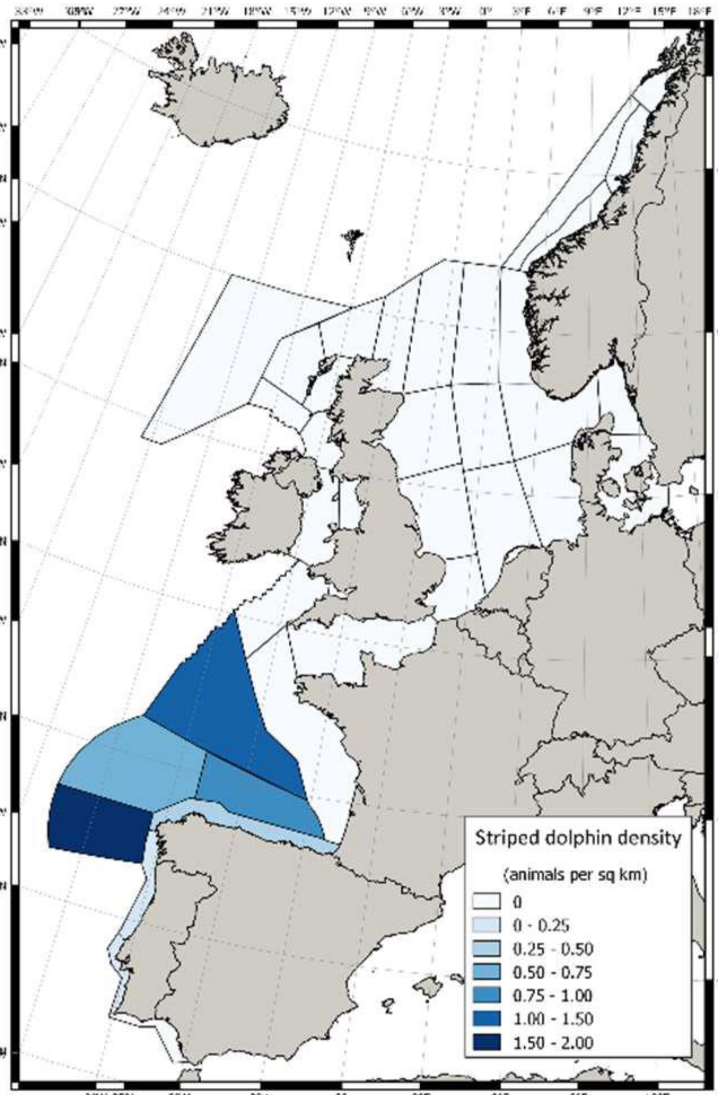

Figure 12.14 Striped Density Estimates from the SCANS III Survey (Hammond et al., 2021)

155. For striped dolphin, the European distribution maps (Waggitt *et al.,* 2019) show a very low relative density within the Celtic and Irish Seas, with presence of striped dolphin most likely to be in the Bay of Biscay and offshore waters (**Figure 12.15**; Waggitt *et al.,* 2019).

156. For striped dolphins, there is a clear seasonal difference in the densities, with higher densities in July to October, which is particularly evident in the north of their range (Waggitt *et al.*, 2019). Examination of this data, including all 10km^2 grids that overlap with the Offshore Development Area, indicates an average annual density estimate of:

- 0.0010 individuals per km^2 for the offshore Windfarm Site:
  - Summer: 0.0016 individuals per km^2
  - Winter: 0.0003 individuals per km
- 0.0006 individuals per km^2 for the ECC:
  - Summer: 0.0010 individuals per km^2
  - Winter: 0.0003 individuals per km^2.

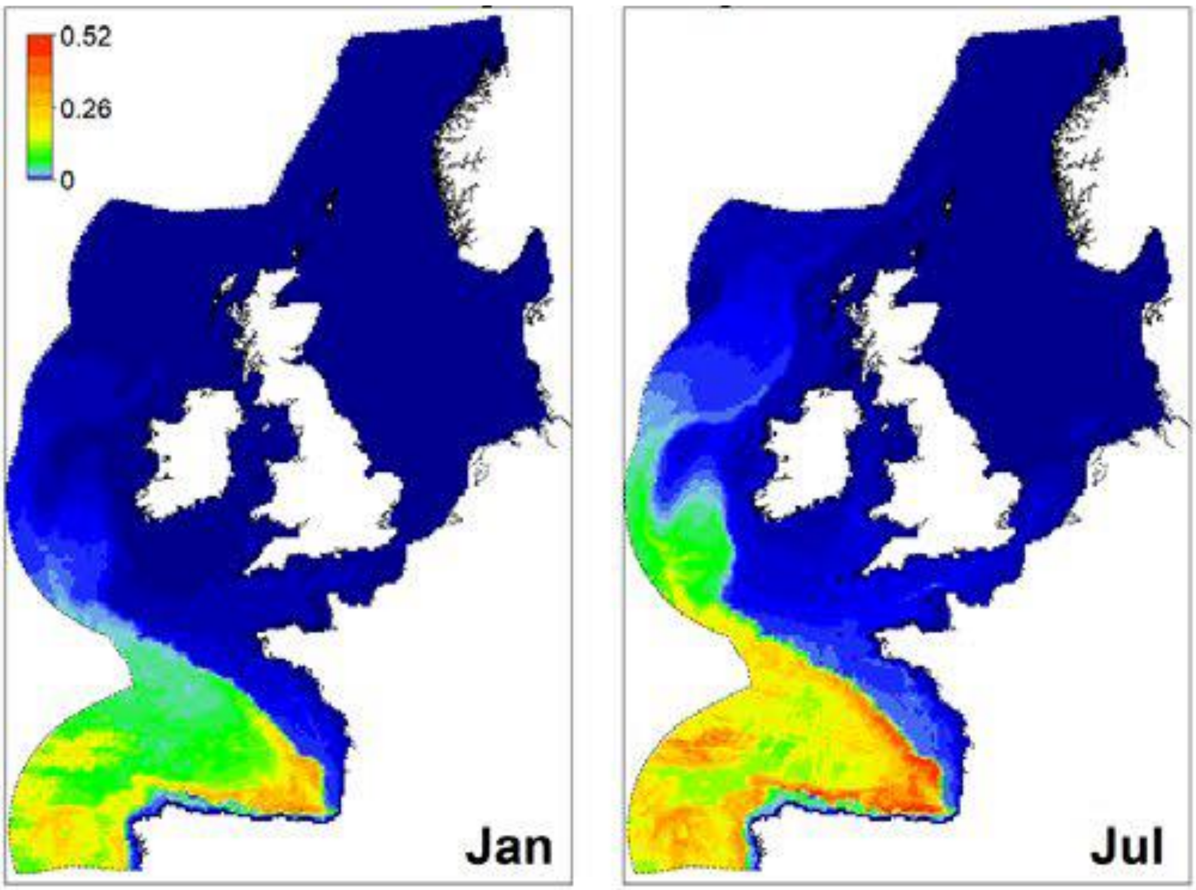

Figure 12.15 Spatial Variation in Predicted Densities (individuals per km of Striped Dolphin in January and July in the North-East Atlantic). Values are provided at 10km Resolution. Source: Waggitt et al., 2019.

12.6.4.3 Site-Specific Survey Data

157. The site-specific aerial survey, conducted by APEM (see **Section 12.3.9.1** for further information), found no striped dolphins individually, but did record a number of dolphins which could not be identified to species level, and could be classified as either common dolphins or striped dolphins as these two species can be difficult to distinguish. Due to this, the sightings have been recorded as a potential for being striped dolphins within the survey area. These results are provided in **Table 12.23**, with peak numbers of dolphins recorded in May 2021, with an estimated abundance

of 269 and density of 0.8 dolphins per km^2 for the survey area. For the Southwest England survey area, a peak density of 1.88 per km^2 was estimated for May 2021.

158. While no striped dolphins were recorded within the site-specific surveys, as for bottlenose dolphin, to produce annual and seasonal density estimates, the maximum density of each month was taken for both the dolphin species and dolphin / porpoise data, as a very precautionary worst-case. **Table 12.24** shows the density estimates for the data for individuals recorded as either porpoise or dolphin, or dolphin species, with an annual density estimate of dolphin / porpoise species of 2.09 individuals per km^2, and a worst-case seasonal density of 2.973 per km^2, for the winter period.

159. While the data for dolphin species has been included here, it is highly unlikely that the individuals recorded within the site-specific surveys as dolphin species were anything other than common dolphin, as common dolphin were the only dolphin species reported to species level. Therefore, for striped dolphin, the assessments will be undertaken based on the worst-case density estimate as found within the above described desk-based sources. This is still considered to be precautionary, as no striped dolphins were recorded within the site-specific surveys, and are likely to be rare in the area.

12.6.4.4 Diet

160. Striped dolphins are not known to undertake extensive migration and tend to stay around area where their prey is abundant. Their prey, in the North Atlantic, tends to mostly be pelagic fish, particularly lanternfish and cod, with the species being able to dive down to 700m depths for prey (Perrin *et al.*, 2008; Archer, 2018). The species don't feed solely on pelagic fish though, in some areas they've been observed to feed on squid and even crustaceans, foraging around various depths in the water column hunting for mesopelagic and benthopelagic species (Archer, 2018).

12.6.5 Minke Whale

12.6.5.1 Distributions

161. Minke whales are widely distributed around the UK and occur mainly on the continental shelf in water depths less than 200m. The species is considered as seasonal visitors, with most sightings occurring in the summer months between May and September, although some sightings do occur all year round in some areas (Hague *et al.*, 2020).

162. The IAMMWG (2022), report identifies a total of 10,288 minke whales within the CGNS UK portion, with a total of 20,118 being modelled for the overall MU (Hammond *et al.*, 2021; Rogan *et al.*, 2018). This is the only single MU for minke whales in the UK, and covers the same area as for common dolphin, shown in **Figure 12.10** Since 2015, there have been two MU abundance estimates for minke whale, the first of these was based off data from SCANS II (Hammond *et al.*, 2013) and CODA (Macleaod *et al.*, 2009), with an updated estimate from SCANS III (Hammond *et al.*, 2021) and ObSERVE (Rogan *et al.*, 2018). The two estimates are shown in **Table 12.29**. The minke whale population has decreased slightly between the 2015 and the 2022 population estimate (for further information see **Section 12.6.10**).

Table 12.29 Minke Whale Management Unit Abundance Estimates

Management Unit	Abundance Estimate (IAMMWG, 2015a)	Abundance Estimate (IAMMWG, 2022)
CGNS	23,528 (0.27)	20,118 (0.18)

12.6.5.2 Density Estimates

163. For the entire SCANS-III survey area, minke whale abundance in the summer of 2016 was estimated to be 14,759 with an overall estimated density of 0.0082/km^2 (CV = 0.319; 95% CI = 8,016 – 27,173; Hammond *et al.*, 2022). The Windfarm Site and the offshore cable corridor are located within the SCANS-III survey block D, where the abundance estimate for minke whale is 543 (95% CL = 0 – 1,559), and the density estimate is 0.0112 individuals per km^2 (CV = 0.755) (**Figure 12.16**; Hammond *et al.*, 2022).

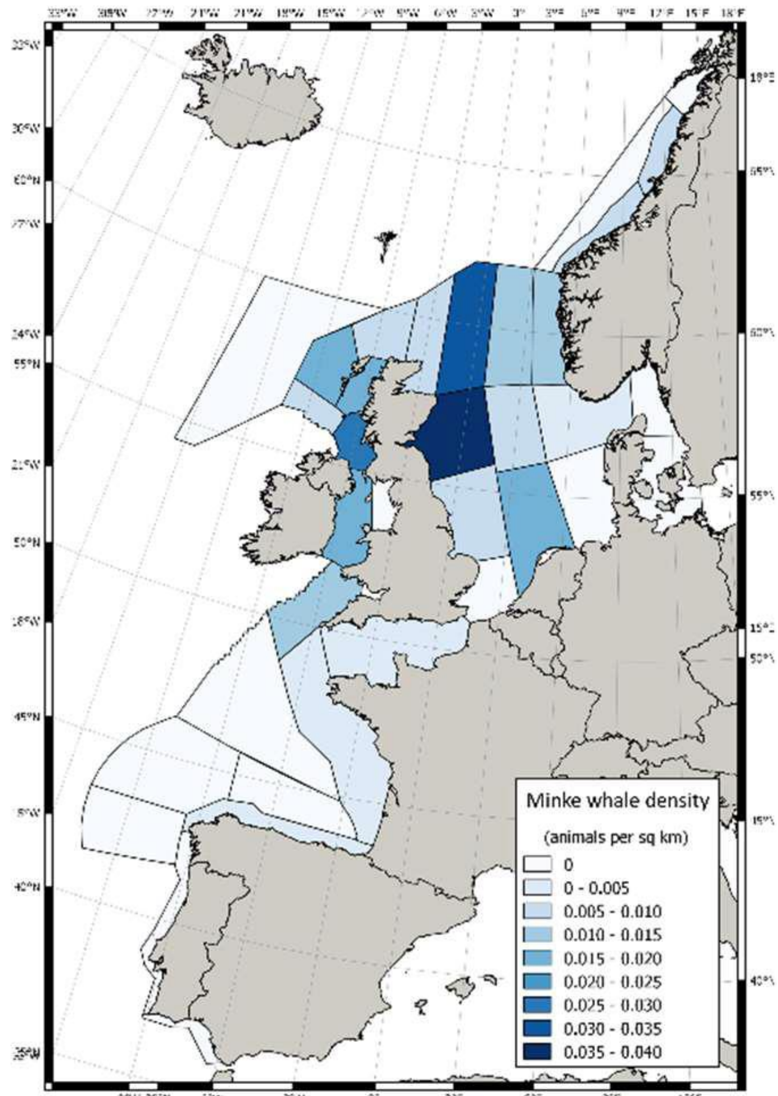

Figure 12.16 Minke Whale Density Estimates from the SCANS III Survey (Hammond et al., 2021)

164. For minke whale, the north-east Atlantic distribution maps (**Figure 12.17**; Waggitt *et al.*, 2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the Celtic and Irish Seas, with decreasing densities southwards of Scotland along the east coast of England. There is a seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (Waggitt *et al.*, 2019). Examination of this data, including all 10 km grids that overlap with the Offshore Development Area, indicates an average annual density estimate of:

- 0.0019 individuals per km^2 for the offshore Windfarm Site (peak of 0.0023 per km^2 in the summer period)

- 0.0013 individuals per km^2 for the ECC (peak of 0.0017 per km^2 in the summer period).

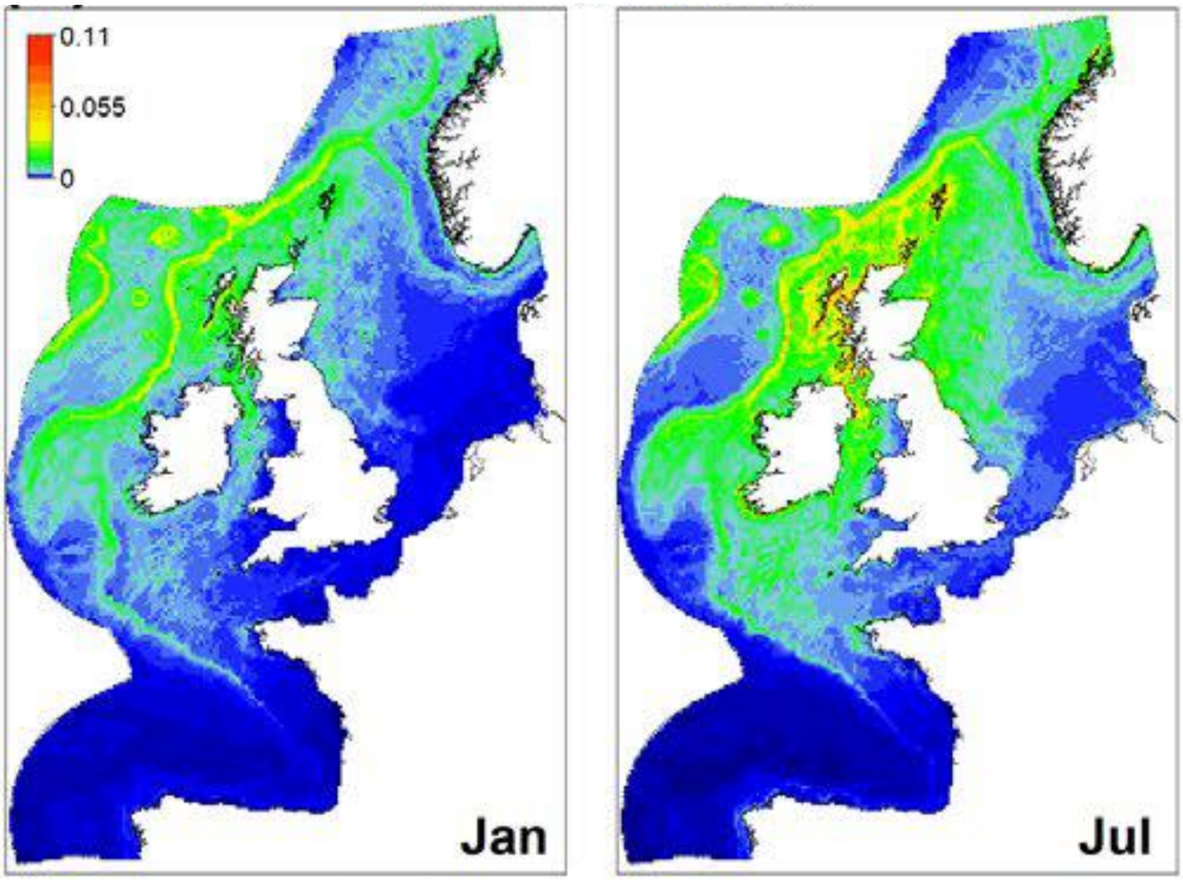

Figure 12.17 Spatial Variation in Predicted Densities (Animals per km^2) of Minke Whale in January and July in the North-East Atlantic. Values are provided at 10km Resolution (taken from Waggitt et al., 2019)

12.6.5.3 Site-Specific Survey Data

165. The site-specific aerial survey, conducted by APEM (see **Section 12.3.9.1** for further information), found minke whales to be present in August 2020 and May 2021, three whales were spotted overall giving an abundance estimate of 8 for 2020 and 15 for 2021 (**Table 12.30**). This data has been provided for information purposes only, as there is insufficient data for which to inform a density or abundance estimate with precision.

Table 12.30 Raw Counts and Abundance and Density Estimates (Individuals per km^2) of Common Minke Whale in: a) Survey Area b) Southwest England Site and c) 4 km Buffer Zone

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
Survey Area						
Aug-20	1	8	1	23	1.00	0.02
May-21	2	15	2	36	0.71	0.04
Southwest England Site						
Aug-20	1	8	1	25	1.00	0.08
4 km Buffer Zone						
May-21	2	14	2	35	0.71	0.06

12.6.5.4 Diet

166. Minke whales feed on a variety of fish species, including herring, cod and haddock. Minke whale feed by engulfing large volumes of prey and water, which they then 'sieve' out of through their baleen plates and swallow their prey whole.

167. A study into the diet of minke whale in the north-eastern Atlantic sampled a total of 210 minke whale forestomach contents from 2000 to 2004, with a total of 37 minke whale samples analysed within the northern North Sea. Within this area, minke whale were found to prey upon a number of different species at the population level, however, 84% of individuals were found to prey upon only one species. Sandeels (56% of total prey by biomass) and mackerel (30% of total prey by biomass) were found to be the most dominant prey species for minke whale in the northern North Sea (Windsland *et al.,* 2007).

12.6.6 Grey Seal

12.6.6.1 Distributions and Movements

168. Grey seals are found on both sides of the North Atlantic Ocean although the greatest proportion of the population is found in UK waters. In recent years, although the populations of grey seals have been showing a steady increase (for further information see **Section 12.6.10**), this has slowed somewhat in the UK population. Approximately 36% of the world's grey seals breed in the UK, with 80% of these being in Scotland, and a much smaller portion in Wales and the Southwest of England (SCOS, 2021).

169. Global Positioning System (GPS) tracking data from Carter *et al*. (2020) and Carter *et al*. (2022) show the species and its presence across the UK, showing a presence

near the Windfarm Site, with movements of grey seal from Wales, and the south-west of the Republic of Ireland (RoI) and in the vicinity of the Offshore Project (**Figure 12.18**).

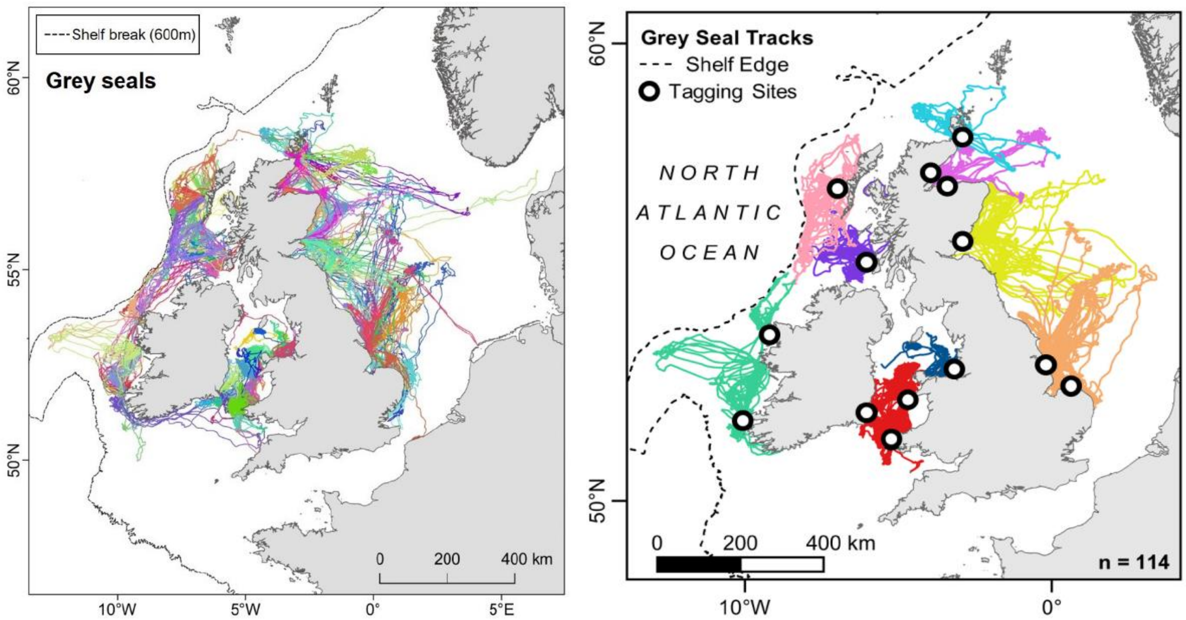

Figure 12.18 Left = GPS Tracking Data for 114 Grey Seals (taken from Carter et al. 2020), tracks are coloured by individual; Right = GPS Tracking Data for 114 Grey Seal (taken from Carter et al. (2022), colours indicate regions, with red being the CIS South region.

170. Earlier grey seal tagging studies also included the movement of grey seal between the north coast of France and UK waters. Jones *et al*. (2015) included the tagging results for a total of 259 grey seal, tagged between 1991 and 2013, and shows the movement of grey seal between the north-west coast of France (and from the English Channel) to the north coast of Devon and Cornwall, Wales, and the south and east coasts of the RoI (**Figure 12.19**). Movements of grey seal from the north coast of France were also monitored through tagging (Vincent *et al.,* 2017), and show a similar pattern of movement from the north coast of France, through the western part of the English Channel, and to Wales and the south and east coasts of the RoI (**Figure 12.19**).

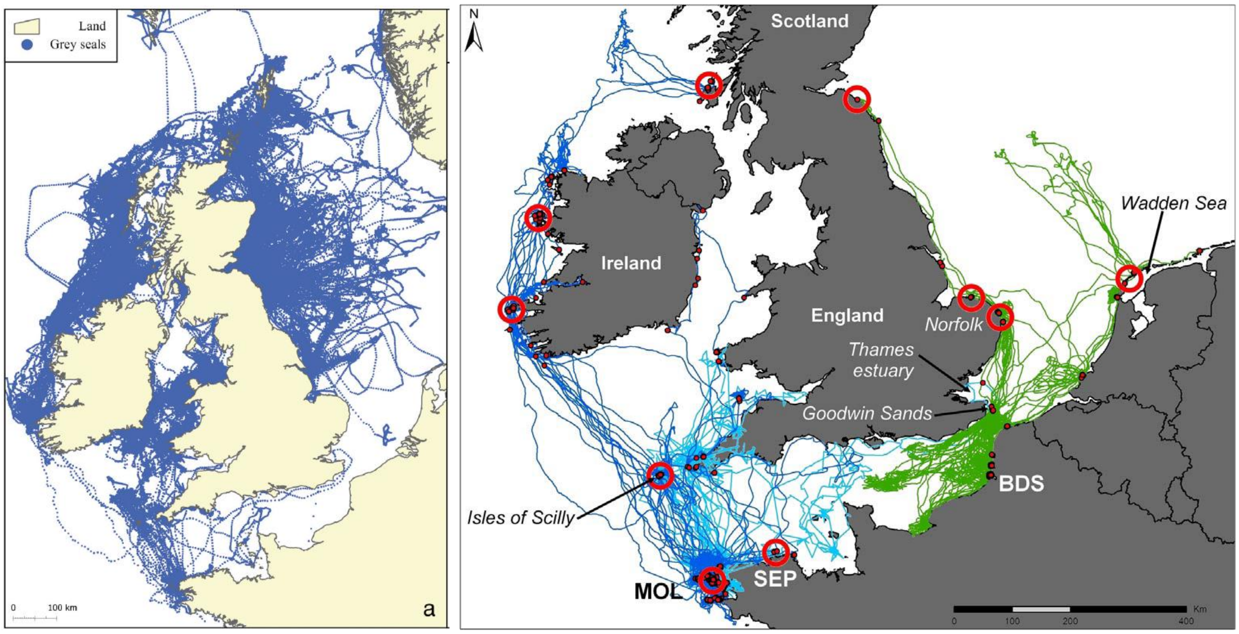

Figure 12.19 Left = Grey Seal Tagging Results for 259 Grey Seal from 1991 to 2013 (Jones et al., 2015); Right = Grey Seal Tagging Results for the North Coast of France (34 Individuals from Molene archipelago (MOL) shown in blue, and 11 from baie de Somme (BDS) shown in green; Vincent et al., 2017).

171. Grey seal spend longer hauled out during their annual moult (December – April) and during their breeding season (August – December). There have been recordings of grey seals moving between haul out sites in Wales and Northwest France to the Inner Hebrides.

172. Grey seals are likely to be present in and around the Windfarm Site, specifically given the proximity to Lundy Island, which is approximately 3.75km from the cable corridor and 43.5km from the Windfarm Site and has a large colony of grey seals present (Lundy Field Society, 2022).

12.6.6.2 Density Estimates

173. Carter *et al.* (2022) provide habitat-based predictions of at-sea distribution for grey seals in the British Isles. The habitat preference approach predicted distribution maps provide estimates per species for $5km^2$ grid squares of relative at-sea density for seals hauling-out in the British Isles (**Figure 12.20**). This map shows the relative density of grey seal in each grid cell to the total at-sea grey seal population.

174. The grey seal density estimates for the survey area have been calculated from the $5km^2$ squares that overlap the relevant areas (Carter *et al.*, 2022):

- 0.005 individuals per km^2 for the Windfarm Site
- 0.119 individuals per km^2 for the ECC.

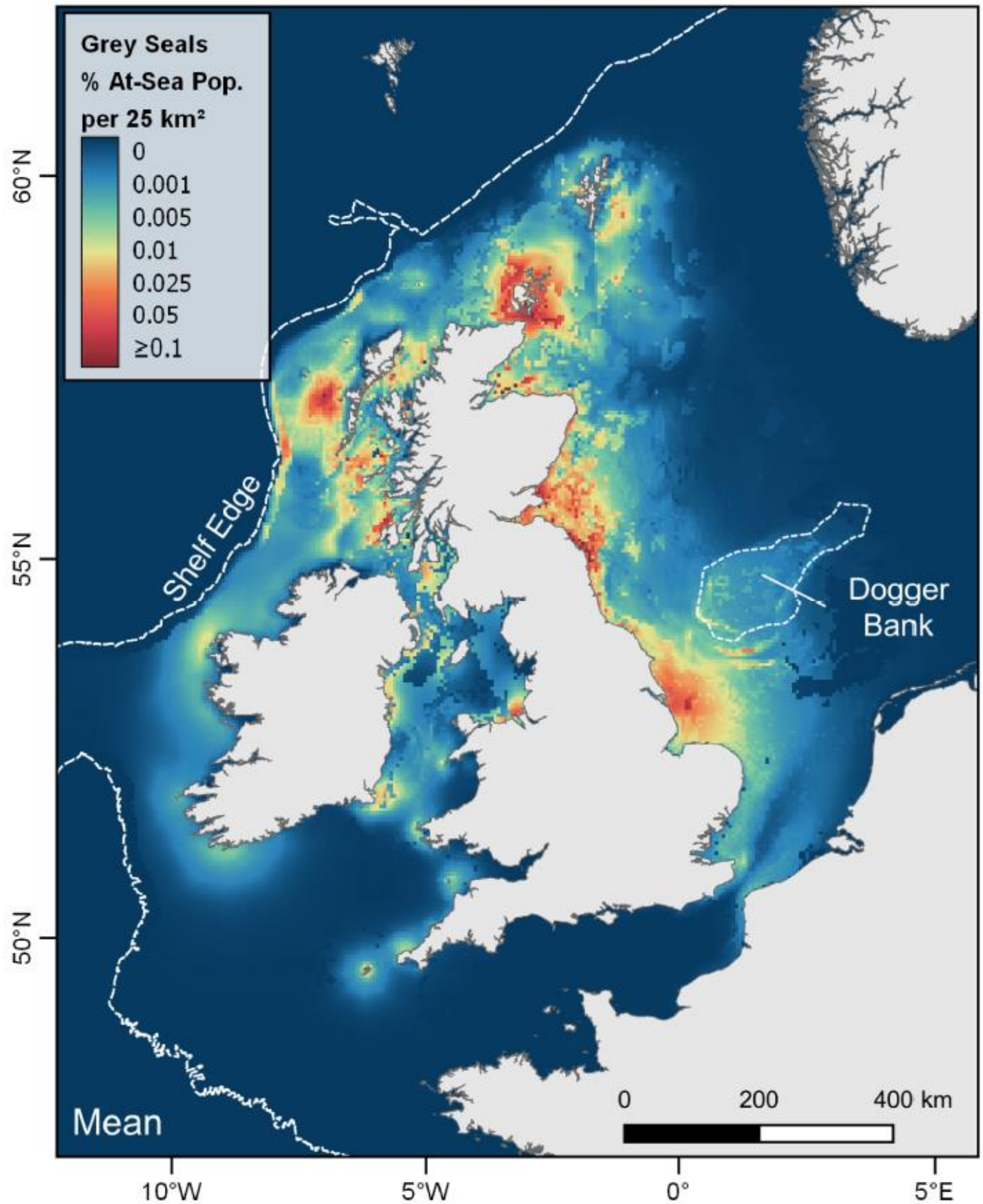

Figure 12.20 At-Sea Distribution of (a) Grey Seal from Haul Outs in the British Isles in 2018. Maps Show Mean Percentage of At-Sea Population Estimated to be Present in each 5 km x 5 km Grid Square at Any One Time, and the Square-Wise (taken from Carter et al., 2020).

12.6.6.3 Population Estimates

175. The most recent surveys of the principal grey seal breeding sites in Scotland, Wales, Northern Ireland and south-west England, resulted in an estimate of 67,850 pups (95% CI = 60,500 - 75,100; SCOS, 2021). The UK grey seal pup production has increased by approximately 1.5% per year, since 2016, and this growth mainly occurred in the North Sea colonies (east coast of Scotland and England) with as estimated increase of 23% from 2016 to 2019, while the pup production decreased by 3.3% in the Inner and Outer Hebrides and Orkney in that same period (SCOS, 2021).

176. When the pup production estimates are converted to estimates of total population size, there was an estimated 157,300 grey seals in 2020 (approximate 95% CI = 144,600 - 169,400; SCOS, 2021).

177. The most recent counts of grey seal in the August surveys 2016-2019, estimated that the minimum count of grey seals in the UK and RoI was 46,463 (SCOS, 2020).

178. Within the southwest (SW) England MU, the grey seal count was estimated to be 500, and for the Wales MU, the grey seal count was estimated to be 900 (SCOS, 2020). The grey seal haul out counts for these MUs has been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.2515 grey seals are available to count within the August surveys (i.e. are hauled-out) (SCOS, 2021), and therefore this has been used as a correction factor, to derive total grey seal numbers within each MU, rather than the number counted within each MU. The total population of grey seal within the SW England MU is therefore 1,988, and for Wales the total population is 3,579.

179. Within the RoI, there is identified connectivity with the east, south-east and south-west coast (**Figure 12.18**), therefore, the wider grey seal reference population will also take into account the population of grey seal in this area. Morris & Duck (2019) undertook haul out counts around the coast of RoI in August 2017 and 2018, and counted a total of 418, 556, and 792 grey seal within the east, south-east, and south-west survey regions respectively. This gives a total of 1,766 grey seal counted in these regions, or a total grey seal population of 7,022 within these three RoI regions.

180. The total reference population for the assessment is therefore 12,588 grey seal. Assessments will be put into context of the wider reference population (of 12,588). As a worst case it is assumed that all seals are from the nearest MU, the SW England MU (1,988), although the more realistic assessment is based on the wider reference population which takes into account the movement of seals.

12.6.6.4 Haul out Sites

181. The closest haul out site for grey seal is at Lundy, approximately 44km from the Windfarm Site and 2.6km from the offshore area of search. There are further haul out sites for grey seal along the north coast of Cornwall, with a minor site at Boscastle, approximately 40km from the offshore development area, and Godrevy on the north-west coast of Cornwall, approximately 89km from the offshore development area (Sayer *et al.*, 2018).

182. Lundy includes a breeding colony of approximately 60 grey seals, with an increase in this number during the summer months. The key haul out sites on Lundy for grey seal include Seals Rock, Gannets Rock, Brazen Ward, Surf Point, Shutter Point and Rat Island (**Figure 12.21**; Lundy Field Society, 2022).

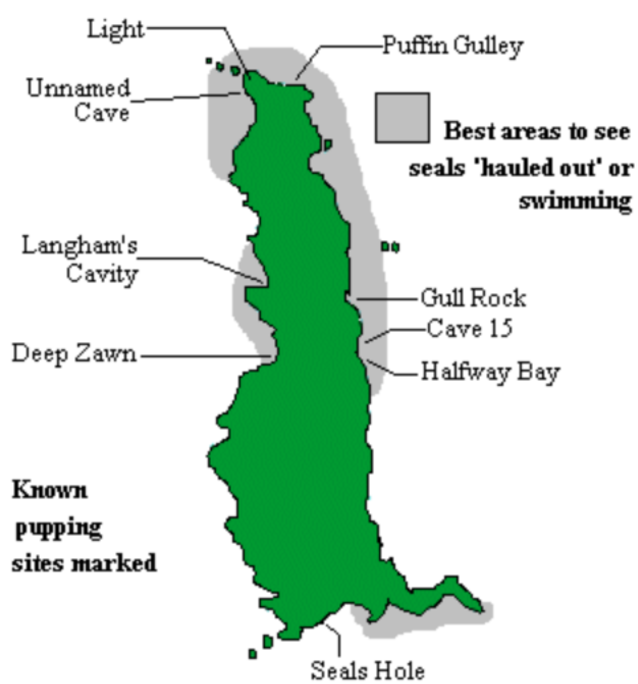

Figure 12.21 Key Grey Seal Locations on Lundy Island (Lundy Field Society, 2022)

183. Lundy Field Society undertake regular surveys of grey seals on the island, the latest report available for which was undertaken in 2020 (Lundy Field Society, 2021). The peak count of grey seal at Lundy Island was in August 2020, with 218 seals counted (including 47 juveniles and one pup); this was the third highest recorded at Lundy since annual surveys started in 2011.

184. In 2016, counts of grey seal in Cornwall were undertaken across different regions in Cornwall (Sayer & Witt, 2018). The haul out site at Boscastle is within the North Cornwall survey region, and the site at Godrevy is within the West Cornwall survey region. In North Cornwall, a total of 21 grey seal pups, and 16 adults were recorded, and in West Cornwall, ten grey seal pups, 12 adults were recorded (Sayer & Witt, 2018).

185. A density map of the number of grey seal pups recorded in each location is provided in **Figure 12.22**, which shows that five to six grey seals per $10km^2$ were recorded at Lundy, 10-15 per $10km^2$ at Boscastle, less than five per $10km^2$ at Trevose Head, and more than 25 per $10km^2$ grey seal were recorded from Newquay to Godrevy (Sayer & Witt, 2018).

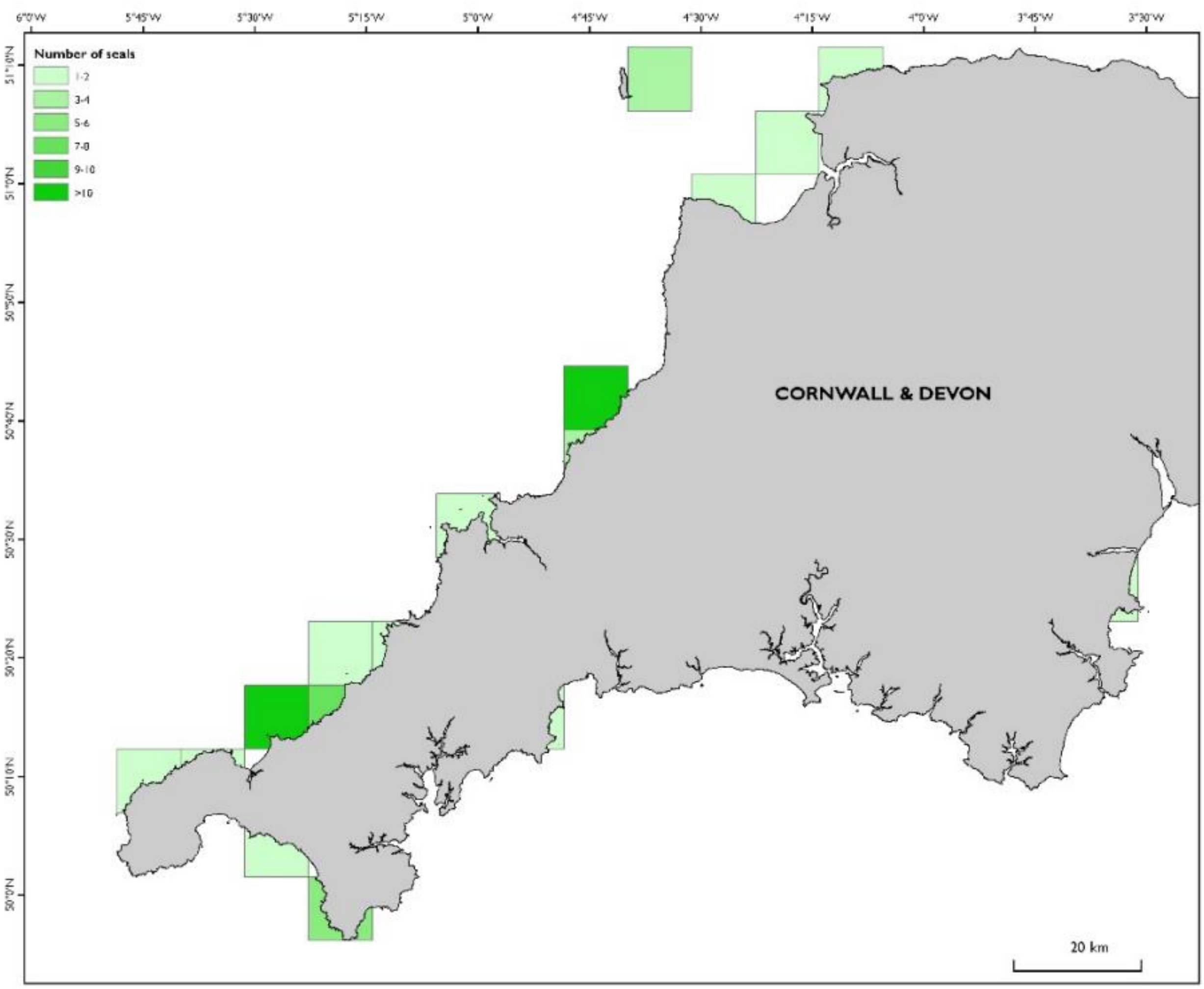

Figure 12.22 Grey Seal Counts (Pups) in Cornwall and Devon from Land-Based Surveys, with the Number of Grey Seal Pups Shown on a 10km x 10km Grid (taken from Sayer & Witt (2018).

186. In 2019, a number of seal counts were undertaken across the south-west region, including south Devon, north Devon, Lundy, Cornwall, and the Isles of Scilly (Sayer, 2020). Overall, grey seal counts were highest in the winter months, with a peak of approximately 750 seals in February. The highest number of seals were mostly recorded in Cornwall, with a peak of approximately 450 in January, however the overall peak in grey seal number in February was due to a significant increase in grey seal in the Isles of Scilly area, with approximately 425 grey seal (**Figure 12.23**; Sayer, 2020).

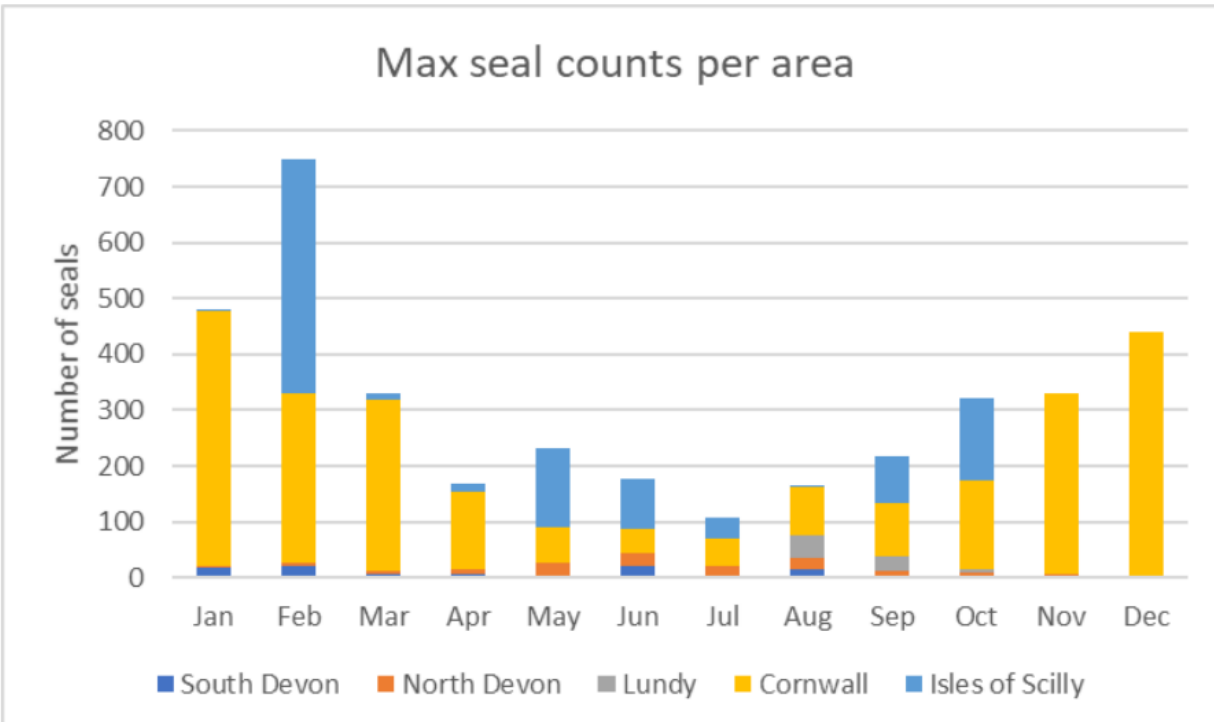

Figure 12.23 Maximum Grey Seal Counts within the Southwest UK Region in 2019 (taken from Sayer, 2020, with data Supplied by The Cornwall Seal Group Research Trust, Lundy Field Society, and The Seal Project)

12.6.6.5 Sites of Specific Scientific Interest

187. A number of SSSIs in the south-west of England have grey listed as a feature of designation. Further information on these can be found in **Section 12.6.8**.

12.6.6.6 Site-Specific Survey Data

188. During the site-specific aerial surveys, conducted by APEM (see **Section 12.3.9.1** for further information), grey seals were recorded in March, May and September 2021, with a peak raw count of three in March 2021, resulting in an abundance estimate of 23 for the Survey Area (**Table 12.31**). This data has been provided for

information purposes only, as there is insufficient data for which to inform a density or abundance estimate with precision.

Table 12.31 Raw Counts, Abundance and Density Estimates (Individuals per km^2) of Grey Seal in: a) Survey Area b) Southwest England Site c) 4 km Buffer Zone

Survey	Raw Count	Abundance	Lower CI	Upper CI	Precision	Density
a) Survey Area						
Mar-21	3	23	3	61	0.58	0.07
May-21	2	15	2	44	0.71	0.04
Sep-21	1	8	1	23	1.00	0.02
b) Southwest England Site						
Mar-21	1	9	1	26	1.00	0.09
Sep-21	1	8	1	25	1.00	0.08
c) 4 km Buffer Zone						
Mar-21	2	15	2	59	0.71	0.06
May-21	2	14	2	42	0.71	0.06

12.6.6.7 Diet

189. Individual grey seals based at a specific haul out site often make repeated trips to the same region offshore, but will occasionally move to a new haul out site and begin foraging in a new region (SCOS, 2020). Telemetry studies of grey seal in the UK have identified a highly heterogeneous spatial distribution with a small number of offshore 'hot spots' continually utilised (Matthiopoulos *et al.,* 2004; Russell *et al.,* 2017).

190. Grey seals are generalist feeders, foraging mainly on the seabed at depths of up to 100m all across the UK continental shelf, with this depth being within the maximum depth of the Windfarm Site (80m). The species takes a wide variety of prey, including sandeels (typically most predominant prey), gadoids (cod, whiting, haddock, ling), and flatfish (plaice, sole, flounder, dab). Grey seals tend to forage in the open sea and return regularly to haul out on land where they rest, moult and breed. They can travel over 100km between haul out sites, and foraging trips can take anywhere between 1 and 30 days (SCOS, 2021). The grey seal maximum foraging range is estimated to be 448km based on tracking data from Carter *et al.* (2022).

191. Food requirements depend on the size of the seal and fat content (oiliness) of the prey, but an average consumption estimate of an adult is 4 to 7kg per seal per day depending on the prey species (SCOS, 2020).

12.6.7 Leatherback Turtle

192. A total of 5 species of marine turtle have been recorded in UK waters; leatherback turtle belongs to the family *Dermochelyidae* while the other four species are all hard-shelled (family *Cheloniidae*); these are the loggerhead turtle (*Caretta caretta*), Kemp's ridley turtle (*Lepidochelys kempii*), green turtle (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*) (**Table 12.32**) (BEIS, 2022c; Botterell *et al.,* 2020; Penrose and Gander, 2020).

Table 12.32 Number of Live Reported Marine Turtles for the UK & Ireland in 2021 (Penrose et al., 2021)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Green turtle ***(Chelonia mydas)***	0	0	0	0	0	0	0	0	0	0	0	0	0
Hawksbill turtle ***(Eretmochelys imbricata)***	0	0	0	0	0	0	0	0	0	0	0	0	0
Kemp's ridley turtle **(*Lepidochelys kempii*)**	0	0	0	0	0	0	0	0	0	0	1	1	2
Leatherback turtle ***(Dermochelys coriacea)***	0	0	0	0	0	0	6	1	2	0	2	0	11
Olive ridley turtle ***(Lepidochelys olivacea)***	0	0	0	0	0	0	0	0	0	0	0	1	1
Unidentified	0	1	0	0	0	0	0	0	0	0	0	0	1
Total	0	0	0	0	0	0	0	0	0	0	0	0	15

193. Of the five species of marine turtle recorded in UK waters, most records are of the leatherback turtle. Records of Kemp's ridley turtle are infrequent while records of other species are extremely rare; all these species are considered vagrants in UK waters (BEIS, 2022c). Leatherback Turtles are listed as 'Vulnerable' by the IUCN, (2022) and is the only species of marine reptile to be considered a regular member

of the UK marine fauna. Leatherback Turtles are a single species globally, with 7 Regional Management Units (RMUs) worldwide, each representing a different subpopulation (Wallace *et al.,* 2010).

194. Leatherback turtles undertake extensive trans-oceanic migrations to waters surrounding the UK, within the Atlantic Northwest RMU (Wallace *et al.*, 2010). Most sightings occur during June-October, with a peak in August; strandings peak slightly later in September and October (Botterell *et al.*, 2020). Leatherback turtles have a wide-ranging migration in response to food distribution including jellyfish and other gelatinous zooplankton and their presence in UK waters is often due to displacement from their normal range by adverse currents (BEIS, 2022c; Robinson *et al.,* 2022; Jones *et al.,* 2012).

195. Botterell *et al.* (2020) undertook a review of marine turtle sightings in the UK and Ireland from 1910 to 2018. Among their findings, reports of leatherback turtles increased over the decades to a peak in the 1990s, but since then records appear to have gradually declined. While there were 553 instances in the 1990s, there were 464 in the 2000s and 256 since 2010; although the data for the most recent decade is not yet complete.

196. The timing of records suggests that leatherback turtles enter British and Irish waters from the south and west. However, these waters are likely to represent the most northern limit of leatherback turtle migration, evidenced by a notable decrease in annual records and a limited number of sightings across the UK (Botterell *et al.,* 2020).

197. The Study Area for the Offshore Project covers the wider CIS region and beyond, to account for the mobile nature of marine turtles. The majority of marine turtle sightings and strandings occur west of the UK and Ireland and along the English Channel coast (Botterell *et al.,* 2020).

198. There were less than ten leatherback turtle sightings along the Devon/Cornwall Coast from 2021. However, to date no marine turtles have been recorded during the site-specific surveys for the Offshore Project (EIA Scoping Report, 2022). One juvenile loggerhead turtle stranded dead at Buck’s Mill, Devon, in January 2021 and a Kemp’s ridley turtle found stranded alive at Northam Burrows, near Appledore, North Devon, in December 2021 (Penrose *et al.,* 2021). However, post-mortem examinations of recovered marine turtles revealed cause of death for all turtles were cold-stunning, starvation or hypothermia. This suggests that the colder water environment of coastal waters across the UK are unfavourable and represent migration limits of marine turtles (Penrose *et al.*, 2021) and that once winter

approaches, leatherback turtles commence their seasonal migration southward (BEIS, 2022c).

199. During 2003-2005 (June-October) (Houghton *et al.*, 2006) carried out aerial surveys throughout the Irish and Celtic Seas to determine the abundance of leatherback turtles and their jellyfish prey. During the surveys, four live and one dead leatherback turtle were observed with two of the live animals found within 1km of *Rhizostoma octopus* (barrel jellyfish) aggregations. These sightings equate to 0.25 leatherbacks per 1,000 km of track flown (or 0.06 leatherbacks per 100 km^2) within the Irish and Celtic Seas (Doyle *et al.,* 2008).

12.6.8 Summary of Designated Sites

200. There are a number of designated SSSI sites nearby to the Offshore Project that are designated for grey seals; **Table 12.33** summarises these areas. Given the location of the Offshore Project, the key potential effect to designated sites are likely to be to hauled-out seals, and this potential effect is considered further within the assessments of disturbance to hauled-out seals during construction (**Section 12.7.7**), operation and maintenance (**Section 12.8.6**) and decommissioning (**Section 12.9**).

201. Designated SACs for marine mammals are assessed within the **RIAA**.

Table 12.33 Summary of Coastal Designated Sites, their Features and the Distance from the Windfarm Site

SSSI Designation	Country	Marine Mammal Designated Feature	Distance at Closest Point (km)
Lundy	England	Grey seal	44
Skokholm	Wales		55
Pentire Peninsula	England		56
Boscastle to Widemouth	England		56
Skomer Island and Middleholm	Wales		58
Trevose Head and Constantine Bay	England		58
Grassholm / Ynys Gwales	Wales		60
The offshore islets off Pembrokeshire / Ynysoedd Glannau Penfro	Wales		62

SSSI Designation	Country	Marine Mammal Designated Feature	Distance at Closest Point (km)
Ramsey / Ynes Dewi	Wales		73
Godrevy Head to St Agnes	England		81

12.6.9 Summary of Marine Mammal and Marine Turtle Densities and Reference Populations for Assessment

202. The data available have confirmed the likely presence of common dolphins, harbour porpoise, bottlenose dolphins, minke whales and grey seals in the vicinity of the Offshore Project site (Windfarm Site and ECC) and, therefore, these species should be considered within the quantitative impact assessment. The most robust and relevant density estimates within each MU were determined for each receptor and have been carried forward into this assessment (**Table 12.34**).

203. The APEM surveys conducted between 2020 to 2022 (for further information, see **Section 12.3.9.1**) noted a high abundance of harbour porpoise, bottlenose dolphin, common dolphin, and minke whale within the May 2021 survey. This occurrence within the survey also coincided with increased numbers of guillemots and manx shearwaters, which leads to the conclusion this survey happened during a feeding frenzy (APEM, 2022). Note that high numbers of these species within the area when due to a feeding frenzy could occur at any given time and is not solely restricted to the month of May.

Table 12.34 Species, MU size and Density Estimates

Species	MU	MU Size (UK Portion)	MU Reference	Density (per km²)	Density Reference
Harbour porpoise	Celtic and Irish Seas (CIS)	62,517 (16,777)	IAMMWG (2022)	0.118	SCANS-III (Hammond *et al.*, 2021)
				0.191 (Windfarm Site) 0.389 (ECC)	Waggitt *et al.*, (2019)
				0.594 (annual estimate) 0.918 (summer density estimate)	Density estimates for harbour porpoise and porpoise / dolphin species group, from APEM site specific surveys (APEM, 2022)
Bottlenose dolphin	Offshore Channel and Southwest England (OCSW)	10,947 (3,866)	IAMMWG (2022)	0.0605	SCANS-III (Hammond *et al.*, 2021)
				0.013 (Windfarm Site) 0.0069 (ECC)	Waggitt *et al.*, (2019)
Common dolphin	Celtic and Greater North Seas (CGNS)	102,656 (57,417)	IAMMWG (2022)	0.3743 0.6545 common / striped dolphin	SCANS-III (Hammond *et al.*, 2021)
				0.185 (Windfarm Site) 0.128 (ECC)	Waggitt *et al.*, (2019)
				3.833 (annual estimate) 5.230 (winter density estimate)	Density estimates for common dolphin and porpoise / dolphin and dolphin species groups, from APEM site specific surveys (APEM, 2022)
Striped dolphin	SCANS-III aerial survey area (in absence of available population estimates)	19,253	IAMMWG (2022)	0.0054 striped dolphins 0.6545 striped / common dolphin	SCANS-III (Hammond *et al.*, 2021)
				0.0010 (Windfarm Site) 0.0006 (ECC)	Waggitt *et al.*, (2019)

Species	MU	MU Size (UK Portion)	MU Reference	Density (per km^2)	Density Reference
Minke whale	CGNS	20,118 (10,288)	IAMMWG (2022)	0.0112	SCANS-III (Hammond *et al.*, 2021)
				0.0019 (Windfarm Site) 0.0013 (ECC)	Waggitt *et al.*, (2019)
Grey seal	Southwest England MU (corrected)	1,988	SCOS (2020); Morris & Duck (2019)	0.005 (Windfarm Site) 0.119 (ECC)	Carter *et al.* (2022)
	Southwest England and Wales MU, and RoI estimates combined (corrected)	12,588			

12.6.10 Do Nothing Scenario

204. The Marine Works (EIA) Regulations 2007 (as amended) require that "an outline of the likely evolution thereof without implementation of the development 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" is included within the ES (EIA Regulations, Schedule 4, Paragraph 3). From the point of assessment, over the course of the development and operational lifetime of the Offshore Project (operational lifetime anticipated to be a minimum of 25 years), long-term trends mean that the condition of the baseline environment is expected to evolve. This section provides a qualitative description of the evolution of the baseline environment, on the assumption that the Offshore Project is not constructed, using available information and scientific knowledge of benthic and intertidal ecology.

205. The existing baseline conditions for marine mammals and marine turtles are considered to be relatively stable, for most species. The baseline environment of the CIS has been influenced by oil and gas exploration since the 1980's and fishing by various methods for hundreds of years. The baseline will continue to evolve as a result of global trends which include the effects of climate change.

206. The potential effects of climate change on marine mammals and marine turtles can be direct, such as the effects of rising sea levels on seal haul out sites, or species tracking a specific range of water temperatures in which they can physically survive (Learmonth *et al.,* 2006; MacLeod *et al*., 2005; Evans and Waggitt, 2020). Species of marine mammal or marine turtle with a narrow range of temperature tolerance have been shown to be more susceptible the effects of climate change (Orgeret *et al*., 2021). Indirect effects of climate change include changes in prey availability affecting distribution, abundance and migration patterns, community structure, and susceptibility to disease and contaminants. Ultimately, these can cause effects on the reproductive success and survival of marine mammals and marine turtle and, hence, have consequences for populations (Learmonth *et al.,* 2006; Evans and Waggitt, 2020).

207. As reviewed in BEIS (2022b), significant change has been documented in many aspects of the UK marine environment, likely due to an array of factors including climatic influences, nutrient inputs and anthropogenic factors, such as fishing. These changes include rising sea temperatures, biogeographical shifts in many zooplankton assemblages, with a northward extension of warm-water species,

changes in the distribution and abundance of fish species, with southern species becoming more prominent.

208. For harbour porpoise in the Celtic and Irish Seas, the SCANS-III 2016 abundance estimate is less than 50% of the SCANS-II 2005 estimate (although the lognormal 95% confidence intervals do overlap slightly). Hammond *et al*. (2021) suggest that if the difference in abundance estimates in the Celtic and Irish Seas reflects a real difference in abundance, possible reasons could include the effect of bycatch or the movement of animals between areas. This change is potentially linked to high densities of harbour porpoise predicted to the south and west of Ireland in the summer of 2015 and 2016, suggesting a distributional shift of the species to this region (Rogan *et al.,* 2018). Such large-scale changes in the distribution of harbour porpoise are likely the result of changes to the availability of their principal prey species, such as sandeel, within the Celtic and wider Irish Seas (SCANS-II, 2008).

209. The effects of climate change on harbour porpoise populations are still relatively unknown. However, it is expected that there will be effects to the population through prey depletion and range shifts. Harbour porpoise habitat and population range is determined from their preferred prey availability, and therefore a change in prey range has the potential to cause a change in the distribution of harbour porpoise (Evans and Bjorge, 2013; Ransijn *et al.*, 2019).

210. The observed distribution of bottlenose dolphins in SCANS-III in 2016 was similar to that observed in SCANS-II and CODA in the European Atlantic in 2005/07 (Hammond *et al.,* 2013; 2021; CODA, 2009). The total abundance estimate for SCANS-III in 2016 of 120,500 (CV = 0.165) is considerably greater than that from 2005/07 of 35,900 (CV = 0.21) (Hammond *et al.*, 2021; WGMME, 2017). The difference in abundance estimates between 2005/07 and 2016 may reflect bottlenose dolphins responding to spatial variation in prey availability across the wider range (Hammond *et al.*, 2021).

211. SCANS III surveys in 2016 predicted relatively low densities of bottlenose dolphin in the offshore development area, though in slightly higher numbers since SCANS II in 2005. This species is relatively common in the Celtic Sea, though higher numbers are encountered further north around Cardigan Bay and the southwest coast of Ireland (Paxton *et al.*, 2016). Bottlenose dolphin are often associated with small, semi-resident coastal communities where accurate abundance estimates can be difficult due to the nature of survey methods. The increase in abundance estimates over time in the Celtic and Irish Sea indicates that the species may be increasing its range northwards in response to climate change and prey availability. However, it

can be difficult to determine whether changes are due to natural variability or climate related effects (Orgeret *et al.*, 2021).

212. SCANS III predicted high densities of common dolphin in the Celtic Sea in 2016, focused on shelf waters off the southwest of England and northwest coast of Spain, and this species is regularly seen around coastal regions of Cornwall. The estimated density areas have shifted northwards over time, with high numbers expected within the offshore development area in 2016 compared to 2005. Between 1994 and 2010 the population in the UK has remained relatively stable. However, there are noted fluctuations on approximately decadal time scales (Paxton *et al.*, 2016). Common dolphins prefer a warm temperate or tropical environment (thermophilic) and are noted as having a flexible diet (Marcalo *et al.*, 2018). Therefore, it may be expected that this species will move into more northerly regions as sea temperatures rise and prey availability changes at the same time (Williamson *et al.*, 2021).

213. Analyses of pooled model-based density data from SCANS II, CODA, and T-NASS in summer 2005 and 2007 showed very low numbers of striped dolphin in the Celtic Sea (OSPAR, 2017). SCANS III in 2016 showed that this trend has continued over time, though there is a noted disjunct population in the deep waters off the west coast of Scotland that was not present in 2005, and rare individual sightings have been reported off the north coast of Cornwall (Hammond *et al.*, 2021). High numbers of the species are predicted further south off the shelf throughout the Bay of Biscay and west of Galicia (north-west Spain), and striped dolphins have previously been found to prefer specific water temperatures (between 21-24^{o}C) within the Mediterranean Sea (Panigada *et al.*, 2008). Increasing effects relating to climate change that include maximum latitude and habitat availability have been recorded for the species, and a northward range expansion and increased summer occurrence into UK and Irish waters is predicted (Weelden *et al.*, 2021).

214. SCANS II predicted a high density of minke whale in the Celtic Sea in 2005, whereas in 2016, SCANS III showed that this distribution has shifted away from the southwest of England to the central and eastern North Sea (Lacey *et al.*, 2021). Minke whale are still a regular occurrence in the Celtic Sea and within the offshore development area, and as of 2021 there has been no obvious change in the status of this species (Evans *et al.*, 2021). A decade of acoustic observations in the western North Atlantic have shown important distributional changes over the range of baleen whales, mirroring known climatic shifts (Davies *et al.*, 2020).

215. There has been a continual increase in the total UK grey seal pup production and population estimates since regular surveys began in the 1960s. The overall UK pup production increased by <1.5% p.a. between 2016 and 2019. The majority of this

growth has been limited to colonies in the North Sea and east coast of Scotland (SCOS, 2021). Small numbers of grey seals breed around the coast of Cornwall, Devon and Somerset (c. 350 pups in 2016), including a large colony at Lundy Island (approximately 180 seals) and haul out sites along the Cornwall coastline (SCOS 2019; Carter *et al*., 2020, 2022). Movement of grey seals has been recorded between the southwest coast of Britain and Ireland to France, and numbers of grey seals are increasing along the French coast (Vincent *et al*., 2017). This increase appears to be due to immigration rather than an increase in local populations (Vincent *et al*., 2017). Grey seals are a relatively flexible species in terms of prey and temperature tolerance; yet they are still effected by climate change. A severe storm event in 2017 reportedly killed 75% of the pups at major breeding sites in Wales and highlights an increasing potential effect of climate change on this species (Evans *et al*., 2020).

216. Potential effects from climate change on seals include rising sea levels and increasing storms effecting haul out locations and therefore breeding success, new infectious diseases (e.g., Brucella bacteria already present in the North Sea (Kroese *et al*., 2018)) and increased toxic algal blooms (Broadwater *et al*., 2018). Seals have a varied diet and can adapt depending on prey availability. However, shortages or changes in prey availability can affect fecundity, survival, lead to movements to new areas, or increased competition between grey and harbour seal.

217. Leatherback turtles are a highly migratory species, often crossing thousands of kilometres between nesting beaches and foraging areas and are one of the most widely distributed extant animal species (Wallace *et al.,* 2018). The species seasonally frequent western waters around the UK and Ireland during the summer and autumn as it is a foraging ground for their prey, whilst their nesting beaches are found in tropical and subtropical regions (Witt *et al*., 2007). The decadal trend of leatherback turtle sightings increased between the 1960's and 1990's and has since declined (Botterell *et al.,* 2020).

218. This increased presence of the species in the UK and Ireland has been attributed to warming temperatures; expanding the range of suitable habitat and prey availability, and over longer periods (Witt *et al.,* 2007). However, leatherback turtles' abundance in general has been in decline for many years. The cause of decline remains unclear but increases in long-line fisheries in African and Latin American waters and a general decline of subpopulations in the Pacific region are noted (Tapilatu *et al*., 2013). Although North Atlantic populations are currently stable or increasing (Colman *et al*., 2019), there has also been a decrease in the reporting

effort of the species in line with reduced fishing effort in the UK (Botterell *et al.*, 2020).

219. Leatherback turtles are in decline in many areas, primarily due to anthropogenic stressors, with by-catch mortality and development on nesting beaches listed as major contributors (Willis-Norton *et al.*, 2015). Climate change is shown to impose additional stresses upon already threatened populations, and core pelagic habitats are predicted to significantly decrease for the species in the next century (Willis-Norton *et al.*, 2015).

220. For marine mammals and marine turtles, there are some changes evident as a result of climate change and it is reasonable to expect further such changes in the future and over the lifetime of the Offshore Project. However, the latest changes in population distribution and abundance have been taken into account in the assessments that have been undertaken.

12.7 Potential Effects during Construction

221. The potential effects for consideration during construction, operation and decommissioning of the Offshore Project have been assessed in **Section 12.7** for construction, **Section 12.7.3** for operation and maintenance and **Section 12.8.10.4** for decommissioning. The potential effects and the applicable assessment methodologies were agreed with stakeholders at the second ETG (14th November 2022). **Table 12.14** lists the worst-case scenario for each potential effect.

222. Potential effects during construction assessed for marine mammals and marine turtles are:

- Impact 1: Underwater noise during foundation installation (piling)
- Impact 2: Underwater noise during UXO clearance
- Impact 3: Underwater noise effects from other activities such as seabed preparations, cable laying and rock placement
- Impact 4: Underwater noise and disturbance from vessels
- Impact 5: Barrier effects caused by underwater noise
- Impact 6: Interactions and collision risk with vessels
- Impact 7: Disturbance at seal haul out sites
- Impact 8: Entanglement
- Impact 9: Electromagnetic fields direct and indirect effects
- Impact 10: Barrier effects from the physical presence of the wind farm
- Impact 11: Changes to prey availability

- Impact 12: Changes to water quality.

223. The realistic worst-case scenario on which the assessments are based is outlined in **Table 12.14**.

12.7.1 Impact 1: Effects due to Underwater Noise during Foundation Installation (Piling)

224. There is the potential for impact piling to be used to install jacket piles for the OSP. Impact piling is a source of high-level underwater noise. Underwater noise can cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) effects on marine mammals and marine turtles.

225. It should be noted that while the potential for impact piling represents the worst-case in terms of underwater noise effects to marine mammals (and marine turtles), there is the potential that no piling will be needed for the construction of the Offshore Project (i.e. if no OSP was required, or if impact piling was not required to install either the OSP or the mooring anchors). Other foundation options are considered within the underwater noise modelling, and assessed where appropriate in the following sections (e.g. suction piles or drag embedment anchors, assessed in **Section 12.7.3**).

226. The high peak pressure sound levels have the potential to cause death or physical injury to any marine mammal and marine turtle (Richardson *et al.*, 1995) that is close to the source of piling, with any severe injury potentially leading to death, if no adequate mitigation is in place. High exposure levels from underwater noise sources can cause auditory injury or hearing impairment taking the form of a permanent loss of hearing sensitivity (PTS) or a temporary loss in hearing sensitivity (TTS).

227. The potential effect of underwater noise will depend on a number of factors which include, but are not limited to:

- The source levels of noise
- Frequency relative to the hearing bandwidth of the animal (dependent upon species)
- Propagation range, which is dependent upon
  - Sediment/sea floor composition
  - Water depth
- Duration of exposure

- Distance of the animal to the source
- Ambient noise levels.

228. The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal but is also influenced by the duration of exposure. The level of effect is a function of the Sound Exposure Level (SEL) that an individual receives as a result of underwater noise. Therefore, an assessment for both peak single strike noise levels (Sound Pressure Level (SPL_{peak})) as well as cumulative exposure levels for the duration of piling (SEL_{cum}) have been undertaken.

229. Underwater noise modelling has been undertaken to determine the potential auditory effect ranges (PTS and TTS), as well as the potential disturbance ranges. **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** provides the full underwater noise modelling report, which has been summarised below.

12.7.1.1 Magnitude of Effect

12.7.1.1.1 Potential for Effect from Permanent Injury (Auditory)

230. PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy applied during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

231. Assessments are based on high marine mammal and marine turtle sensitivity to PTS (**Section 12.7.1.1**).

12.7.1.1.1.1 Magnitude of Permanent Injury (Auditory) from a Single Strike at Maximum Hammer Energy

232. The maximum predicted effect range for instantaneous PTS (SPL_{peak}) from a single strike of the maximum hammer energy, without any mitigation, is up to 0.57km for harbour porpoise for OSP jacket piles with a maximum hammer energy of 2,500kJ, and up to 0.26km for harbour porpoise for mooring pin piles with a maximum hammer energy of 800kJ (**Table 12.49**).

233. An assessment of the maximum number of marine mammals for each species that could be at risk of instantaneous PTS from the single strike from maximum energy without any mitigation, based on worst-case, is presented in **Table 12.45**. This assessment is based on the number of each species that could be at risk of the

effect based on the known densities in the area, and the proportion of that number of individuals of the relevant reference populations for each species.

234. The magnitude of the potential effect without any mitigation is assessed as **low to negligible** for harbour porpoise with 0.01% or less of the relevant reference populations, and **negligible** for bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal, with 0.001% or less of the relevant reference populations anticipated to be exposed to any permanent effect (**Table 12.45**).

235. For leatherback turtles, the maximum potential effect range, for mortality or potential mortal injury, of a single strike from piling is 0.26km (with an effect area of $0.21km^2$) (**Table 12.51**). While there is a possibility of leatherback turtles to be present within the Offshore Project area, given the low number in the area, it is considered highly unlikely that any would be present within the potential effect area. Therefore, the magnitude without any mitigation is assessed as **negligible**.

Table 12.35 Maximum Number of Individuals (and % of Reference Population) that could be at Risk of PTS from a Single Strike at the Maximum Energy for OSP Jacket Pile and Mooring Pin Pile Without Mitigation, based on worst-case scenarios and Effect Areas as Presented in Table 12.49.

Species	OSP Jacket Pile With Maximum Hammer Energy of 2,500kJ		Mooring Pin Pile with Maximum Hammer Energy of 800kJ	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)
Harbour porpoise	0.92 (0.0015% of CIS MU based on the APEM summer density estimate) 0.59 (0.001% of CIS MU based on the APEM annual density estimate)	**Low to Negligible**	0.19 (0.0003% of CIS MU based on the APEM summer density estimate) 0.13 (0.0002% of CIS MU based on the APEM annual density estimate)	**Negligible**
Bottlenose dolphin	0.0006 (0.00006% of OCSW MU)	**Negligible**	0.0006 (0.000006% of OCSW MU)	**Negligible**
Common dolphin	0.04 (0.00004% of CGNS MU based on the APEM winter density estimate) 0.05 (0.00005%of CGNS MU based on the APEM annual density estimate)	**Negligible**	0.05 (0.00004% of CGNS MU based on the APEM winter density estimate) 0.04 (0.00005% of CGNS MU based on the APEM annual density estimate)	**Negligible**
Striped dolphin	0.007 (0.00003% of CGNS MU)	**Negligible**	0.007 (0.00003% of reference population)	**Negligible**

Species	OSP Jacket Pile With Maximum Hammer Energy of 2,500kJ		Mooring Pin Pile with Maximum Hammer Energy of 800kJ	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)
Minke whale	0.0001 (0.000001% of CGNS MU)	**Negligible**	0.0001 (0.000001%of CGNS MU)	**Negligible**
Grey seal	0.00005 (0.000002% of the SW MU; 0.0000004% of the combined MU)	**Negligible**	0.00005 (0.000002% of the SW MU; 0.0000004% of the combined MU)	**Negligible**

12.7.1.1.1.2 Magnitude of Permanent Injury (Auditory) from Cumulative Exposure

237. The SEL_{cum} is a measure of the total received noise over the whole piling operation. The SEL_{cum} range indicates the distance from the piling location that if the receptor were to start fleeing in a straight line from the noise source. Starting at a range closer than the modelled range, it would receive a noise exposure in excess of the criteria threshold, and if the receptor were to start fleeing from a range further than the modelled range it would receive a noise exposure below the criteria threshold.

238. The maximum predicted effect range for PTS from cumulative exposure (SEL_{cum}), during the installation of up to four OSP jacket piles in a 24-hour period, without any mitigation, is up to 4.6km for harbour porpoise and 12km for minke whale. For the installation of up to eight mooring pin piles in a 24-hour period, without any mitigation, the maximum PTS (SEL_{cum}) range is 6km for harbour porpoise, and 2.1km for minke whale. This can be seen as a worst-case as the other marine mammals show a smaller impact range (**Table 12.49**).

239. An assessment of the maximum number of marine mammals and marine turtles for each species that could be at risk of PTS from cumulative exposure during installation of multiple OSP jacket pile or mooring pin piles, without any mitigation, is presented in **Table 12.46**.

240. The magnitude of the potential effect for the installation of up to four OSP jacket piles in a 24 hour period, without any mitigation, is assessed as **medium** for harbour porpoise and minke whale, with 0.1% or less of the relevant reference populations affected, and **negligible** for bottlenose dolphin, common dolphin, striped dolphin and grey seal, with 0.001% or less of the relevant reference populations anticipated to be exposed to any permanent effect (**Table 12.46**).

241. The magnitude of the potential effect for up to eight mooring pin pile installations in a 24 hour period, without any mitigation, is assessed as **medium** for harbour porpoise with 0.1% or less of the relevant reference populations affected, **low** for minke whale with 0.01% or less of the relevant reference populations effected, and **negligible** for bottlenose dolphin, common dolphin, striped dolphin and grey seal (**Table 12.46**).

242. For leatherback turtles, the maximum potential effect range, for mortality or potential mortal injury, from the installation of up to four OSP jacket piles is 6.0km (with an effect area of 110.0km^2), and the maximum potential effect range for the installation of up to eight mooring pin piles is 2.4km (**Table 12.51**). While there is a possibility of leatherback turtles to be present within the Offshore Project area,

given the low number in the area, it is unlikely that a significant number would be present within the potential effect areas. Therefore, the magnitude without any mitigation, is assessed as **low**.

243. It is important to note that assessment for PTS from cumulative exposure is highly precautionary, as the maximum hammer energy is only likely to be required at a few of the piling installation locations and for shorter periods of time than has been modelled and assessed.

Table 12.36 Maximum Number of Individuals (and % of Reference Population) that could be at risk of PTS from Cumulative Exposure (SEL_{cum}) during Installation of Multiple OSP Jacket Pile or Mooring Pin Piles, Without Mitigation, based on Worst-Case Scenarios.

Species	Installation of up to four OSP Jacket Piles		Installation of up to eight Mooring Pin Piles	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)
Harbour porpoise	50.5 (0.08% of CIS MU based on the APEM summer density estimate) 32.7 (0.05% of CIS MU based on the APEM annual density estimate)	**Medium**	11.0 (0.011% of CIS MU based on the APEM summer density estimate) 7.1 (0.018% of CIS MU based on the APEM annual density estimate)	**Medium**
Bottlenose dolphin	0.006 (0.00006% of OCSW MU)	**Negligible**	0.006 (0.00006% of OCSW MU)	**Negligible**
Common dolphin	0.38 (0.0004% of CGNS MU based on the APEM winter density estimate) 0.52 (0.0005%of CGNS MU based on the APEM annual density estimate)	**Negligible**	0.38 (0.0004% of CGNS MU based on the APEM winter density estimate) 0.52 (0.0005%of CGNS MU based on the APEM annual density estimate)	**Negligible**
Striped dolphin	0.07 (0.0003% of CGNS MU)	**Negligible**	0.07 (0.0003% of reference population)	**Negligible**
Minke whale	3.5	**Medium**	1.0	**Low**

Species	Installation of up to four OSP Jacket Piles		Installation of up to eight Mooring Pin Piles	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Permanent Effect)
	(0.017% of CGNS MU)		(0.005% of CGNS MU)	
Grey seal	0.0005 (0.00002% of the SW MU; 0.000004% of the combined MU)	**Negligible**	0.0005 (0.00002% of the SW MU; 0.000004% of the combined MU)	**Negligible**

12.7.1.1.2 Potential for Effect from Temporary Injury (Auditory)

244. TTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy during piling. TTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

245. The underwater noise modelling results for the maximum predicted ranges (and areas) for TTS in marine mammals are presented in **Table 12.50**.

12.7.1.1.2.1 Magnitude of Temporary Injury (Auditory) from a Single Strike at Maximum Hammer Energy

246. The maximum predicted effect range for TTS from a single strike of a OSP jacket pile with maximum hammer energy, without any mitigation, is up to 1.4km for harbour porpoise, and the maximum effect range for TTS from a single strike of a mooring pin pile is 0.68km for harbour porpoise. All other marine mammal species assessed have a predicted effect range for TTS from a single strike of a OSP jacket pile with maximum hammer energy, without any mitigation, to be below 120m. From a single strike of a mooring pin pile, this maximum distance for all other marine mammal species assessed is below 50m (**Table 12.50**).

247. An assessment of the maximum number of marine mammals for each species that could be at risk of TTS, from a single strike of either a OSP jacket pile or mooring pin pile with maximum hammer energy, without any mitigation, based on worst-case, is presented in **Table 12.47**.

248. The magnitude of the potential effect without any mitigation is assessed as **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal, with 1% or less of the relevant reference populations anticipated to be exposed to any temporary effect (**Table 12.47**).

249. For leatherback turtles, due to piling, there is a high risk of recoverable injury and/or TTS in the near field (<100m), and a low risk in the intermediate (>100m and <1,000m) and far fields (>1,000m) (**Table 12.48**). Within the high risk area of less than 100m, given the low number of leatherback turtles in the area, it is highly unlikely that any individuals would be present. Within the low risk of effect area (of more than 100m), there is a low risk of recoverable injury/TTS, and it is unlikely that there would be significant presence of the species. Therefore, given the low risk of presence in the high risk area, as well as the low risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

Table 12.37 Maximum Number of Individuals (and % of Reference Population) that could be at risk of TTS from a Single Strike (SPL_{peak}) of OSP Jacket Pile or Mooring Pin Pile at Maximum Hammer Energy, Without Mitigation, based on Worst-Case Scenarios

Species	OSP Jacket Pile with Maximum Hammer Energy of 2,500kJ		Mooring Pin Pile with Maximum Hammer Energy of 800kJ	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Harbour porpoise	6.0 (0.01% of CIS MU based on the APEM summer density estimate) 3.9 (0.006% of CIS MU based on the APEM annual density estimate)	**Negligible**	1.3 (0.002% of CIS MU based on the APEM summer density estimate) 0.83 (0.001% of CIS MU based on the APEM annual density estimate)	**Negligible**
Bottlenose dolphin	0.0005 (0.000004% of OCSW MU)	**Negligible**	0.0005 (0.000004% of OCSW MU)	**Negligible**
Common dolphin	0.04 (0.00004% of CGNS MU based on the APEM winter density estimate) 0.03 (0.00003% of CGNS MU based on the APEM annual density estimate)	**Negligible**	0.04 (0.00004% of CGNS MU based on the APEM winter density estimate) 0.03 (0.00003% of CGNS MU based on the APEM annual density estimate)	**Negligible**
Striped dolphin	0.005 (0.00003% of CGNS MU)	**Negligible**	0.005 (0.00003% of reference population)	**Negligible**
Minke whale	0.0004 (0.000002% of CGNS MU)	**Negligible**	0.0001 (0.0000004% of CGNS MU)	**Negligible**
Grey seal	0.0002 (0.00001% of the SW MU; 0.000002% of the combined MU)	**Negligible**	0.00004 (0.000002% of the SW MU; 0.0000003% of the combined MU)	**Negligible**

12.7.1.1.2.2 Magnitude of Temporary Injury (Auditory) from Cumulative Exposure

250. The maximum predicted effect range for TTS from the cumulative exposure (SEL_{cum}) during installation of up to four OSP jacket piles is up to 37km for harbour porpoise and 54km for minke whale, and for the installation of up to eight mooring pin piles is up to 27km for harbour porpoise, and 41km for minke whale (**Table 12.50**).

251. An assessment of the maximum number of marine mammals for each species that could be at risk of TTS from cumulative exposure during installation of multiple OSP jacket pile or mooring pin pile, without any mitigation, based on worst-case, is presented in **Table 12.48**.

252. The magnitude of the potential effect, without any mitigation, for OSP jacket piles and mooring pin piles is assessed as **low** for harbour porpoise, and **negligible** for bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal (**Table 12.48**).

253. The potential magnitude of effect for leatherback turtles would be **negligible**, as described in **Section 12.7.1.2.3** above.

Table 12.38 Maximum Number of Individuals (and % of Reference Population) that could be at risk of TTS from Cumulative Exposure (SEL_{cum}) during Installation of OSP Jacket Pile or Mooring Pin Piles Without Mitigation, based on Worst-Case Scenarios

Species	Installation of up to four OSP Jacket Piles		Installation of up to eight Mooring Pin Piles	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Harbour porpoise	2,754.0 (4.4% of CIS MU based on the APEM summer density estimate) 1,782.0 (2.9% of CIS MU based on the APEM annual density estimate)	**Low**	1,652.4 (2.6% of CIS MU based on the APEM summer density estimate) 1,069.2 (1.7% of CIS MU based on the APEM annual density estimate)	**Low**
Bottlenose dolphin	0.006 (0.00006% of OCSW MU)	**Negligible**	0.006 (0.00006% of OCSW MU)	**Negligible**
Common dolphin	0.52 (0.0005% of CGNS MU based on the APEM winter density estimate) 0.38 (0.0004% of CGNS MU based on the APEM annual density estimate)	**Negligible**	0.52 (0.0005% of CGNS MU based on the APEM winter density estimate) 0.38 (0.0004% of CGNS MU based on the APEM annual density estimate)	**Negligible**
Striped dolphin	0.07 (0.0003% of CGNS MU)	**Negligible**	0.07 (0.0003% of reference population)	**Negligible**
Minke whale	60.5 (0.30% of CGNS MU)	**Negligible**	41.4 (0.21% of CGNS MU)	**Negligible**
Grey seal	2.9 (0.15% of the SW MU; 0.023% of the combined MU)	**Negligible**	1.4 (0.07% of the SW MU; 0.01% of the combined MU)	**Negligible**

12.7.1.1.3 Potential for Disturbance Effect

254. The range of possible behavioural reactions that may occur as a result of exposure to noise include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment and, in severe cases, panic, or stranding, sometimes resulting in injury or death (Southall *et al.,* 2007).

255. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals, therefore it is not possible to conduct underwater noise modelling to predict effect ranges.

256. For marine mammals a fleeing response is assumed to occur at the same noise levels as TTS. Therefore, the potential effect range and areas for TTS, as shown in **Table 12.50**, with the estimated number of marine mammals and percentage of reference populations presented in **Table 12.48** providing an indication of the effect level of a possible fleeing response.

257. The potential disturbance of marine mammals from underwater during piling has been assessed based on:

- Behavioural response
- Effective Deterrence Radius (EDR) approach for harbour porpoise
- Disturbance during ADD activation.

12.7.1.1.3.1 Behavioural Response of Harbour Porpoise to Piling

258. The Gescha 2 study (Effects of noise-mitigated offshore pile driving on harbour porpoise abundance in the German Bight 2014-2016; Rose *et al.,* 2019) analysed the effect from the construction of 11 Offshore Windfarms (OWFs) in Germany on harbour porpoise in the German North Sea and adjacent Dutch waters, from 2014 to 2016. This study also included analysis of previously completed surveys within the Gescha 1 study, which studied the effect from the construction of eight German OWFs from 2009 to 2013. The study involved the deployment of Cetacean Porpoise Detectors (CPODs) and digital aerial surveys in order to monitor harbour porpoise presence and abundance during the construction of these projects, alongside the measurement of noise levels associated with piling at both 750m and 1,500m from source. The piling activities monitored in this study were mostly undertaken with noise abatement systems in order to reduce disturbance effects on harbour porpoise.

259. The Gescha 2 study (Rose *et al.,* 2019) found that noise levels recorded during piling were predominantly below the limit of 160dB at 750m (the German Federal Maritime and Hydrographic Agency (BSH) mandatory noise limit for German waters), and were 9dB lower than the noise levels recorded during the Gescha 1 study, due to advancement in noise abatement methods. The study also found that noise levels were 15dB less using noise abatement than for noise levels from unmitigated piling. It was expected that the improved efficiency of noise abatement for piling, and therefore the overall reduced noise levels, would lead to a reduction in disturbance effects on harbour porpoise, however, this was not the case.

260. The range of disturbance effect of harbour porpoise to piling within the Gescha 2 study (Rose *et al.,* 2019) was 17km (Standard Deviation (SD) 15-19km), and the duration of disturbance (i.e. the time it took for harbour porpoise to return to baseline levels) was between 28 and 48 hours, as shown by CPOD data, and the effect range was found to be between 11.4 and 19.5km based on aerial data (at least 12 hours after piling) (Rose *et al.,* 2019). These results are similar to those reported in the Gescha 1 study (with a disturbance range of 15km (SD 14-16km) and duration of disturbance of 25 to 30 hours), which showed higher piling noise levels (Rose *et al.,* 2019). This suggests that the noise level of the piling is not the only determining factor when discussing the potential for disturbance.

261. Analysis of the CPOD data collected in the Gescha 2 study (Rose *et al.,* 2019) indicated that there is no correlation between noise levels received and the range at which harbour porpoise become disturbed, for noise that is below 165dB at 750m from source. This could be due to individuals maintaining a certain distance from noisy activities, irrespective of the actual noise levels, provided that noise level is above a certain threshold for that individual (Rose *et al.,* 2019). It should be noted however that this study recorded noise levels up to 20kHz only, and therefore there may be higher frequency noise associated with piling that these results do not take into account.

262. A reduction in harbour porpoise presence was seen for all wind farms, for both the Gescha 1 and 2 studies, up to 24 hours prior to any noisy activity occurring, which could be due to the increased vessel activity at the pile location prior to piling taking place (Rose *et al.,* 2019). However, the displacement during pile driving was noted to be larger than for the period prior to piling. In Gescha 2, a decrease in detection rates was found in the three hours prior to piling activity at a distance up to 15km from the piling location, with no difference in detection rates observed at a distance of 25km (Rose *et al.,* 2019).

263. A study of harbour porpoise at Horns Rev (Brandt *et al.,* 2011), found that at closer distances (2.5 to 4.8km) there was 100% avoidance. However, this proportion decreased significantly moving away from the pile driving activity, such that at distances of 10.1 to 17.8km, avoidance occurred in 32 to 49% of the population and at 21.2km, the abundance reduced by just 2%. This suggests that an assumption of behavioural displacement of all individuals is unrealistic and that in reality not all individuals would move out of the area.

264. During the piling campaign at Beatrice Offshore Wind Farm in 2017, an array of underwater noise recorders were deployed to determine noise levels associated with the piling campaign, alongside a separate array of acoustic recorders to monitor the presence of harbour porpoise during piling (Graham *et al.,* 2019). Piling at Beatrice comprised of four pin piles at each turbine or sub-station structure, with a 2.2m diameter and a hammer energy of 2,400kJ. The sound levels recorded were then used to determine the sound level at each of the acoustic recorders.

265. This study assumed that a change in the number of harbour porpoise present at each location was based on the number of positive identifications of porpoise vocalisations (Graham *et al.,* 2019). These two data sets (the harbour porpoise presence and the perceived sound level at each location) were then analysed in order to determine any disturbance effects as a result of the piling activities and at what sound level effects are observed. Harbour porpoise presence was measured over a period of 48 hours prior to piling, and continued following the cessation of piling to ensure that any change in porpoise detections could be observed (a total period of 96 hours was recorded for each included piling event, with a total of 17 piling events included within this analysis) (Graham *et al.,* 2019).

266. The results of the study at Beatrice Offshore Wind Farm (Graham *et al.,* 2019) found that at the start of the piling campaign, there was a 50% chance of a harbour porpoise responding to piling activity, within a distance of 7.4km, during the 24 hours following piling. At the middle of the piling campaign, this 50% response distance had reduced to 4.0km, and by the end of the piling had reduced further to 1.3km.

267. The response to audiogram-weighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 54.1dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 60.0dB re 1 1μPa^2s during the middle of the campaign, and to 70.9dB re 1 μPa^2s by the end of the piling activities. Similarly, the response to unweighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 144.3dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 150.0dB re 1

1μPa²s during the middle of the campaign, and to 160.4dB re 1 μPa²s by the end of the piling activities (Graham *et al.,* 2019).

268. Additional comparisons were made through this study (Graham *et al.,* 2019) to assess the difference in harbour porpoise presence where ADDs were used and where they were not, as well as relating to the number of vessels present within 1km of the piling site. A significant difference was observed in the presence of harbour porpoise where ADDs were used compared to where they were not, but only in the short-term (less than 12 hours following piling), and there was no significant difference when considering a longer time period from piling. With 50% response distances for pile locations with ADD use recorded as up to 5.3km (during 12 hours after piling), and up to 0.7km with no ADD in use, in the 12 hours following piling. It should be noted however that only two locations used in the analysis had ADD use, and therefore the sample number in this analysis is small (Graham *et al.,* 2019).

269. Overall, this study has shown that the response of harbour porpoise to piling activities reduces over time, suggesting a habituation effect occurred. In addition, there is some indication that the use of ADDs does reduce the presence of harbour porpoise in the short term. In addition, higher levels of vessel activity increased the potential for a response by harbour porpoise. Harbour porpoise response to piling activity was best explained by the distance from the piling location, or from the received noise levels (taking into account weighting for their hearing) (Graham *et al.,* 2019).

270. During the construction of two Scottish windfarms (Beatrice Offshore Windfarm and Moray East Offshore Windfarm), a set of CPODs were deployed to monitor harbour porpoise presence during construction (Benhemma-Le Gall *et al*., 2021). In addition, the broadband noise levels were recorded and monitored, and vessel AIS data. The purpose of this study was to assess the response of harbour porpoise to both the changes in the baseline noise level due to impact piling at the two wind farms, and due to an increase in vessel activity. Piling at Beatrice was for 2.2m jacket piles. The result of this study was that there was an 8-17% decline in porpoise presence during impact piling and other construction activities, compared to baseline levels (Benhemma-Le Gall *et al*., 2021).

271. An increase in broadband noise levels due to piling led to a significant reduction in porpoise presence. When piling was not occurring, porpoise detections decreased by 17% as the noise levels increased (from 102dB re 1 μPa (SPL) to 159dB re 1 μPa (SPL)) (**Figure 12.24**; Benhemma-Le Gall *et al*., 2021). During piling, porpoise detections decreased by 9% as noise levels increased (from 102dB to 159dB). A

similar reduction in buzzes was also evident; the presence of buzzes can be attributed to foraging behaviours. When piling was not taking place, buzzes decreased by 41.5% as the noise levels increased (from 104dB re 1 µPa (SPL) to 155dB re 1 µPa (SPL)). During piling, porpoise detections decreased by 61.8% as noise levels increased (from 104dB to 155dB re 1 µPa (SPL)) (Benhemma-Le Gall *et al.*, 2021).

272. Harbour porpoise buzz vocalisations increased by 4.2% during Moray East piling compared to the baseline levels. At this point, Beatrice foundations were constructed, and the introduction of hard substrates are likely to have improved the fine-scale habitat for key harbour porpoise prey species, with the potential of increasing prey resources (Benhemma-Le Gall *et al.*, 2021).

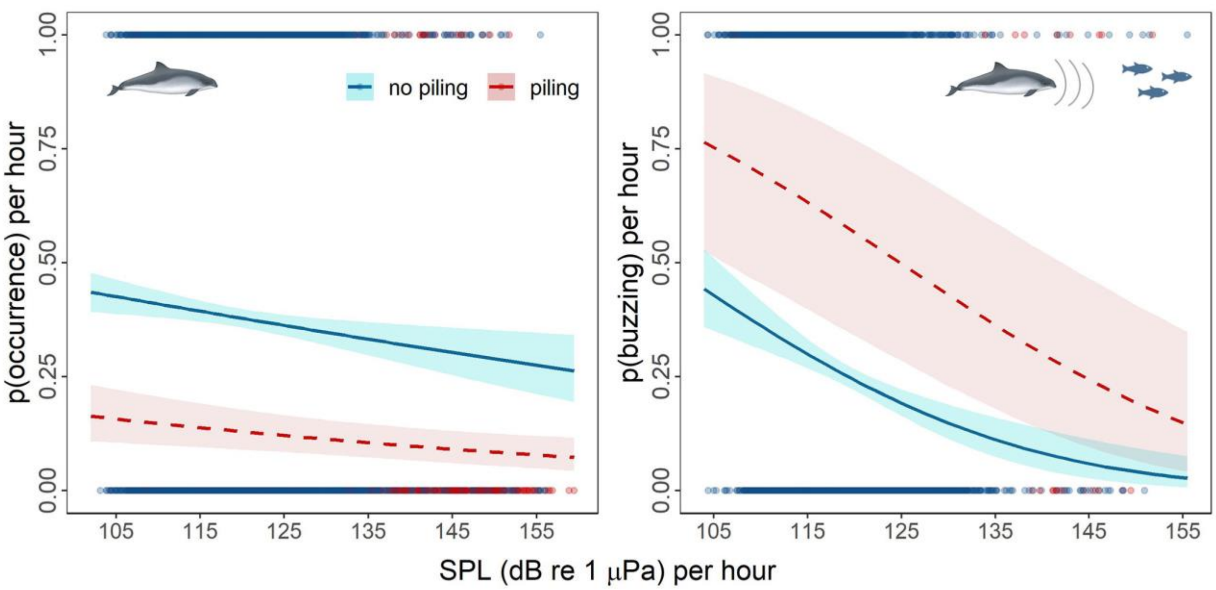

Figure 12.24 [Left] The Probability of Harbour Porpoise Presence in Relation to the SPL (Red = During Piling, Blue = Outside of Piling Time, and [Right] the Probability of Buzzing Activity per Hour in Relation to the SPL (Red = During Piling, Blue = Outside of Piling Time (Benhemma-Le Gall et al., 2021)

12.7.1.1.3.2 Behavioural Response of Dolphins to Piling

273. There is limited information on the behavioural response of any dolphin species to piling.

274. Within the Southall *et al.* (2007) paper, a review of the data available for mid-frequency cetaceans (which include species other than dolphins, such as sperm whale *Physeter macrocephalus* and beluga *Delphinapterus leucas*) indicate that some significant response was observed at a SPL of 120 dB to 130 dB re 1µPa (rms),

although the majority of individuals did not display significant behavioural response until exposed to a level of 170 dB to 180 dB re 1µPa (rms). Other mid-frequency species were observed to have no behavioural response even when exposed to a level of 170 dB to 180 dB re 1µPa (rms). It should be noted that few of the reviewed studies were based on dolphin species.

275. Graham *et al.* (2017) studied the responses of bottlenose dolphins due to both impact and vibration pile driving noise during harbour construction works in northeast Scotland. The study used passive acoustic monitoring devices to record cetacean activity, and noise recorders to measure and predict received noise levels. Local abundance and patterns of occurrence of bottlenose dolphins were also compared with a five-year baseline. The median peak-to-peak source level estimated for impact piling was 240 dB re 1 µPa (single-pulse SEL 198 dB re 1 µPa^{2}s), and the rms source level for vibration piling was 192 dB re 1 µPa (Graham *et al.*, 2017).

276. The results of the study found that bottlenose dolphin were not excluded from sites in the vicinity of impact piling or vibration piling; nevertheless, some small effects were detected, where bottlenose dolphins spent a reduced period of time in the vicinity of construction works during both impact and vibration piling (Graham *et al.*, 2017). Dolphins generally showed a weak behavioural response to impact piling, reducing the amount of time they spend around the construction activity during piling (Graham *et al.*, 2017). Observed fine-scale behavioural responses by dolphins during this study to piling occurred at predicted received single-pulse SEL values of between 104 and 136.2 dB re 1 µPa^2 s for impact piling (Graham *et al.*, 2017).

277. During the Beatrice wind farm piling campaign in 2017, dolphin detections decreased by 50% in the *Impact Areas* (minimum of 53km from the piling site), and decreased by 14% in the *Reference Area* (minimum of 80km from the piling site), compared to baseline years (Fernandez-Betelu *et al.*, 2021). When impact piling was conducted at Moray East wind farm in 2019, no significant difference in dolphin detections between the study areas (*Impact Area* at a minimum of 45km from the piling site; *Reference Area* at a minimum of 78km from the piling site) was found in comparison to baseline years (Fernandez-Betelu *et al.*, 2021).

278. The southern coast of the Moray Firth is the closest area to the offshore activities within this bottlenose dolphin population's range, with piling at Beatrice is 50–70km from the studied population, and Moray East 40–70 km from the population. The analyses showed that dolphins continued using the southern coast of the Moray Firth during the seismic survey and impact pile-driving (and therefore the species was not significantly affected at this distance of 40-70km) (Fernandez-Betelu *et al.*,

2021). While displacement distances are available for other marine mammal species (such as harbour porpoise), there are no such studies conducted for bottlenose dolphins. However, as dolphins are generally less sensitive than harbour porpoises to underwater noise, shorter ranges of displacement would be expected (Fernandez-Betelu *et al.*, 2021).

12.7.1.1.3.3 Behavioural Response of Minke Whale to Piling

279. There is limited information on the behavioural response of minke whale to piling.

280. Southall *et al.* (2007) recommended that the most appropriate way to assess the disturbance effect of a noise source on marine mammals is the use of empirical studies. The same paper presented a severity scale to apply to observed behavioural responses, and subsequent JNCC guidance indicates that a score of five or more on this behavioural response severity scale could be significant. A score of five relates to extensive changes in swim speed and direction, or dive pattern, but no avoidance of the noise source, or a moderate shift in distributions, a change in group size, aggregations and separation distances, and a prolonged cessation in vocal behaviours. The higher the behavioural response score, the more likely the associated noise source is to cause a significant disturbance effect.

281. Southall *et al.* (2007) includes a summary of the observed behavioural responses from noise sources. However, the majority of the studies included were based on the responses to seismic surveys. These studies contain some relevant information for whale species behavioural responses.

282. Whale species were typically observed to respond significantly at a received level of 150dB to 160dB re 1 µPa (rms) (Malme *et al.,* 1983, 1984; Richardson *et al.,* 1986; Ljungblad *et al.,* 1988; Todd *et al.,* 1996; McCauley *et al.,* 1998), with behavioural changes including:

   - Visible startle responses
   - Extended cessation or modification of vocal behaviour
   - Brief cessation of reproductive behaviour
   - Brief and minor separation of females and dependent offspring.

283. During migration periods, avoidance behaviours of bowhead whales, *Balaena mysticetus,* were observed at distances of more than 20km from seismic sources (Koski & Johnson, 1987; Richardson *et al.,* 1999). However, during foraging periods, bowhead whales did not respond at greater than 6km from the source (Richardson *et al.,* 1986; Miller *et al.,* 2005). Richardson *et al.* (1986) concluded that due to a

single airgun, avoidance and behavioural response was observed once noise levels reached more than 160dB re 1 µPa.

284. For a migrating bowhead whale study, most individuals avoided a seismic survey source at distances of up to 20km (the seismic surveys used airgun arrays of up to 16 guns, and total volume of 560 to 1,500 cu. in.), with significantly reduced bowhead whale presence between 20 and 30km from the source, with estimated received noise levels of 120 to 130dB re 1 µPa ($_{rms}$) at that distance (Richardson *et al.,* 1999).

285. Observations of behavioural changes in baleen whale species have shown avoidance reactions of up to 10km for a seismic survey, with a noise source level of 143dB 1 µPa (peak to peak) (Macdonald *et al.,* 1995).

286. Dose-response functions for avoidance responses of grey whales *Eschrichtius robustus* to both continuous and impulsive noises were developed for vessel noise and seismic air guns by Malme (1984). For continuous noise sources, avoidance of minke whale started at a received level of 110-119dB re 1 µPa (L_{peak}, $_{rms}$), with more than 80% of individuals responding at 130dB re 1 µPa (L_{peak}, $_{rms}$), and 50% at 120dBdB re 1 µPa (L_{peak}, $_{rms}$).

287. Higher noise levels were required for an avoidance response due to the impulsive noise source (seismic airguns), with 10% of migrating grey whales responding at 164dB re 1 µPa (L_{peak}, $_{rms}$), 50% at 170dB re 1 µPa (L_{peak}, $_{rms}$), and 90% at 180dB re 1 µPa (L_{peak}, $_{rms}$) (Malme, 1984 *cited in* Tyack & Thomas, 2019). A secondary study (Malme, 1987) using 100 cu. in. air guns (with a source level of 226dB re 1µPa) for foraging grey whales found a response level (where individuals would cease foraging activities) of 50% at 173dB re 1 µPa (L_{peak}, $_{rms}$), and 10% at 163dB re 1 µPa (L_{peak}, $_{rms}$).

12.7.1.1.3.4 Behavioural Response of Seals to Piling

288. There is limited data on seal species presented within the Southall *et al.*, 2007 paper. One included study was for ringed seals *Pusa hispida*, bearded seals *Erignathus barbatus,* and spotted seals *Phoca largha* (Harris *et al.,* 2001), which found the onset of a significant response at a received noise level of 160 to 170dB re 1 µPa (rms), although a larger proportion of individuals showed no response at noise levels of up to 180dB re 1 µPa (rms). Only at much higher sound pressure levels (190 to 200dB re 1 µPa (rms)) did significant numbers of seals exhibit a significant disturbance response.

289. Tagged harbour seals in the Wash indicated that seals were not excluded from the vicinity of the Lincs windfarm during the overall construction phase but that there was clear evidence of avoidance during pile driving, with significantly reduced levels of seal activity at ranges of up to 25km from piling sites (Russell *et al.,* 2016). However, within two hours of cessation of piling, seal distribution returned to pre-piling levels (Russell *et al.,* 2016).

12.7.1.1.3.5 Disturbance / Displacement Based on Known Deterrence Ranges

290. The current advice from the SNCBs is that a potential disturbance range (EDR) of 26km (potential disturbance area of up to 2,124km^2) around piling locations for monopiles without noise abatement, and 15km (potential disturbance area of up to 707km^2) for pin piles, with and without noise abatement, is used to assess the area that harbour porpoise may be disturbed in designated SACs in England, Wales and Northern Ireland (JNCC *et al.*, 2020). This approach has been used to provide an assessment of an EDRs for the piling.

291. Not all harbour porpoise within the EDRs will be disturbed, however as worst-case scenario, 100% disturbance of harbour porpoise in the areas has been assumed.

292. The estimated number of harbour porpoise and percentage of the CIS MU reference population that could be disturbed as a result of underwater noise during piling at the Offshore Project is presented in **Table 12.39**, based on the 15km EDR for pin piles.

293. The magnitude of the potential effect is assessed as **low** for the 15km EDR at the Offshore Project, based on the APEM summer density estimate, with 1-5% of CIS MU anticipated to be temporarily disturbed (**Table 12.39**).

Table 12.39 Maximum Number of Harbour Porpoise (and % of Reference Population) that could be at Disturbed During Piling at the Offshore Project based on EDR

Species	15km EDR (707km^2) for Pin Piles	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Harbour porpoise	649.0 (1.04% of CIS MU based on the APEM summer density estimate) 420.0 (0.67% of CIS MU based on the APEM annual density estimate)	Low to Negligible

294. There is very little information on the potential disturbance ranges of minke whale due to impact piling. As noted above, baleen whale species (bowhead whale) have been recorded to have a deterrence distance of up to 30km from a seismic source (Richardson *et al.,* 1999). While this was for a seismic survey rather than impact piling, it is an impulsive noise source with a high source level. This 30km potential avoidance range is smaller than the modelled TTS / fleeing response range for minke whale of 54km for cumulative OSP jacket pile installation, or 41km for cumulative mooring pin pile installation (**Table 12.50**).

295. Therefore, in the absence of any further information on the potential for disturbance of minke whale from piling, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect, and represents the worst-case for currently available information on the potential disturbance range of minke whales (**Table 12.39**). There is therefore the potential for a **negligible** magnitude of effect for minke whale from the disturbance of piling.

296. For dolphin species, there is very little information on the potential disturbance ranges due to impact piling (or any impulsive noise source). Therefore, in the absence of any further information, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect for all dolphin species, and represents the worst-case for currently available information (**Table 12.39**). There is therefore the potential for a **negligible** magnitude of effect for all dolphin species, due to the potential disturbance effect of piling.

297. Regarding both grey and harbour seal, as noted above, a study has shown that harbour seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) (Russell *et al.,* 2016). This range has been used to determine the number of grey seal that may be disturbed during piling at the Offshore Project (**Table 12.40**).

298. The magnitude of the potential effect is assessed as **negligible** for grey seal, with less than 1% of the reference population anticipated to be temporarily disturbed (**Table 12.40**).

Table 12.40 Maximum Number of Grey Seal (and % of Reference Population) that could be Disturbed During Piling at the Offshore Project based on their Known Disturbance Ranges

Species	Known Disturbance Range for Piling	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Grey seal	25km (Russell *et al.*, 2016)	9.5 (0.48% of SW MU; 0.08% of the combined MU)	**Negligible**

299. For marine turtles, under the Popper *et al.*, (2014) criteria for piling, there is a high risk of masking / behavioural response in the near field (<100m), a moderate risk in the intermediate field (>100m and <1,000m), and a low risk in the far field (>1,000m) (**Table 12.48**).

300. Within the high risk area of less than 100m, given the low number of leatherback turtles in the area, it is highly unlikely that any individuals would be present, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. Within the moderate risk of effect area (of between 100m and 1,000m), it remains highly unlikely that any individual would be present, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. Within the low risk of masking/behavioural response effect area (of more than 1,000m), it is unlikely that any individual would be present, and therefore unlikely that any individual would be exposed to a potential masking/behavioural response effect.

301. Therefore, given the very low potential for presence in the high and moderate risk of masking and behavioural response area, as well as low potential for presence in the low risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

12.7.1.1.3.6 Potential for Disturbance during ADD activation

302. The assessments of the potential disturbance during any ADD activation is indicative only, as the final requirements for mitigation will be confirmed in the Draft MMMP (**Appendix 12.C: Draft MMMP**), under consultation with the relevant regulator and SNCBs.

303. As outlined in **Section 12.4.4**, mitigation to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing.

304. The maximum predicted PTS effect ranges are 4.6km for harbour porpoise and 12km for minke whale, based on worst-case for cumulative exposure (SEL_{cum}) during

the installation of up to four OSP jacket piles. The maximum predicted PTS SEL_{cum} effect ranges for mooring pin piles is 2.1km for harbour porpoise, and 6.0km for minke whale. The rest of the marine mammals assessed had a maximum predicted PTS effect range of 50m or less and 100m or less for cumulative exposure (SEL_{cum}) based on the worst-case (**Table 12.49**).

305. Based on a precautionary swim speed of 1.5m/s (Otani *et al.*, 2000), the ADD would need to be activated for a minimum of 52 minutes to ensure harbour porpoise were beyond the maximum 4.6km PTS effect range for OSP jacket piles, or 24 minutes period for mooring pin piles. Based on a swim speed of 3.25m/s for minke whale (Blix and Folkow, 1995), the ADD would need to be activated for a minimum of 62 minutes to ensure minke whale are outwith the predicted PTS effect range for OSP jacket piles, or 31 minutes for mooring pin piles.

306. Therefore, the assessments for disturbance during ADD activation are based on 62 minute ADD activation for OSP jacket piles, and 31 minutes for mooring pin piles.

307. During the 62 minute ADD activation for OSP jacket piles, it is predicted that harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, and grey seal would move at least 5.58km from the ADD location (based on a precautionary swim speed of 1.5m/s (Otani *et al.*, 2000)), resulting in a potential disturbance area of 97.82km^2. Minke whale would move at least 12.09km from the ADD location (based on a precautionary swimming speed of 3.25m/s (Blix and Folkow, 1995)), resulting in a potential disturbance area of 459.20km^2.

308. The magnitude of the potential effect is assessed as **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale and grey seal, with 1% or less of the relevant reference populations anticipated to be temporarily disturbed (see **Table 12.41**).

309. For all dolphin species, the potential for disturbance from the use of ADD prior to piling is significantly higher (**Table 12.41**) than the potential for disturbance from piling (**Table 12.38**). While it is not a significant effect for any species, with a negligible magnitude in all cases, the balance of potential for disturbance to these species, against the requirement to mitigate against permanent auditory injury, is an important consideration that will be made during the finalisation of the Draft MMMP (**Appendix 12.C**), and submission of EPS licence application, in the post-consent phase. One consideration would be to limit the use of extended ADD activation periods, to either once per 24 hour piling period, and/or to the season of most importance for the species requiring the longest ADD activation time (i.e. minke whale in the summer period).

310. It is not currently known whether ADD activation would have the same effect on leatherback turtle as for marine mammal species (i.e. deterrence). As a worst-case, if it is assumed that ADD activation would cause the same level of behavioural response in leatherback turtles as would be expected from impact piling, then there would be a high risk of masking / behavioural response in the near field (<100m), a moderate risk in the intermediate field (>100m and <1,000m), and a low risk in the far field (>1,000m) (**Table 12.48**), and therefore a magnitude of effect of **negligible** (see **Section 12.7.1.1.3.5** for further detail).

Table 12.41 Maximum Number of Individuals (and % of Reference Population) that could be Disturbed During ADD Activation Prior to Piling

Species	ADD Activation of 62 Minutes for the Installation of up to four OSP Jacket Piles in a 24 Hour Period		ADD Activation of 31 Minutes for the installation of up to eight Mooring Pin Piles in a 24 Hour Period	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Harbour porpoise	89.8 (0.14% of CIS MU based on the APEM summer density estimate) 58.1 (0.09% of CIS MU based on the APEM annual density estimate)	**Negligible**	22.5 (0.04% of CIS MU based on the APEM summer density estimate) 14.5 (0.02% of CIS MU based on the APEM annual density estimate)	**Negligible**
Bottlenose dolphin	5.9 (0.05% of OCSW MU)	**Negligible**	1.5 (0.01% of OCSW MU)	**Negligible**
Common dolphin	511.6 (0.50% of CGNS MU based on the APEM winter density estimate) 374.9 (0.37% of CGNS MU based on the APEM annual density estimate)	**Negligible**	127.9 (0.13% of CGNS MU based on the APEM winter density estimate) 93.7 (0.09% of CGNS MU based on the APEM annual density estimate)	**Negligible**
Striped dolphin	64.0 (0.33% of CGNS MU)	**Negligible**	16.0 (0.08% of reference population)	**Negligible**
Minke whale	5.1 (0.03% of CGNS MU)	**Negligible**	1.3 (0.006% of CGNS MU)	**Negligible**
Grey seal	0.47 (0.02% of the SW MU; 0.004% of the combined MU)	**Negligible**	0.12 (0.006% of the SW MU; 0.001% of the combined MU)	**Negligible**

12.7.1.1.3.7 Duration of Piling and ADD Activation

311. The total duration of the installation campaign for the WTGs and OSP is expected to be a maximum of six months for the Offshore Project (**Table 12.14**). This will include transit of the foundation components in batches to the Windfarm Site and foundation installation, including any piling.

312. Piling would not be constant during the piling phases and construction periods. There will be gaps between the installations of individual piles and there could be time periods when piling is not taking place as piles are brought out to the site. There will also be potential delays for weather or other technical issues. **Table 12.42** summarises the worst-case scenarios for the duration of piling based on the maximum number of WTGs and OSP, number of piles and piling duration to install each pile, including soft-start, ramp-up and ADD activation. Within the six month foundation installation window, up to 6.25 days (up to 1 day for OSP and 5.25 days for WTG pin piles) of active piling and ADD activation may take place.

Table 12.42 Maximum Duration of Piling at the Offshore Project, based on Worst Case Scenarios, Including Soft-Start, Ramp-Up and ADD Activation

Parameter	Number of Piles	Maximum Active Piling Time per Pile	Total Piling Time	ADD Activation	Total Duration
Up to eight WTGs	Up to 48 mooring pin piles (up to six per WTG)	2.21 hours (132.5 minutes) including soft-start and ramp-up	Up to 106 hours (4.42 days) for 48 mooring pin piles	24 hours and 48 minutes for 31 minute ADD activation for all 48 mooring pin piles	Up to 130 hours and 48 minutes (5.5 days) with 31 minute ADD activation for eight WTGs
One OSP	Up to 4 OSP jacket piles	4.5 hours (270 minutes) including soft-start and ramp-up	Up to 18 hours (0.75 days) for four OSP jacket piles	4 hours 8 minutes for 24 minute for 62 minute ADD activation per OSP jacket pile	Up to 22 hours 8 minutes (0.95 days) with 62 minute ADD activation for four OSP jacket piles
Piling of up to 48 mooring pin piles (including soft-start, ramp-up and 31 minute ADD activation) = up to 131 hours (up to 5.5 days); or Piling of up to four OSP jacket piles (including soft-start, ramp-up and 62 minute ADD activation) = up to 23 hours (0.95 days).					

313. The duration of piling is based on a worst-case scenario and a very precautionary approach, and as has been shown at other offshore wind farms, the duration used in the impact assessment can be overestimated. For example, for the installation of monopile foundations at Dudgeon Offshore Wind Farm (DOW) the impact assessment was based on an estimated piling period of 93 days, time to install each monopile was estimated to be up to 4.5 hours and the estimated duration of active piling was 301.5 hours (approximately 13 days). However, the actual total duration of active piling to install the 67 monopiles was 65 hours (approximately 3 days) with the average time for installation per monopile of 71 minutes (DOWL, 2016). Therefore, the actual piling duration was approximately 21% of the predicated maximum piling duration. The piling duration to install the individual monopiles at DOW varied considerably for each location and the worst-case scenario of up to 4.5 hours to install a pile was an accurate assessment of the actual maximum duration (4.35 hours), however the majority of piles were installed in much shorter duration.

314. At DOW the time intervals between the installations of individual monopiles, not including the intervals between groups of monopiles was on average approximately 23 hours. Monopiles were installed in groups of up to three, due to the capacity of the piling vessel, which meant that it could only carry three monopiles and three transition pieces before returning to port to collect the next three monopiles. The intervals between groups of monopiles being installed ranged from approximately 2.5 days to 11 days with an average of approximately four days between the 22 groups of three monopiles (DOWL, 2016).

315. Similar results were also observed for the Beatrice Offshore Wind Farm, where within the ES it was estimated that each pin pile would require 5 hours of active piling time. However, during construction, the total duration of piling ranged from 19 minutes to 2 hours and 45 minutes, with an average duration of 1 hour and 15 minutes per pile (Beatrice Offshore Wind Farm Ltd, 2018).

316. The duration of the exclusion of harbour porpoise could last up to three days following a single piling event if the animal is close to the source. Data presented by Brandt *et al.* (2009, 2011) indicated that harbour porpoise would completely leave the area (indicated by the duration of waiting time between porpoise detections after first piling) for a median time of 16.6 hours, and a maximum of 74.2 hours within 0.5-6km of the noise source. Waiting times did not return to 'normal' until 22.7 hours after piling. At distances of greater than approximately 9km from the noise source there was a much shorter duration of effect; with waiting times returning to 'normal' between one and 2.6 hours after piling ceased. However, at 18-25km there was still a marked effect. Porpoise activity (measured by the

number of minutes per hour in which porpoise were detected expressed as porpoise positive minutes) was significantly lower within approximately 3km of the noise source for 40 hours after piling.

317. A study on the effects of offshore wind farm construction on harbour porpoise within the German North Sea between 2009 and 2013 (Brandt *et al.,* 2016), indicated that the duration of effect after piling was about 20-31 hours within close vicinity of the construction site (up to 2km) and decreased with increasing distance. The study also observed significant decreases in porpoise detections prior to piling at distances of up to 10km, which is thought to relate to increased shipping activity during preparation works. The study concluded that although there were adverse short-term effects (1-2 days in duration) of construction on acoustic porpoise detections, there is currently no indication that harbour porpoises within the German Bight were negatively affected by wind farm construction at the population level (Brandt *et al.,* 2016). It is acknowledged that some of the projects included in this study used noise mitigation techniques.

318. The duration of any potential displacement effect will differ depending on the distance of the individual from the piling activity and the noise level the animal is exposed to. Furthermore, for those individuals that are distant from the activity that do not respond, and therefore are not affected, will continue with their normal behaviour that may involve approaching the wind farm area.

12.7.1.2 Sensitivity of the Receptor

12.7.1.2.1 Auditory Injury

319. All species of cetaceans rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall *et al.*, 2007). As such, sensitivity to PTS from pile driving noise is assessed as high for all cetacean species (**Table 12.43**). However, when considering the effect that any auditory injury has on an individual, the frequency range over which the auditory injury occurs must be considered. PTS would normally only be expected in the critical hearing bands in and around the critical band of the fatiguing sound (Kastelein *et al.,* 2012). Auditory injury resulting from sound sources like piling (where most of the energy occurs at lower frequencies) is unlikely to negatively affect the ability of high-frequency cetaceans to communicate or echo-locate. PTS would not result in an individual being unable to hear but could result in some permanent change to hearing sensitivity.

320. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al.,* 2007), but not for finding prey. Therefore, Thompson *et al.* (2012)

suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. Pinnipeds also have the ability to hold their heads out of the water during exposure to loud noise, and potentially avoid PTS during piling. As such, sensitivity to PTS in harbour and grey seal is expected to be lower than cetacean species such as harbour porpoise, with the individual showing some tolerance to avoid, adapt to or accommodate or recover from the effect (for example, Russell *et al.,* 2016b), but as a precautionary approach they are also considered as having high sensitivity in this assessment (**Table 12.43**).

321. Leatherback hearing sensitivity overlaps with the frequencies and source levels produced by piling (Eckert, 2012). Marine turtles hear through a vertebrate tympanic middle ear path, which is a tympanum connected to facial tissue, an air-filled middle ear cavity, and a connection to the inner ear via a single middle ear bone (Lenhardt *et al*., 1985). There is limited data on the physiological and behavioural effects of noise, with research to date focused on observations of behavioural responses to underwater explosions and seismic airguns. With the current research showing notable behavioural responses, such as erratic swimming and diving behaviour (Deruiter and Doukara, 2012). As a precautionary approach, marine turtles will also be considered as having high sensitivity in this assessment (**Table 12.43**).

322. Any PTS would be permanent and marine mammals within the potential effect area are considered to have very limited capacity to avoid such effects, and be unable to recover from the effects.

323. All marine mammal and marine turtle species are assessed as having medium sensitivity to temporary changes in hearing sensitivity (TTS). Any TTS would be temporary, and individuals would recover from any temporary changes in hearing sensitivity after the noise source has ceased. However, as a precautionary approach, medium sensitivity to TTS assumes an individual has limited capacity to avoid, adapt to, tolerate or recover from the anticipated affect see (**Table 12.43**).

12.7.1.2.2 Behavioural Response

324. Marine mammals and marine turtle may exhibit varying intensities of behavioural response at different noise levels. These include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment. The response can vary due to exposure level, the hearing sensitivity of the individual, context, previous exposure history or habituation, motivation and ambient noise levels (e.g. Southall *et al*., 2007).

325. The response of individuals to a noise stimulus will vary and not all individuals will respond, however, for the purpose of this assessment, it is assumed that at the disturbance range, 100% of the individuals exposed to the noise stimulus will respond and be displaced from the area. Although, it is unlikely that all individuals would be displaced from the potential disturbance area, therefore this a very precautionary approach.

326. The sensitivity of marine mammals and marine turtle to disturbance is considered to be medium in this assessment as a precautionary approach (**Table 12.43**). Marine mammals and marine turtle within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased (**Table 12.6**).

12.7.1.2.3 Summary of Marine Mammal and Marine Turtle Sensitivity to Underwater Noise

327. **Table 12.43** summarises the sensitivity of marine mammal and marine turtle species to underwater noise effects.

Table 12.43 Summary of Marine Mammal and Marine Turtle Sensitivity to Noise Effects

Species	PTS	TTS	Disturbance
Harbour porpoise	High	Medium	Medium
Bottlenose dolphin	High	Medium	Medium
Common dolphin	High	Medium	Medium
Striped dolphin	High	Medium	Medium
Minke whale	High	Medium	Medium
Grey seal	High	Medium	Medium
Leatherback turtle	High	Medium	Medium

12.7.1.3 Underwater Noise Modelling

328. Underwater noise modelling was undertaken by Subacoustech Environmental Ltd (2022) to estimate the noise levels likely to arise during OSP piling and determine the effects on marine mammals and marine turtles using INSPIRE (**Appendix 12.A**). The INSPIRE model is a semi-empirical noise propagation model based on the use of a combination of numerical modelling and actual measured underwater noise data. It is designed to calculate the propagation of noise in shallow, mixed water, typical of both conditions around the UK (see **Appendix 12.A** for further details).

329. The modelling considers a wide array of input parameters, including variations in bathymetry and source frequency content to ensure as detailed results as possible. It should also be noted that the results presented in this assessment are precautionary as the worst-case parameters have been selected for:

- Piling hammer energies
- Soft-start, ramp-up profile and strike rate
- Duration of piling
- Receptor swim speeds.

12.7.1.3.1 Methodology

- Modelling was undertaken at three representative locations; the South-East (SE) corner of the Windfarm Site, giving a worst-case location for the OSP at the closest point to the Bristol Channel Approaches SAC, and mooring anchor locations covering the extents of the Windfarm Site at the North-West (NW) and South-West (SW) corners (**Figure 4-1** in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**). Water depths at the modelling locations range from 71.6m to 75.3m.

12.7.1.3.2 Hammer Energy, Soft-Start and Ramp-Up

330. Two piling scenarios have been modelled covering the potential OSP jacket piles for the OSP foundation and the potential mooring pin piles for the substructure mooring anchors:

- OSP jacket piles – 4.0 m diameter piles, installed using a maximum blow energy of 2,500 kJ, with a maximum of four piles installed in a 24-hour period
- Mooring pin piles – 2.0 m diameter piles, installed using a maximum blow energy of 800 kJ, with a maximum of eight piles installed in a 24-hour period.

331. To determine the potential for PTS or TTS from cumulative SEL_{cum}, the soft-start, ramp-up, hammer energy, total duration and strike rate are taken into account. The soft-start takes place over the first 20 minutes of piling, at a reduced hammer energy (or starting hammer energy) of no more than 400 kJ. Following the soft-start at the starting hammer energy, the hammer energy will increase (ramp-up) to the maximum hammer energy required to safely install the pile. The soft-start and ramp-up parameters used to inform the modelling are provided in **Table 12.44**.

332. As a worst-case scenario it is assumed that 100% maximum hammer energy will be required and applied for the remaining duration of the pile installation. However, maximum hammer energy is only likely to be required at a few of the piling

installation locations and for shorter periods of time. Therefore, the modelling and assessments are based on the worst-case scenario.

333. The soft-start, ramp-up and piling duration used to assess SEL_{cum} for OSP jacket piles and mooring pin piles are summarised in **Table 12.44**.

Table 12.44 Hammer Energy, Ramp-Up and Piling Duration

Parameter	Starting Hammer Energy	Ramp-Up				Maximum Hammer Energy
Jacket Piles						
Jack pile hammer energy (kJ)	400	800	1,200	1,600	2,000	2,500
Number of strikes	200	150	150	150	150	7,350
Strikes per minute	10	15	15	15	15	35
Duration (minutes)	20	10	10	10	10	210 (3 hours and 30 minutes)
Total duration	**8,150 strikes, 4.5 hours per pile / 32,600 strikes, 18 hours for four piles**					
Mooring Pin piles						
Mooring pin piles hammer energy (kJ)	128	256	384	512	640	800
Number of strikes	98	74	74	74	74	3,607
Strikes per minute	10	15	15	15	15	35
Duration (minutes)	9.8	4.9	4.9	4.9	4.9	103.1 (1 hours and 43.1 minutes)
Total duration	**4,001 strikes, 2.21 hours per pile / 32,008 strikes, 17.68 hours for eight piles**					

12.7.1.3.3 Noise Source Levels

334. For impact piling, the INSPIRE model assumes that the noise source (the hammer striking the pile) acts as a single point, as it will appear at a distance. The source level is estimated based on the pile diameter and the blow energy imparted on the pile by the hammer. This is then adjusted based on the length of the pile in contact with the water, which can affect the amount of noise that is transmitted from the pile into its surroundings (further information is provided in **Appendix 12.A**).

335. The unweighted, single strike, SPL_{peak} and SEL_{ss} source levels estimated for impact piling are provided in **Table 12.45**. Due to the deep water considered, and that all piling will occur sub-surface, there is no difference in source level between the two pin pile mooring anchor locations.

Table 12.45 Summary of the Maximum Unweighted SPL_{peak} and SEL_{ss} Source Levels used for Impact Piling Modelling

Source Levels	OSP Jacket Piles	Mooring Pin Piles
Unweighted SPL_{peak}	241.3 dB re 1 μPa @ 1 m	236.4 dB re 1 μPa @ 1 m
Unweighted SEL_{ss}	222.1 dB re 1 $μPa^2s$ @ 1 m	216.4 dB re 1 $μPa^2s$ @ 1 m

12.7.1.3.4 Environmental Conditions

336. The inclusion of measured data for similar offshore piling operations in UK waters, allows the INSPIRE model to intrinsically account for various environmental conditions. This includes the differences that can occur with the temperature and salinity of water as well as the sediment type surrounding the site. Data from the European Marine Observation and Data Network (EMODnet) geology study show that the seabed surrounding the Windfarm Site is generally made up of sand and sandy gravel.

337. Digital bathymetry, also from the EMODnet, has been used for this modelling. Mean tidal depth has been used throughout (**Appendix 12.A**).

12.7.1.3.5 Baseline Noise Levels

338. There is no known available source of background noise data for the Celtic Sea region, some baseline noise data is available from monitoring undertaken from a station installed in the middle of the Burbo Bank Extension, which continuously monitored the ambient noise levels between 23rd March 2016 and 25th April 2016. Although not the Celtic Sea, the noise levels are expected to represent a best estimate of the subsea noise levels in this region prior to the installation of WTGs.

Measurements from Burbo Bank Extension shows that the range of underwater noise levels typically lie, with isolated exceptions, between 95 dB and 130 dB re 1 µPa SPL_{RMS}. Further information on background noise levels is provided in **Appendix 12.A**.

12.7.1.3.6 Thresholds and Criteria

339. Sound measurements underwater are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound.

340. The SPL is normally used to characterise noise and vibration of a continuous nature. The variation in sound pressure can be measured over a specific time period to determine the root mean square (RMS) level of the time varying acoustic pressure, therefore SPL (i.e. SPL_{RMS}) can be considered as a measure of the average unweighted level of the sound over the measurement period.

341. Peak SPLs (SPL_{peak}) are often used to characterise sound transients from impulsive sources, such as percussive impact piling. SPL_{peak} is calculated using the maximum variation of the pressure from positive to zero within the wave. This represents the maximum change in positive pressure (differential pressure from positive to zero) as the transient pressure wave propagates.

342. The SEL sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound source and the duration the sound is present in the acoustic environment (further details are provided in **Appendix 12.A**).

343. SEL_{ss} is the potential SEL from a single strike of the hammer, e.g. one hammer strike at the starting hammer energy or maximum hammer energy applied.

344. SEL_{cum} is the cumulative SEL over the duration of piling including the soft-start, ramp-up and time required to complete the installation of the pile (**Table 12.44**). To determine SEL_{cum} ranges for marine mammals, a fleeing animal model has been used. This assumes that the animal exposed to high noise levels will swim away from the noise source. For this, a constant swimming speed of 3.25m/s has been assumed for minke whale (Blix and Folkow, 1995), and as a precautionary approach for all other species a constant swimming speed of 1.5m/s has been used, based on the average swimming speed for harbour porpoise mother calf pairs (Otani *et al*., 2000). This is considered a 'worst-case' scenario as marine mammals are expected to be able to swim faster.

345. However, leatherback turtles are slower in general than marine mammals, with an average constant swim speed of 0.56 – 0.84m/s (Eckert, 2002). Even though the constant swim speed is lower, turtles will swim away erratically from any known

noise source and so a speed of 1.5m/s is used for the noise calculations, same as the marine mammals (Deruiter and Doukara, 2012).

346. Further details on how SEL_{cum} is modelled is provided in **Appendix 12.A**.

347. The metrics and criteria that have been used to assess the potential effect of underwater noise on marine mammals and marine turtles are based on, at the time of writing, the most up to date publications and recommended guidance.

348. Southall *et al*. (2019), presents unweighted peak criteria (SPL_{peak}) for single strike, weighted sound exposure criteria for single strike (SEL_{ss}) and cumulative (i.e. more than a single sound impulse) weighted sound exposure criteria (SEL_{cum}) for both PTS (where unrecoverable reduction in hearing sensitivity may occur) and TTS (where a temporary reduction in hearing sensitivity may occur).

349. Southall *et al*. (2019), categorises marine mammal species into hearing groups and applies filters to the unweighted noise. This allows for approximating the hearing sensitivities of the species for specific hearing abilities and sensitivities of each group. This provided the weighted SEL criteria, which corrects the sound level based on the sensitivity of the receiver, for example, harbour porpoises are less sensitive to low frequency sound than minke whales. Marine mammal hearing group ranges are summarised in **Table 12.46.**

Table 12.46 Southall et al. (2019) Marine Mammal Hearing Ranges

Species Hearing Group	Generalised Hearing Range
Harbour porpoise **Very high-frequency cetaceans (VHF)**	275Hz to 160kHz
Bottlenose dolphin, common dolphin, and striped dolphin **High-frequency cetaceans (HF)**	150Hz to 160kHz
Minke whale **Low-frequency cetaceans (LF)**	7Hz to 35kHz
Grey seal and harbour seal **Phocid carnivores in water (PCW)**	50Hz to 86kHz

350. Southall *et al.* (2019), also includes criteria based on SPL_{peak}, which are unweighted and do not take species sensitivity into account. It is important to note that they are different criteria and as such they should not be compared directly. All decibel SPL values are referenced to 1μPa and all SEL values are referenced to $1μPa^2s$.

Assessments have been based on the criteria with the greatest predicted effect ranges.

351. Note that the Southall *et al*. (2019) Marine Mammal Noise Exposure Criteria are the same as the National Marine and Fisheries Service (NMFS) (2018) criteria, although Southall *et al*. (2019) renames the species groupings: Medium-Frequency (MF) Cetaceans are now classed as High-Frequency (HF) Cetaceans, and previous HF Cetaceans as Very High Frequency (VHF) Cetaceans.

352. The Popper *et al.* (2014) study provides sound exposure guidelines for marine turtles. The guidance also gives specific criteria (as both unweighted SPL_{peak} and unweighted SEL_{cum} values) for a variety of noise sources. A further set of criteria also exists for turtles, which have not been included as part of this study as they are not expected to be present at the site.

353. The Southall *et al*. (2019) thresholds and criteria used in the assessments are summarised in **Table 12.47**. Popper *et al*. (2014) is summarised in **Table 12.48**.

Table 12.47 Southall et al. (2019) thresholds and Criteria used in the Underwater Noise Modelling and Assessments for Marine Mammals

Species	Species Group	Potential Effect	SPL_{peak} Unweighted (dB re 1 µPa) Impulsive	SEL_{ss} and SEL_{cum} Weighted (dB re 1 $\mu Pa^2 s$)	
				Impulsive	Non-impulsive
Harbour porpoise	Very High Frequency (VHF) cetacean	PTS	202	155	173
		TTS	196	140	153
Bottlenose dolphin, common dolphin, and striped dolphin	High Frequency (HF) cetacean	PTS	230	185	198
		TTS	224	170	178
Minke whale	Low Frequency (LF) cetacean	PTS	219	183	199
		TTS	213	168	179
Grey seal	Phocid carnivores in water (PCW)	PTS	218	185	201
		TTS	212	170	181

Table 12.48 Popper et al. (2014) Thresholds and Criteria used in the Underwater Noise Modelling and Assessments for Marine Turtles from Pile Driving Noise (N = Near-field (tens of metres (<100m), I = Intermediate-field (hundreds of metres (>100m and <1,000m), F = Far-field (thousands of metres (>1,000m))

Species	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Leatherback turtle	>210 dB SEL_{cum} >207 dB SPL_{peak}	N - High	N - High	N - High	N - High
		I – Low	I – Low	I – Moderate	I – Moderate
		F – Low	F – Low	F – Low	F – Low

354. The PTS thresholds are extrapolated from TTS thresholds. These PTS thresholds ultimately are used to indicate the potential number of animals that could be at risk of PTS (e.g. experience permanent hearing sensitivity loss even once exposure to sound ceases or in between successive sounds exposures) as a opposed to the number of animals that could develop TTS (temporary hearing sensitivity loss that will recover completely once exposure to sound ceases or in between successive sounds exposures).

355. The likelihood of individual animals experiencing PTS and TTS is also dependent on the frequency band at which PTS and TTS is predicted to occur and whether that frequency band is in the critical hearing sensitivity band for that species. If PTS or TTS is predicted to occur at a frequency outside the critical hearing band, potential effects will be minimal.

356. Noise sources are categorised as either impulsive or non-impulsive (Southall *et al.*, 2019):

- Impulsive (single or multiple pulsed) - high peak sound pressure, short duration, fast rise-time and broad frequency content at source. Explosives, impact piling and seismic airguns are considered impulsive noise sources

- Non-impulsive - continuous non-pulsed sound. Vessel engines, sonars, vibro-piling, drilling and other low-level continuous noises are considered non-impulsive. However, a non-impulsive noise does not necessarily have to have a long duration.

357. As sound pulses propagate through the environment and dissipate, they lose their most injurious characteristics (e.g. rapid pulse rise time and high peak sound pressure) and become more like a "non-pulse" at greater distances. Active research is currently underway into the identification of the distance at which the pulse can be considered effectively non-impulsive (see **Appendix 12.A**). Both impulsive and non-impulsive criteria from Southall *et al.,* (2019) have been included in the underwater noise modelling, however assessments have been based on the criteria with the greatest predicted effect ranges.

358. In addition, the unweighted impulsive single-strike criteria from Lucke *et al.* (2009) have also been used in the assessments for behavioural thresholds for harbour porpoise, which are based on impulsive seismic airgun stimuli. The criteria used are unweighted single strike SEL:

- Behavioural reaction in harbour porpoise at 145 dB re 1µPa^{2}s (SEL_{ss}).

12.7.1.3.7 Assumptions and Considerations

359. It should be noted and taken into account that the underwater noise modelling and assessment is based on 'worst-case' scenarios and precautionary approaches, this includes, but is not limited to:

- The maximum hammer energy to be applied and maximum piling duration is assumed for all piling locations; however, it is unlikely that maximum hammer energy applied, and duration will be required at the majority of piling locations;
- The maximum predicted effect ranges are based on the location with the greatest potential noise propagation range, and this was assumed as the worst-case for each piling location
- Effect ranges modelled for a single strike are from the piling location and do not take into account:
  - The distance marine mammals and marine turtles could move away from the piling location during mitigation measures, such as the use of Acoustic Deterrent Devices (ADDs) to move marine mammals and marine turtles out of the area where there could be a risk of physical or auditory injury

  - The potential disturbance and movement of marine mammals and marine turtles away from the site as a result of the vessels and set-up prior to mitigation
- The assumption that fleeing animals (harbour porpoise, common dolphin, bottlenose dolphin, striped dolphin, minke whale, and grey seal) are swimming at a constant speed of 1.5m/s (based on swimming speed of harbour porpoise mother calf pairs; Otani *et al.*, 2000). However, marine mammals are expected to swim much faster. For example, harbour porpoise have been recorded swimming at speeds of up to 4.3m/s (Otani *et al.*, 2000) and, the swimming speed of a harbour porpoise during playbacks of pile driving sounds (SPL of 154 dB re 1µPa) was 1.97m/s (7.1km/h) and during quiet baseline periods the mean swimming speed was 1.2m/s (4.3km/h; Kastelein *et al.*, 2018). However, leatherback turtles are slower in general than marine mammals, with an average constant swim speed of 0.56 – 0.84m/s (Eckert, 2002)
- The assumption is that animals are submerged 100% of the time which does not account for any time that an individual may spend at the surface or the reduced SELs near the surface where the animal would not be exposed to such high levels or for seals having their head out of the water.

360. Underwater noise modelling assumes that marine mammals and marine turtles will travel in the mid-water column where sound pressure levels are greatest. However, in reality animals would not be subjected to these high sound pressure levels at all times since they are likely to move up and down through the water column, and surface to breathe, where the sound pressure would drop to zero. A study by Teilmann *et al*. (2007) on diving behaviour of harbour porpoise in Danish waters suggests that animals spent 55% of their time in the upper 2m of the water column from April to August and over the whole year they spent 68% of their time in less than 5m depth. However, it should be noted that this study was conducted for "undisturbed" animals, which could show a different behaviour.

361. The swimming patterns of harbour porpoise undertaking direct travel are typically characterised by short submergence periods, compared to feeding animals (Watson and Gaskin, 1983). These short duration dives with horizontal travel suggest that travelling animals, such as harbour porpoise moving away from pile driving noise, would swim in the upper part of the water column. It would be anticipated, that during a fleeing response from a loud underwater noise, such as piling, that their swimming behaviour may change with a reduction in deep dives. For example, during pile driving playback sounds to examine TTS, harbour porpoise showed

behaviour response during the exposure periods, which included increased swimming speeds and jumping out of the water more (Kastelein *et al.*, 2016).

362. Noise impact assessments assume that all animals within the noise contour may be affected to the same degree for the maximum worst-case scenario (**Table 12.14**). For example, that all animals exposed to noise levels that induce behavioural avoidance will be displaced or all animals exposed to noise levels that are predicted as inducing PTS or TTS will suffer permanent or temporary auditory injury, respectively. However, a study looking at the proportion of trials at different SELs that result in TTS in exposed bottlenose dolphins suggests that to induce TTS in 50% of animals it would be necessary to extrapolate well beyond the range of measured SEL levels (Finneran *et al.*, 2005). This suggests that for a given species, the potential effects follow a dose-response curve such that the probability of inducing TTS will decrease moving further away from the SEL threshold required to induce TTS.

363. The soft-start and ramp-up is included as embedded mitigation (**Section 12.4.4.1**). The soft-start begins with a lower hammer energy before ramping-up and reaching maximum hammer energy, with the assumption that marine mammals and marine turtles will move out of the area as the hammer energy is increased and before there is the increased risk of PTS from the maximum hammer energy. However, research around the installation of jacket foundations in the Moray Firth found that received levels at any given distance were highest at low hammer energies (Thompson *et al.*, 2020). Modelling highlighted that this was because noise from pin pile installations was dominated by the strong negative relationship with pile penetration depth, with only a weak positive relationship with hammer energy (Thompson *et al.*, 2020). Although the responses to ADD play-back indicated that disturbance was beyond that required to mitigate injury (Thompson *et al.*, 2020).

12.7.1.3.8 Results of Underwater Noise Modelling

364. **Table 12.49** presents the underwater noise modelling results for the predicted effect ranges and areas for PTS from a single strike from the maximum hammer energy, and cumulative SEL for OSP jacket piles and mooring pin piles (based on the worst-case locations for the mooring piles).

365. **Table 12.50** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS from a single strike from the maximum hammer energy and cumulative SEL for OSP jacket piles and mooring pin piles (based on the worst-case locations for the mooring piles).

366. **Table 12.51** presents the underwater noise modelling results for predicted effect ranges and areas for mortality and potential mortal injury for leatherback turtles from a single strike from the maximum hammer energy and cumulative SEL for OSP jacket piles and mooring pin piles (based on the worst-case locations for the mooring piles).

367. **Table 12.52** presents the underwater noise modelling results for the predicted effect ranges and areas for behavioural response of harbour porpoise from a single strike from the maximum hammer energy for OSP jacket piles and mooring pin piles (based on the worst-case locations for the mooring piles).

368. Single strike ranges (SPL_{peak}) were modelled to the nearest 50m, and cumulative effect ranges (SEL_{cum}) to the nearest 100m. Results of all underwater noise modelling are provided in **Appendix 12.A**.

369. The first strike of ramp up effect ranges for TTS, with a beginning energy of 400kJ for OSP jacket piles and 128kJ for mooring pin piles has the same effect ranges and areas those shown in **Table 12.50.**

Table 12.49 Predicted Effect Ranges (and Areas) for PTS from a Single Strike (SPL_{peak}) and from Cumulative Exposure (SEL_{cum}) (Maximum Effect Range and Area for Each Species used in Assessments) for Marine Mammals

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km^2)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km^2)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
Harbour porpoise (VHF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (202 dB re 1µPa) Impulsive	570m (1km^2)	260m (0.21km^2)
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (155 dB re 1µPa^{2}s) Impulsive	4.6km (55km^2)	2.1km (12km^2)
Bottlenose dolphin, common dolphin and striped dolphin (HF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (230 dB re 1µPa) Impulsive	<50m (<0.01km^2)	<50m (<0.01km^2)
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (185 dB re 1µPa^{2}s) Impulsive	<100m (<0.1km^2)	<100m (<0.1km^2)
Minke whale (LF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (219 dB re 1µPa) Impulsive	<50m (<0.01km^2)	<50m (<0.01km^2)
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (183 dB re 1µPa^{2}s) Impulsive	12km (310km^2)	6km (90km^2)

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km^2)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km^2)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
Grey seal (PCW)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (218 dB re 1µPa) Impulsive	<50m (0.01km^2)	<50m (0.01km^2)
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (185 dB re 1µPa^2s) Impulsive	<100m (<0.1km^2)	<100m (<0.1km^2)

Table 12.50 Predicted Effect Ranges (and Areas) for TTS from a Single Strike (SPL_{peak}) and from Cumulative Exposure (SEL_{cum}) (Maximum Effect Range and Area for Each Species used in Assessments) for Marine Mammals

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km^2)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km^2)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
Harbour porpoise (VHF)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (196 dB re 1µPa) Impulsive	1.4km (6.5km^2)	680m (1.4km^2)

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km^2)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km^2)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (140 dB re 1μPa^2s) Impulsive	37km (3,000km^2)	27km (1,800km^2)
Bottlenose dolphin, common dolphin and striped dolphin (HF)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (224 dB re 1μPa) Impulsive	<50m (<0.01km^2)	<50m (<0.01km^2)
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (170 dB re 1μPa^2s) Impulsive	<100m (<0.1km^2)	<100m (<0.1km^2)
Minke whale (LF)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (213 dB re 1μPa) Impulsive	100m (<0.03km^2)	<50m (0.01km^2)
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (168 dB re 1μPa^2s) Impulsive	54km (5,400km^2)	41km (3,700km^2)
Grey seal (PCW)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (212 dB re 1μPa) Impulsive	120m (0.04km^2)	50m (0.01km^2)

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km^2)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km^2)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (170 dB re $1\mu Pa^2s$) Impulsive	16km (600km^2)	10km (290km^2)

Table 12.51 Predicted Effect Ranges (and Areas) from a Single Strike (SPL_{peak}) and from Cumulative Exposure (SEL_{cum}) (Maximum Effect Range and Area for Each Species used in Assessments) for Leatherback Turtles

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km²)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km²)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
Leatherback turtles	Mortality and potential mortal injury Single strike (without mitigation)	SPL_{peak} Unweighted (>207 dB re 1µPa) Pile driving noise	0.26km (0.21km²)	0.12km (0.04km²)
	Mortality and potential mortal injury Cumulative SEL (including soft-start and ramp-up) for a stationary receptor	SEL_{cum} Weighted (>210 dB re 1µPa²s) Pile driving noise	6.0km (110.0km²)	2.4km (18.0km²)

Table 12.52 Predicted Effect Ranges (and Areas) for Behavioural Response in Harbour Porpoise from Piling

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km²)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km²)
			Maximum Hammer Energy (2,500kJ)	Maximum Hammer Energy (800kJ)
Harbour porpoise	Behavioural responses from	SEL_{ss} Unweighted (145 dB re 1µPa) Impulsive	47km (5,700km²)	33km (3,000km²)

Species	Potential Effect	Criteria Threshold (Southall *et al.*, 2019; Popper *et al.*, 2014)	OSP Jacket Pile (4m Diameter) Maximum Effect Range (km) and Area (km^2) Maximum Hammer Energy (2,500kJ)	Mooring Pin Piles (2m Diameter) Maximum Effect Range (km) and Area (km^2) Maximum Hammer Energy (800kJ)
	single strike (without mitigation)			

12.7.1.4 Significance of Effect

370. For PTS, taking into account high marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (i.e. number of individuals as a percentage of the reference population; **Table 12.35** to **Table 12.36**), the effect significance for PTS from a single strike of the maximum hammer energy for OSP jacket piles or mooring pin piles, without any mitigation, has been assessed as **minor to moderate adverse** for harbour porpoise, and **minor adverse** for bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle (**Table 12.53**).

371. For PTS from cumulative exposure, without mitigation, the effect significance has been assessed **major adverse** for harbour porpoise for both jacket and mooring pin piles, **major adverse** for minke whale for OSP jacket piles, **moderate adverse** for minke whale from mooring pin piles, and **minor adverse** for both jacket and mooring pin piles for bottlenose dolphin, common dolphin, striped dolphin, grey seal and leatherback turtle (**Table 12.53**).

372. For TTS, taking into account the medium marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (**Table 12.37** and **Table 12.38**), the effect significance for TTS from a single strike of the maximum hammer energy for OSP jacket piles or mooring pin piles has been assessed as **minor adverse** for all species assessed (**Table 12.54**). For TTS from cumulative exposure, the effect significance has also been assessed as **minor adverse** for all species assessed (**Table 12.54**).

373. For the potential for disturbance, taking into account the marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (**Table 12.38**, **Table 12.39** and **Table 12.40**), the effect significance for disturbance due to impact piling has been assessed as **negligible to minor adverse** for all species assessed (**Table 12.55**).

Table 12.53 Assessment of Effect Significance for PTS in Marine Mammals and Marine Turtles from Underwater Noise During Jacket Piling or Mooring Pin-Piling

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect Significance
PTS from single strike of the maximum hammer energy	Harbour porpoise	High	Low to negligible for OSP jacket pile; Negligible for mooring pin pile	Minor to moderate adverse for OSP jacket pile; Minor adverse for mooring pin pile	MMMP (**Section 12.7.1.5**)	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle		Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**
PTS during piling from cumulative exposure for piling	Harbour porpoise		Medium for both OSP jacket pile and mooring pin pile	Major adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, and leatherback turtle		Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect Significance
	Minke whale		Medium for OSP jacket pile; Low for mooring pin pile	Major adverse for OSP jacket pile; Moderate adverse for mooring pin pile		**Minor adverse**

Table 12.54 Assessment of Effect Significance for TTS in Marine Mammals and Marine Turtles from Underwater Noise During Jacket Piling or Mooring Pin-Piling

Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect Significance
TTS from single strike of maximum energy	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle	Medium	Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile	None required	**Minor adverse**
TTS during piling from cumulative exposure for piling	Harbour porpoise		Low for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle		Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**

Table 12.55 Assessment of Effect Significance for Disturbance In Marine Mammals and Marine Turtles from Underwater Noise During Jacket Piling, Mooring Pin-Piling and ADD Activation

Potential effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect Significance
Disturbance / Displacement	Harbour porpoise	Medium	Low to negligible	Negligible to minor adverse	None required	**Negligible to minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle		Negligible	Negligible		**Negligible**

12.7.1.5 Further Mitigation

374. The MMMP for piling (**Section 12.4.4**) would reduce the risk of PTS from the single strike of the maximum hammer energy; and the risk of PTS from cumulative exposure. The MMMP for piling will be developed post-consent in consultation with the MMO and other relevant organisations (including Natural England) and will be based on the latest information, scientific understanding and guidance, as well as detailed project design. The final MMMP for piling will be based on **Appendix 12.C: Draft MMMP** which has been submitted alongside this ES.

375. The proposed mitigation to reduce the risk of PTS would include establishing a monitoring zone of 500m, and ADD activation prior to the soft-start commencing. The mitigation measures would be designed in line with JNCC's *Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise*[12].

376. ADDs have proven to be effective mitigation for harbour porpoise, dolphin species, minke whale, grey seal (Sparling *et al*., 2015; McGarry *et al*., 2017, 2020). ADDs have been widely used as mitigation to deter marine mammals during offshore wind farm piling. A recent study conducted by Graham *et al*. (2023) demonstrated their effectiveness and showed a significant directional movement away from sound sources during ADD use and piling soft starts. The study used a self-contained portable hydrogen cluster to detect small cetacean movements in order to demonstrate the mitigation.

377. In order to deter marine mammals from the predicted cumulative PTS ranges, of up to 12km for minke whale and 4.6km for harbour porpoise (for OSP jacket piles), and up to 6km and 2.1km for minke whale and harbour porpoise, respectively (for mooring pin piles), an ADD would need to be activated for 62 minutes prior to the start of jack-up piling, and for 31 minutes prior to piling of mooring pin piles. See **Section 12.7.1.1.3.6** for more information on the ADD activation period (and an associated assessment of potential disturbance effects).

378. The mitigation measures (including ADD activation period) would be designed to ensure that all marine mammal species are outside of the potential PTS effect range prior to the onset of piling. This would significantly reduce the potential for any marine mammal species to be within the potential PTS effect areas. The mitigation measures would also include consideration of marine turtle species. Note that the

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12 https://data.jncc.gov.uk/data/31662b6a-19ed-4918-9fab-8fbcff752046/JNCC-CNCB-Piling-protocol-August2010-Web.pdf

mitigation measures for marine mammals would apply to all marine mammal (and marine turtle species), regardless of their inclusion within this assessment.

379. It is also important to note that Brandt *et al.* (2018) found that at seven German offshore wind farms in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice offshore wind farm, indicate higher vessel activity within 1km was associated with an increased probability of response in harbour porpoise (Graham *et al.*, 2019). This vessel disturbance of marine mammals and marine turtles from the area around the construction site prior to piling would also reduce the risk of PTS.

380. The mitigation measures in the Draft MMMP (**Appendix 12.C: Draft MMMP**) to reduce the risk of PTS would also reduce the number of marine mammals and marine turtles at risk of TTS.

12.7.1.6 Residual Effect Significance

381. Taking into account the mitigation to reduce the risk of PTS, the residual effect of the potential risk of PTS to marine mammals as a result of underwater noise during piling would be **minor adverse** (not significant) for all species (**Table 12.53**), with the proposed mitigation (**Section 12.7.1.5**).

382. The mitigation to reduce the risk of PTS would also reduce the risk of TTS. The residual effect of the potential risk of TTS to marine mammals as a result of underwater noise during piling, would be **minor adverse** (not significant) for all species (**Table 12.54**).

12.7.2 Impact 2: Underwater Noise during Unexploded Ordnance (UXO) Clearance

383. Prior to construction, there is the potential for UXO clearance to be required. While any identified UXO will either be avoided or removed and disposed of onshore in a designated place, there is the potential that underwater detonation could be required where it is necessary and unsafe to remove the UXO.

384. In order to undertake any UXO clearance, a marine licence is required from the MMO under the Marine and Coastal Access Act 2009. In addition, the clearance of UXO by detonation will require an EPS Licence under the Conservation of Offshore Marine Habitats and Species Regulations 2017.

385. The following assessment has been provided for information purposes only.

386. A separate Marine Licence application will be submitted when a detailed UXO survey has been completed prior to construction and a detailed assessment based on the latest available information has been undertaken.

12.7.2.1 UXO Risk Assessment

387. The number of possible UXO that may require clearing and the duration of UXO clearance operations are currently unknown.

388. A UXO Threat and Risk Assessment has been undertaken for the Offshore Project. Based upon the threat component of this assessment, the following types of UXO (**Table 12.56**), complete with their measurements, estimated ferrous mass, and expected Net Explosive Quantity (NEQ - based upon equivalent Trinitrotoluene (TNT) masses), may pose a UXO threat at the Study Site.

Table 12.56 Types of UXO that may Pose a Threat to the Study Site

Designation	Length x Diameter (mm)	Ferrous Mass (kg)	Net Explosive Quantity (kg)
Naval Torpedoes and Projectiles			
1,000lb MC bomb	1,334 x 451	202-225	309.4
SC-500 HE bomb	1,415 x 457	280	220
1,000lb GP bomb	1,334 x 411	325.4	161.9
500lb MC bomb	1,041 x 328	111-121	136.5
SC-250 HE bomb	1,194 x 368	126	130
250lb MC bomb	699 x 254	51	67.8
500lb GP bomb	925 x 328	147.5	65.5
250lb GP bomb	711 x 262	82	30
SC-50 HE bomb	762 x 200	25-30	25
50cm G6 torpedo	6,000 x 500	1,364	213.2
8.8cm naval projectile	394 x 88	12.4	1.42
Naval and Shore Mines			
Mark XV mine	1,460 x 1,014	68-236	145-227
Mark XVII/XXII	1,321 x 1,016	68-236	145-227
E-Mine	1,168 x 864	208	165
UC 200 mine	800 x 800	191	141.1
Mark XIX mine	688 x 688	86	45.5
Beach type C mine	83 x 203	1.82	2.04

Designation	Length x Diameter (mm)	Ferrous Mass (kg)	Net Explosive Quantity (kg)
4.7" artillery projectile	423 x 119	19.6	3.1
4" artillery projectile	445 x 102	13.2	0.82
3" mortar bomb	406 x 81	3.99	0.55
Mills bomb	95 x 61	0.66	0.1
40mm bofors projectile	184 x 40	0.83	0.07
Mk2 grenade	90 x 57	0.58	0.06

389. An appropriately specified geophysical UXO survey will be undertaken in order to provide details on potential UXO that could require clearance in advance of construction activities. However, the details of the surveys were not available prior to the underwater noise modelling and assessments for UXO clearance.

390. Underwater noise modelling was undertaken for a range of UXO (different types and sizes) that could be in the area (as per the examples for provided in **Table 12.56**). **Table 12.60** includes the type and size of UXO, NEQ, donor charge, total and TNT Eq., to cover the potential UXO that could be present.

12.7.2.2 Magnitude of Effect

12.7.2.2.1 Potential for Effect from Permanent Injury (Auditory)

391. The number of harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal that could potentially be impacted by a high-order UXO detonation (up to 309kg NEQ), and low-order clearance (2kg) has been estimated for the Offshore Project site, based on the maximum potential PTS effect ranges (**Table 12.57**).

392. For the high-order detonation, of the maximum potential UXO with an NEQ of 309kg plus donor charge, the magnitude for PTS is assessed as a worst-case for the Offshore Project (**Table 12.57**) to be:

- **Medium** for harbour porpoise and for grey seal based on the density estimate for the ECC
- **Low** for common dolphin, striped dolphin and minke whale
- **Negligible to low** for grey seal based on the density estimate for the Windfarm Site
- **Negligible** for bottlenose dolphin.

393. For low-order clearance (2kg donor charge for all sizes of UXO) the magnitude for PTS is assessed to be:

- **Medium** for harbour porpoise
- **Low** for common dolphin
- **Negligible to low** for grey seal based on the density estimate for the ECC
- **Negligible** for bottlenose dolphin, striped dolphin, minke whale, and grey seal based on the density estimate for the Windfarm Site.

394. For leatherback turtles, the maximum potential effect range, for mortality or potential mortal injury, for a high-order detonation is 680m, and for low-order is 120m (**Table 12.51**). While there is a possibility of leatherback turtles to be present within the Offshore Project area, given the low number in the area, it is considered highly unlikely that any would be present within the potential effect area. Therefore, the magnitude for both high-order and low-order detonation is assessed as **negligible**.

Table 12.57 Maximum Number of Marine Mammals Potentially at risk of PTS During UXO Clearance

Species	Maximum Effect Range (and Area)	Maximum Number of Individuals	% of Reference Population	Magnitude (Permanent Effect)
Harbour porpoise	High-order detonation (309kg (NEQ) + donor charge) 11.0km (380.13km^2)	349.0 based on the APEM summer density estimate 225.8 based on the APEM annual density estimate	0.56% of the CIS MU, based on the APEM summer density estimate 0.36% of the CIS MU, based on the APEM annual density estimate	**Medium**
	Low-order clearance (2kg (NEQ)) 1.90km (11.34km^2)	10.4 based on the APEM summer density estimate 6.7 based on the APEM annual density estimate	0.017% of the CIS MU, based on the APEM summer density estimate 0.011% of the CIS MU, based on the APEM annual density estimate	**Medium**
Bottlenose dolphin	High-order detonation (309kg (NEQ) + donor charge) 0.61km (1.17km^2)	0.07	0.0006% of the IS MU	**Negligible**
	Low-order clearance (2kg (NEQ)) 0.11km (0.04km^2)	0.002	0.00002% of the IS MU	**Negligible**
Common dolphin	High-order detonation (309kg (NEQ) + donor charge) 0.61km (1.17km^2)	6.1 based on the APEM winter density estimate	0.004% of the CGNS MU, based on the APEM winter density estimate	**Low**

Species	Maximum Effect Range (and Area)	Maximum Number of Individuals	% of Reference Population	Magnitude (Permanent Effect)
		4.5 based on the APEM annual density estimate	0.006% of the CGNS MU, based on the APEM annual density estimate	
	Low-order clearance (2kg (NEQ)) 0.11km (0.04km^2)	0.20 based on the APEM winter density estimate 0.15 based on the APEM annual density estimate	0.0002% of the CGNS MU, based on the APEM winter density estimate 0.0001% of the CGNS MU, based on the APEM annual density estimate	**Low**
Striped dolphin	High-order detonation (309kg (NEQ) + donor charge) 0.61km (1.17km^2)	0.77	0.004% of the reference population	**Low**
	Low-order clearance (2kg (NEQ)) 0.11km (0.04km^2)	0.025	0.0001% of the reference population	**Negligible**
Minke whale	High-order detonation (309kg (NEQ) + donor charge) 7.4km (172.03km^2)	1.9	0.01% of the CGNS MU	**Low**
	Low-order clearance (2kg (NEQ)) 0.63km (1.25km^2)	0.014	0.00007% of the CGNS MU	**Negligible**
Grey seal	High-order detonation (309kg (NEQ) + donor charge) 2.0km (12.57km^2)	1.5 based on the ECC density estimate	0.075% of the SW MU, and 0.012% of the combined MU, based on the ECC density estimate	**Medium** based on the ECC density estimate

Species	Maximum Effect Range (and Area)	Maximum Number of Individuals	% of Reference Population	Magnitude (Permanent Effect)
		0.06 based on the Windfarm Site density estimate	0.003% of the SW MU, and 0.0005% of the combined MU, based on the Windfarm Site density estimate	**Negligible to low** based on the Windfarm Site density estimate
	Low-order clearance (2kg (NEQ)) 0.39km (0.48km^2)	0.06 based on the ECC density estimate 0.002 based on the Windfarm Site density estimate	0.003% of the SW MU, and 0.0005% of the combined MU, based on the ECC density estimate 0.0001% of the SW MU, and 0.00002% of the combined MU, based on the Windfarm Site density estimate	**Negligible to low** based on the ECC density estimate **Negligible** based on the Windfarm Site density estimate

12.7.2.2.2 Potential for Effect from Temporary Injury (Auditory)

395. The number of harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal that could potentially be impacted by a high-order UXO detonation (up to 309kg NEQ), and low-order clearance (2kg) has been estimated for the Offshore Project based on the maximum potential TTS effect ranges (**Table 12.58**).

396. For the high-order detonation of the maximum potential UXO with an NEQ of 309kg plus donor charge, the magnitude for TTS is assessed, as a worst-case (**Table 12.58**), to be:

- **Low** for harbour porpoise, minke whale
- **Negligible to low** for grey seal based on the ECC density estimate
- **Negligible** for bottlenose dolphin, common dolphin, striped dolphin, and grey seal based on the density estimate for the Windfarm Site.

397. For low-order clearance (2kg donor charge for all sizes of UXO) the magnitude is assessed to be:

- **Low** for harbour porpoise
- **Negligible** for bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal.

398. For leatherback turtles, based on the noise criteria for explosions (Popper *et al.*, 2014), there is a high risk of recoverable injury and/or TTS in the near (<100m) and intermediate fields (>100m and <1,000m), and a low risk of recoverable injury and/or TTS in the far field (>1,000m). Within the high risk area of less than 1,000m, given the low number of leatherback turtles in the area, it is unlikely that any individuals would be present. Within the low risk of effect area (of more than 1,000m), there is a low risk of recoverable injury/TTS, and it is unlikely that there would be significant presence of the species. Therefore, given the low risk of presence in the high risk area, as well as within the low risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

Table 12.58 Maximum Number of Marine Mammals Potentially at risk of TTS During UXO Clearance

Species	Maximum Effect Range (and Area)	Maximum Number of Individuals	% of Reference Population	Magnitude (Temporary Effect)
Harbour porpoise	High-order detonation (309kg (NEQ) + donor charge) 20km (1,256.64km^2)	1,153.6 based on the APEM summer density estimate 746.4 based on the APEM annual density estimate	1.85% of the CIS MU, based on the APEM summer density estimate 1.19% of the CIS MU, based on the APEM annual density estimate	**Low**
	Low-order clearance (2kg (NEQ)) 3.6km (40.72km^2)	37.4 based on the APEM summer density estimate 24.2 based on the APEM annual density estimate	0.06% of the CIS MU, based on the APEM summer density estimate 0.04% of the CIS MU, based on the APEM annual density estimate	**Low**
Bottlenose dolphin	High-order detonation (309kg (NEQ) + donor charge) 1.1km (3.8km^2)	0.23	0.002% of the IS MU	**Negligible**
	Low-order clearance (2kg (NEQ)) 0.21km (0.14km^2)	0.008	0.00008% of the IS MU	**Negligible**
Common dolphin	High-order detonation (309kg (NEQ) + donor charge) 1.1km (3.8km^2)	19.9 based on the APEM winter density estimate	0.014% of the CGNS MU, based on the APEM winter density estimate	**Negligible**

Species	Maximum Effect Range (and Area)	Maximum Number of Individuals	% of Reference Population	Magnitude (Temporary Effect)
		14.6 based on the APEM annual density estimate	0.019% of the CGNS MU, based on the APEM annual density estimate	
	Low-order clearance (2kg (NEQ)) 0.21km (0.14km^2)	0.72 based on the APEM winter density estimate 0.53 based on the APEM annual density estimate	0.0007% of the CGNS MU, based on the APEM winter density estimate 0.0005% of the CGNS MU, based on the APEM annual density estimate	**Negligible**
Striped dolphin	High-order detonation (309kg (NEQ) + donor charge) 1.1km (3.8km^2)	2.5	0.013% of the reference population	**Negligible**
	Low-order clearance (2kg (NEQ)) 0.21km (0.14km^2)	0.09	0.0005% of the reference population	**Negligible**
Minke whale	High-order detonation (309kg (NEQ) + donor charge) 85.0km (22,698.01km^2)	254.2	1.26% of the CGNS MU	**Low**

Species	Maximum Effect Range (and Area)	Maximum Number of Individuals	% of Reference Population	Magnitude (Temporary Effect)
	Low-order clearance (2kg (NEQ)) 8.8km (243.29km^2)	2.7	0.014% of the CGNS MU	**Negligible**
Grey seal	High-order detonation (309kg (NEQ) + donor charge) 16.0km (804.25km^2)	96.0 based on the ECC density estimate 3.9 based on the Windfarm Site density estimate	4.83% of the SW MU, and 0.76% of the combined MU, based on the ECC density estimate 0.20% of the SW MU, and 0.031% of the combined MU, based on the Windfarm Site density estimate	**Negligible** to **low** based on the ECC density estimate **Negligible** based on the Windfarm Site density estimate
	Low-order clearance (2kg (NEQ)) 1.5km (7.07km^2)	0.84 based on the ECC density estimate 0.034 based on the Windfarm Site density estimate	0.042% of the SW MU, and 0.007% of the combined MU, based on the ECC density estimate 0.002% of the SW MU, and 0.0002% of the combined MU, based on the Windfarm Site density estimate	**Negligible** based on the ECC density estimate **Negligible** based on the Windfarm Site density estimate

12.7.2.2.3 Potential for Effect from Disturbance

12.7.2.2.3.1 Potential for Disturbance during UXO Clearance

399. For marine mammal species, there is currently no agreed threshold for disturbance from underwater noise, however, a fleeing response is assumed to occur at the same noise levels as TTS. As outlined in Southall *et al.* (2007), the onset of behavioural disturbance is proposed to occur at the lowest level of noise exposure that has a measurable transient effect on hearing (i.e. TTS). Although, as Southall *et al.* (2007) recognise that this is not a behavioural effect *per se*, exposures to lower noise levels from a single pulse are not expected to cause disturbance. However, any compromise, even temporarily, to hearing functions could have the potential to affect behaviour.

400. The use of the TTS threshold is appropriate for UXO disturbance, because the noise from the UXO explosion is only fleetingly in the environment. Therefore, the assumption is that although noise levels lower than TTS threshold may startle the individual, this has no lasting effect. TTS results in a temporary reduction in hearing ability, and therefore may affect the individuals' fitness temporarily (as recommended in Southall *et al.* (2007) for a single pulse).

401. As outlined in Southall *et al.* (2021), thresholds that attempt to relate single noise exposure parameters (e.g. received noise level) and behavioural response across broad taxonomic grouping and sound types can lead to severe errors in predicting effects. Differences between species, individuals, exposure situational context, the temporal and spatial scales over which they occur, and the potential interacting effects of multiple stressors can lead to inherent variability in the probability and severity of behavioural responses.

402. The assessments for TTS / fleeing response have therefore been used for assessing the potential disturbance ranges for UXO clearance, with the exception of harbour porpoise.

403. The SNCBs currently recommend that a potential disturbance range based on an EDR of 26km around UXO high-order detonation is used to assess harbour porpoise disturbance from the BCA SAC (JNCC *et al.,* 2020). The maximum number of harbour porpoise based on the 26km EDR (an area of up to 2,123.7km^2) that could be disturbed would be up to 1,949.6 based on the worst-case APEM summer density estimate (or up to 3.12% of the CIS MU). The potential effect would therefore be **low**, with between 1% and 5% of the reference population anticipated to be exposed to the temporary effect.

404. The magnitude of effect for the potential for disturbance, for high-order clearance, is therefore **negligible** for bottlenose dolphin, common dolphin, striped dolphin, and grey seal based on the density estimate for the Windfarm Site, **negligible to low** for grey seal based on the ECC density estimate (**Table 12.58**), and **low** for harbour porpoise and minke whale.

405. For low-order clearance, the magnitude of effect for the potential for disturbance is **negligible** for bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal, and **low** for harbour porpoise (**Table 12.58**).

406. For leatherback turtles, based on the noise criteria for explosions (Popper *et al*., 2014), the risk of a behavioural response due to explosions is the same as the risk of recoverable injury and/or TTS (as described in **Section 12.7.1.1.2**). Therefore, the magnitude of effect, without any mitigation, is assessed as **negligible**.

12.7.2.2.3.2 Potential for Disturbance during ADD activation

407. The assessments of the potential disturbance during any ADD activation is indicative only, as the final requirements for mitigation will be confirmed during the full Marine Licencing process for the clearance of UXO.

408. As outlined in **Section 12.4.4**, mitigation to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing.

409. The maximum predicted PTS effect ranges for high-order clearance are 11.0km for harbour porpoise and 7.4km for minke whale (**Table 12.49**). The maximum predicted PTS effect ranges for low-order clearance are 1.9km for harbour porpoise, and 0.63km for minke whale. The PTS effect ranges for other species and less than that of harbour porpoise, and therefore the ADD activation period would be designed to deter for the harbour porpoise effect range (and the minke whale effect range, as they have a different flee speed to all other species).

410. Based on a precautionary swim speed of 1.5m/s (Otani *et al*., 2000), the ADD would need to be activated for a minimum of 123 minutes to ensure harbour porpoise were beyond the maximum 11.0km PTS effect range for high-order clearance, or 22 minutes for low-order clearance. Based on a swim speed of 3.25m/s for minke whale (Blix and Folkow, 1995), the ADD would need to be activated for a minimum of 38 minutes to ensure minke whale are outwith the predicted PTS effect range for high-order clearance, or four minutes for low-order clearance.

411. Therefore, the assessments for disturbance during ADD activation are based on 123 minute ADD activation for high-order clearance, and 22 minutes for low-order clearance.

412. During the 123 minute ADD activation for high-order clearance, it is predicted that harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, and grey seal would move at least 11.07km from the ADD location (based on a precautionary swim speed of 1.5m/s (Otani *et al.*, 2000)), resulting in a potential disturbance area of 384.99km^2. Minke whale would move at least 23.99km from the ADD location (based on a precautionary swimming speed of 3.25m/s (Blix and Folkow, 1995)), resulting in a potential disturbance area of 1,807.30km^2.

413. For disturbance due to ADD activation for high-order clearance, the magnitude of the potential effect is assessed as **low** for common dolphin and striped dolphin, **negligible to low** for grey seal, and **negligible** for harbour porpoise, bottlenose dolphin and minke whale (**Table 12.59**).

414. For disturbance due to ADD activation for low-order clearance, the magnitude of the potential effect is assessed as **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, minke whale and grey seal (**Table 12.59**).

415. It should be noted that this is considered an absolute worst-case potential for disturbance during UXO clearance, as high-order clearance would only be used where it was not possible to undertake low-order clearance. The following assessments are based on the assumed largest UXO that could be present in the area, in the absence of site-specific information, and based on an ADD activation period of 123 minutes, which is unlikely to be used in reality. Therefore, the potential for disturbance to marine mammals due to ADD activation prior to UXO clearance is likely to be less than assessed here. During the Marine Licence application process, the actual required ADD activation period will be confirmed, and final assessments updated accordingly.

416. For all dolphin species, the potential for disturbance from the use of ADD prior to UXO clearance (**Table 12.59**) is significantly higher than the potential for disturbance from piling (**Table 12.58**). While it is not a significant effect for any species, with a negligible to low magnitude in all cases, the balance of potential for disturbance to these species, against the requirement to mitigate against permanent auditory injury, is an important consideration that will be made during the submission of the UXO Marine Licence Application and submission of EPS licence application, in the post-consent phase. One consideration would be to limit the use of extended ADD activation periods, to either once per 24 hour piling period, and/or to the season of most importance for the species requiring the longest ADD activation time (i.e. minke whale in the summer period).

417. It is not currently known whether ADD activation would have the same effect on leatherback turtle as for marine mammal species (i.e. deterrence). As a worst-case, if it is assumed that ADD activation would cause the same level of behavioural response in leatherback turtles as would be expected from impact piling, as an impulsive source, then there would be a high risk of masking / behavioural response in the near field (<100m), a moderate risk in the intermediate field (>100m and <1,000m), and a low risk in the far field (>1,000m) (**Table 12.48**).

418. Within the high risk area of less than 100m, given the low number of leatherback turtles in the area, it is highly unlikely that any individuals would be present, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. Within the moderate risk of effect area (of between 100m and 1,000m), it remains highly unlikely that any individual would be present, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. Within the low risk of masking/behavioural response effect area (of more than 1,000m), it is unlikely that any individual would be present, and therefore unlikely that any individual would be exposed to a potential masking/behavioural response effect. Therefore, given the very low potential for presence in the high and moderate risk of masking and behavioural response area, as well as low potential for presence in the low risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

Table 12.59 Maximum Number of Individuals (and % of Reference Population) that could be Disturbed During ADD Activation Prior to UXC Clearance

Species	ADD Activation of 123 Minutes for High-Order UXO Clearance		ADD Activation of 22 Minutes for Low-Order UXO Clearance	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Harbour porpoise	353.4 (0.57% of CIS MU based on the APEM summer density estimate) 228.7 (0.37% of CIS MU based on the APEM annual density estimate)	**Negligible**	11.3 (0.02% of CIS MU based on the APEM summer density estimate) 7.3 (0.01% of CIS MU based on the APEM annual density estimate)	**Negligible**
Bottlenose dolphin	23.3 (0.21% of OCSW MU)	**Negligible**	0.8 (0.007% of OCSW MU)	**Negligible**
Common dolphin	2,013.5 (1.96% of CGNS MU based on the APEM winter density estimate) 1,475.7	**Low**	64.4 (0.06% of CGNS MU based on the APEM winter density estimate) 47.2	**Negligible**

Species	ADD Activation of 123 Minutes for High-Order UXO Clearance		ADD Activation of 22 Minutes for Low-Order UXO Clearance	
	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
	(1.44% of CGNS MU based on the APEM annual density estimate)		(0.05% of CGNS MU based on the APEM annual density estimate)	
Striped dolphin	252.2 (1.31% of reference population)	**Low**	8.1 (0.04% of reference population)	**Negligible**
Minke whale	20.2 (0.10% of CGNS MU)	**Negligible**	0.7 (0.003% of CGNS MU)	**Negligible**
Grey seal	46.0 based on the ECC density estimate (2.31% of the SW MU; 0.37% of the combined MU) 1.9 based on the Windfarm Site density estimate (0.09% of the SW MU; 0.02% of the combined MU)	**Negligible to low** for the ECC **Negligible** for the Windfarm Site	1.5 based on the ECC density estimate (0.07% of the SW MU; 0.01% of the combined MU) 0.06 based on the Windfarm Site density estimate (0.003% of the SW MU; 0.0005% of the combined MU)	**Negligible**

12.7.2.3 Sensitivity of the Receptor

419. In this assessment, all species of marine mammals and marine turtles are considered to have a high sensitivity to UXO detonations if they are within the potential effect ranges for physical injury or PTS. Marine mammals and marine turtles within the potential effect area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

420. The sensitivity of marine mammals and marine turtles to TTS and flee response / likely disturbance as a result of underwater UXO detonations is considered to be medium in this assessment as a precautionary approach. This is for animals within the potential TTS and flee response / likely disturbance range, but beyond the potential effect range for PTS. Marine mammals within the potential effect area are considered to have limited capacity to avoid such effects, although any effects on marine mammals would be temporary and they would be expected to return to the area once the activity had ceased.

12.7.2.4 Underwater Noise Modelling

421. Subacoustech Environmental Ltd. conducted underwater noise modelling to predict the potential effects to marine mammals and marine turtles during UXO clearance

(see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**).

422. The precise details and locations of potential UXO are unknown at this time. For the purposes of the underwater noise modelling, five UXO clearance scenarios were considered:

- High-order detonation, unmitigated
- High-order detonation, with bubble curtain
- Low-order clearance (e.g., deflagration)
- Low-yield clearance (e.g., HYDRA system)
- Low-yield clearance (e.g., HYDRA system, with bubble curtain).

423. For further information on the five UXO clearance scenarios, see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.

424. For the following assessment, two of these scenarios have been further assessed; high-order detonation (unmitigated), and low-order clearance (e.g., deflagration). It is not expected that the use of bubble curtains will be possible for the clearance of UXO for the Offshore Project due to the water depths at the site, however, this will be considered further through the Marine Licence Application. It is also not expected that the low-yield clearance method (HYDRA) will be possible at the time of any UXO clearance, due to the remaining uncertainties in the efficacy of the process in terms of underwater noise reduction. Therefore, for the purposes of this initial assessment, high-order clearance and low-order clearance (deflagration) are considered in detail.

425. For this assessment, the attenuation of the noise from UXO detonation has been accounted for in calculations using geometric spreading and a sound absorption coefficient, primarily using the methodologies cited in Soloway and Dahl (2014), which establishes a trend based on measured data in open water. A range of TNT equivalent charge weights for the potential UXO devices that could be present within the Offshore Project site boundary have been estimated from the smaller to largest with a selection in between (**Table 12.60**). For the low-order clearance, a charge weight of 2kg has been used to inform the modelling results.

Table 12.60 Selection of Potential UXO, and Respective Charge Weights and NEQ

Description	4.7" Artillery	SC-50 HE Bomb	250lb MC Bomb	SC-250 HE Bomb	Mark XV Mine	1,000lb MC Bomb
Predicted charge weight, NEQ	3.1 kg	25 kg	67.8 kg	130 kg	227 kg	309.4 kg

426. A summary of the unweighted UXO clearance source levels calculated in **Appendix 12.A** are shown in **Table 12.61**.

Table 12.61 Clearance Source Levels, following Soloway and Dahl (2014)

Unweighted Noise Source Levels, UXO Clearance						
	LO[2]	**25kg**	**67.8kg**	**130kg**	**227kg**	**309.4kg**
SPL_{peak} dB	276.6	284.9	288.1	290.2	292.1	293.1
SEL, dB	220.9	227.9	230.7	232.5	234.0	234.9

427. The marine mammal and marine turtle thresholds used within the underwater noise modelling are as per impact piling; Southall *et al*. (2019) for marine mammals, and Popper *et al*. (2014) for marine turtles (for this assessment, the explosions criteria were used).

428. To account for the weightings required for modelling using the Southall *et al.* (2019) criteria (**Table 12.47**), reductions in source level have been applied, based on the frequencies in a typical explosive noise spectrum to acquire a single weighted figure. **Table 12.62** presents details of the reductions in source level for each of the weighting used for modelling (for further information, see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**).

Table 12.62 Reductions in Source Level for UXO Clearance when the Southall et al. (2019) Weightings are Applied

Noise Source	**Reduction in Source Level from the Unweighted Level**			
	LF	**HF**	**VHF**	**PCW**
UXO Clearance	1.4 dB	28.9 dB	35.0 dB	9.2 dB

12.7.2.4.1 Results

429. **Table 12.63** presents the underwater noise modelling results for the predicted effect ranges and areas for PTS and TTS from UXO detonation using impulsive unweighted SPL_{peak} and weighted SEL_{ss}.

430. **Table 12.64** presents the underwater noise modelling results for predicted effect ranges and areas for mortality and potential mortal injury for leatherback turtles from UXO detonation.

Table 12.63 Summary of the PTS and TTS Effect Ranges for Unmitigated UXO Detonation using the Impulsive, Unweighted SPL_{peak} and Weighted SEL_{ss} Noise Criteria from Southall et al. (2019) for Marine Mammals

Southall *et al.* (2019) Unweighted SPL_{peak}; Impulsive		Low Order (m)	25kg (m)	67.8kg (m)	130kg (m)	227kg (m)	309kg (m)
PTS	219 dB (LF)	350	810	1,100	1,400	1,700	1,800
	230 dB (HF)	110	260	370	460	550	610
	202 dB (VHF)	1,900	4,600	6,400	8,000	9,600	11,000
	218 dB (PCW)	390	900	1,200	1,500	1,800	2,000
TTS	213 dB (LF)	650	1,500	2,100	2,600	3,100	3,400
	230 dB (HF)	210	490	680	850	1,000	1,100
	196 dB (VHF)	3,600	8,500	1,2000	15,000	18,000	20,000
	212 dB (PCW)	720	1,600	2,300	2,800	3,400	3,800
Southall et al. (2019) Weighted SEL_{ss}; Impulsive		Low Order (m)	25kg (m)	67.8kg (m)	130kg (m)	227kg (m)	309kg (m)
PTS	183 dB (LF)	630	2,100	3,500	4,800	6,300	7,400
	185 dB (HF)	<50	<50	<50	<50	<50	<50
	155 dB (VHF)	200	560	800	980	1,100	1,200
	185 dB (PCW)	110	380	630	860	1,100	1,300
TTS	168 dB (LF)	8,800	29,000	45,000	60,000	75,000	85,000
	170 dB (HF)	<50	150	230	310	380	430
	140 dB (VHF)	1,300	2,400	2,900	3,200	3,500	3,700
	170 dB (PCW)	1,500	5,200	8,200	11,000	14,000	16,000

Table 12.64 Summary of the Mortality and Potential Mortal Injury Effect Ranges for Unmitigated UXO Detonation using the Unweighted SPL_{peak} Explosions Noise Criteria from Popper et al. (2014) for Marine Turtles

Popper *et al.* (2014) Unweighted SPL_{peak}		Low Order (m)	25kg (m)	67.8kg (m)	130kg (m)	227kg (m)	309kg (m)
Mortality & Potential Mortal Injury	234 dB	80	170	240	300	370	410
	229 dB	120	290	410	510	610	680

12.7.2.5 Significance of Effect

431. For PTS, taking into account high marine mammal and marine turtle sensitivity, and the potential magnitude of the effect (i.e. number of individuals as a percentage of the reference population; **Table 12.57**), the significance of effect for permanent changes in hearing sensitivity (PTS) from high-order UXO detonations, with no mitigation, has been assessed as (**Table 12.65**):

- **Major adverse** for harbour porpoise
- **Minor to major adverse** for grey seal
- **Moderate adverse** for common dolphin, striped dolphin and minke whale
- **Minor adverse** for bottlenose dolphin and leatherback turtle.

432. The effect significance for permanent changes in hearing sensitivity (PTS) from low-order UXO detonations, with no additional mitigation, has been assessed as (**Table 12.65**):

- **Major adverse** for harbour porpoise
- **Moderate adverse** for common dolphin
- **Minor to moderate adverse** for grey seal
- **Minor adverse** for bottlenose dolphin, striped dolphin, minke whale and leatherback turtle.

433. For TTS, taking into account medium marine mammal and marine turtle sensitivity, and the potential magnitude of the effect (**Table 12.58**), the effect significance for temporary changes in hearing sensitivity (TTS) from high-order UXO detonations has been assessed as (**Table 12.66**):

- **Minor adverse** for harbour porpoise and minke whale
- **Negligible to minor adverse** for grey seal
- **Negligible** for bottlenose dolphin, common dolphin, striped dolphin and leatherback turtle.

434. The significance of effect for temporary changes in hearing sensitivity (TTS) from low-order UXO detonations has been assessed as **minor adverse** for harbour porpoise, and **negligible** for bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle (**Table 12.66**).

435. For the potential for disturbance due to high-order UXO clearance, taking into account the marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (**Table 12.58**), the effect significance has been assessed as **negligible to minor adverse** for all species assessed (

436. **Table** 12.67).

437. For the potential for disturbance due to low-order clearance, taking into account the marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (**Table 12.58**), the effect significance has been assessed as **negligible to minor adverse** for all species assessed (

438. **Table** 12.67).

439. For the potential for disturbance due to ADD activation prior to high-order UXO clearance, taking into account the marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (**Table 12.58**), the effect significance has been assessed as **negligible to minor adverse** for all species assessed (

440. **Table** 12.67).

441. For the potential for disturbance due to ADD activation prior to low-order UXO clearance, taking into account the marine mammal and marine turtle sensitivity (**Table 12.43**), and the potential magnitude of the effect (**Table 12.58**), the effect significance has been assessed as **negligible** for all species assessed (

442. **Table** 12.67).

Table 12.65 Assessment of Effect Significance for PTS in Marine Mammals and Marine Turtles from Underwater Noise During High-Order and Low-Order UXO Clearance

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
PTS from high-order detonation	Harbour porpoise	High	Medium	Major adverse	MMMP (**Section 12.7.2.6**)	Minor adverse
	Bottlenose dolphin		Negligible	Minor adverse		Minor adverse
	Common dolphin, striped dolphin, minke whale		Low	Moderate adverse		Minor adverse
	Grey seal		Medium for the ECC; Negligible to low for the Windfarm Site	Major adverse for the ECC; Minor to moderate adverse for the Windfarm Site		Minor adverse
	Leatherback turtle		Negligible	Minor adverse		Minor adverse
PTS from low-order detonation	Harbour porpoise		Medium	Major adverse		Minor adverse
	Bottlenose dolphin, striped dolphin, minke whale		Negligible	Minor adverse		Minor adverse

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
	Common dolphin		Low	Moderate adverse		Minor adverse
	Grey seal		Negligible to low for the ECC; Negligible for the Windfarm Site	Minor to moderate adverse for the ECC; Minor adverse for the Windfarm Site		Minor adverse
	Leatherback turtle		Negligible	Minor adverse		Minor adverse

Table 12.66 Assessment of Effect Significance for TTS in Marine Mammals and Marine Turtles from Underwater Noise During High-Order and Low-Order UXO Clearance

Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
TTS from high-order detonation	Harbour porpoise, minke whale	Medium	Low	Minor adverse	None required, however, the MMMP will reduce the potential for TTS	Minor adverse
	Bottlenose dolphin, common dolphin, striped dolphin		Negligible	Negligible		Negligible
	Grey seal		Negligible to low for the ECC;	Negligible to minor adverse for the ECC;		Negligible to minor adverse

Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
			Negligible for the Windfarm Site	Negligible for the Windfarm Site		
	Leatherback turtle		Negligible	Negligible		Negligible
TTS from low-order detonation	Harbour porpoise		Low	Minor adverse		Minor adverse
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, leatherback turtle		Negligible	Negligible		Negligible

Table 12.67 Assessment of Effect Significance for Disturbance in Marine Mammals and Marine Turtles from Underwater Noise During High-Order and Low-Order UXO Clearance

Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Disturbance from high-order detonation	Harbour porpoise, minke whale	Medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin, common dolphin, striped dolphin		Negligible	Negligible		Negligible

Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
	Grey seal		Negligible to low for the ECC; Negligible for the Windfarm Site	Negligible to minor adverse for the ECC; Negligible for the Windfarm Site		Negligible to minor adverse
	Leatherback turtle		Negligible	Negligible		Negligible
Disturbance from low-order detonation	Harbour porpoise		Low	Minor adverse		Minor adverse
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, leatherback turtle		Negligible	Negligible		Negligible
Disturbance from ADD activation prior to high-order UXO clearance	Harbour porpoise, bottlenose dolphin, minke whale, leatherback turtle		Negligible	Negligible		Negligible
	Common dolphin, striped dolphin		Low	Minor adverse		Minor adverse
	Grey seal		Negligible to low	Negligible to minor adverse		Negligible to minor adverse
Disturbance from ADD activation prior to low-order UXO clearance	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey		Negligible	Negligible		Negligible

Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
	seal, leatherback turtle					

12.7.2.6 Further Mitigation

443. As outlined in **Section 12.4.4**, a MMMP for UXO clearance will be produced post-consent in consultation with the MMO and relevant SNCBs (such as Natural England). The final MMMP for UXO clearance will be based on the latest scientific understanding and guidance, pre-construction UXO surveys at the Windfarm Site, as well as detailed project design. The implementation of the mitigation measures within the MMMP for UXO clearance will reduce the risk of any PTS during UXO clearance. The mitigation measure would also reduce the risk of TTS.

444. The proposed mitigation measures for consideration in the MMMP for UXO clearance include, the use of low-order clearance techniques, such as deflagration, establishing a monitoring zone and surveying prior to UXO clearance, the use of ADDs if any high-order detonations are required. As noted in **Table 12.16**, high-order clearance will only be undertaken in the event that all other options are not possible, following the identified hierarchy.

445. A Marine Wildlife Licence (EPS) application, if required, will be submitted post-consent. At this time, pre-construction UXO surveys would have been conducted, and full consideration will have been given to any necessary mitigation measures that may be required following the development of the MMMP for UXO clearance.

12.7.2.7 Residual Effect Significance

446. Taking into account the mitigation to reduce the risk of PTS, the residual effect of the potential risk of PTS to marine mammals as a result of underwater noise during piling would be **minor adverse** (not significant) for all species (**Table 12.53**), with the proposed mitigation (**Section 12.7.1.5**).

447. The mitigation to reduce the risk of PTS would also reduce the risk of TTS. The residual effect of the potential risk of TTS to marine mammals as a result of underwater noise during piling, would be **negligible to minor adverse** (not significant) for all species (**Table 12.54**).

12.7.3 Impact 3: Underwater Noise from Other Activities

448. Potential sources of underwater noise during construction activities, other than impact piling or UXO clearance, include foundation installation (if OSP required) using non-impact piling techniques, seabed preparation, anchor dragging/embedment, dredging, rock placement, drilling (if piling is technically refused (i.e. the pile cannot breach the seabed to the required depth) at any location), trenching and cable installation.

449. The seabed preparation methods with the potential for underwater noise include:

- Backhoe dredging
- Suction dredging.

450. The foundation installation methods (other than impact piling) that are currently being considered are:

- Drag embedment anchors
- Suction piles.

451. The cable installation methods that are currently being considered are:

- Trenching
- Mechanical cutting; Surface laid with cable protection where burial is not possible
- Rock placement for protection of the cables.

452. There are no clear indications that underwater noise caused by the installation of sub-sea cables poses a high risk of harming marine fauna (OSPAR, 2009). However, behavioural responses of marine mammals and marine turtles to dredging, an activity emitting comparatively higher underwater noise levels, are predicted to be similar to those during cable installation (OSPAR, 2009).

453. Dredging produces continuous, broadband sound. Sound pressure levels (SPLs) can vary widely, for example, with dredger type, operational stage, or environmental conditions (e.g. sediment type, water depth, salinity and seasonal phenomena such as thermoclines (Jones and Marten, 2016)). These factors will also affect the propagation of sound from dredging/cable installation activities and along with ambient sound already present, will influence the distance at which sounds can be detected.

454. Dredging/cable installation activities have the potential to generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals and marine turtles. Noise measurements indicate that the most intense sound emissions from trailing suction hopper dredgers (TSHD) are typically low frequencies, up to and including 1kHz (Robinson *et al.,* 2011) and is comparable to those for a cargo ship travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011).

455. Reviews of published sources of underwater noise during dredging activity (e.g. Thomsen *et al.,* 2006; Theobald *et al.,* 2011; Todd *et al.,* 2014), indicate that the

sound levels that marine mammals and marine turtles may be exposed to during dredging activities are typically below PTS exposure criteria (as defined in Southall *et al.,* 2019). Therefore, the potential risk of any auditory injury in marine mammals and marine turtles as a result of dredging activity is highly unlikely. The thresholds for TTS could be exceeded during dredging, however, only if marine mammals and marine turtles remain in close proximity to the active dredger for extended periods, which is highly unlikely (Todd *et al.,* 2014).

456. Underwater noise as a result of dredging activity/cable installation, also has the potential to disturb marine mammals and marine turtles (Pirotta *et al.,* 2013). Therefore, there is the potential for short, perhaps medium-term behavioural reactions and disturbance to marine mammals and marine turtles in the area during dredging/cable installation activity. Marine mammals and marine turtles may exhibit varying behavioural reactions intensities as a result of exposure to noise (Southall *et al.,* 2007; Deruiter and Doukara, 2012).

457. The noise levels produced by dredging activity/cable installation, could overlap with the hearing sensitives and communication frequencies used by marine mammals marine turtles (Todd *et al.,* 2014), and therefore have the potential to impact marine mammals and marine turtles present in the area. However, species such as harbour porpoise have a relatively poor sensitivity below 1kHz, and are less likely to be affected by masking, although for seals there could be the potential of masking communication, especially during the breeding season (Todd *et al.,* 2014).

458. The cutting and removal of cables has the potential to generate underwater noise levels, however, cable cutting (such as diamond wire cutting for the removal of subsea structures) has not been studied in detail. One available study found that noise levels did not exceed approximately 130 dB SPL_{rms} and is therefore significantly below any marine mammal noise thresholds for continuous noise. Cable cutting has therefore not been considered further. See **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** for further information).

12.7.3.1 Magnitude of Effect

12.7.3.1.1 Potential for Effect from Permanent or Temporary Injury (Auditory)

459. The number of marine mammals and marine turtles that could be impacted as a result of underwater noise during construction from activities other than piling has been assessed based on the number of animals that could be present in each of the modelled impact ranges for the construction activities (**Table 12.70**).

460. It is important to note that PTS is unlikely to occur in marine mammals as the modelling indicates that an individual would have to remain less than 10m for 12 hours, for any potential risk of PTS (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**). Therefore, PTS as a result of construction activity, other than piling, is highly unlikely and has not been assessed further.

461. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that in most cases, the marine mammal would have to remain at less than 10m from the activity for a 12-hour period. For some of the activities, the effect ranges are higher than 10m, as shown in **Table 12.70**. Therefore, TTS as a result of construction activity, other than piling, is considered highly unlikely, but has been assessed further (**Table 12.68**).

462. As a worst-case, the following assessment for TTS assumes that more than one (and potentially all) could be taking place at the same time, or within the same day. Therefore assessments are provided for all effect areas together (**Table 12.68**).

463. For any one activity, the magnitude of the potential effect for any TTS as a result of non-piling construction noise is **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale and grey seal. With less than 1% of the reference populations exposed to any temporary impact (**Table 12.68**).

464. There is the potential that more than one of these activities could be underway at the ECC and/or Windfarm Site at the same time. As a worst-case and unlikely scenario, an assessment for all seven of these construction activities being undertaken simultaneously has also been undertaken. The magnitude of the potential impact of TTS as a result of non-piling construction noise is **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale and grey seal (**Table 12.68**).

465. The potential for TTS effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, are not consistent throughout the offshore construction periods for the Offshore Project. Therefore, would be limited to only part of the overall construction period and area at any one time.

466. It should be noted that the predicted impact ranges are the distances which represent the 'onset' stage, which is the minimum exposure that could potentially lead to the start of an effect and may only be marginal. In most hearing groups, the noise levels are low enough that there is negligible risk.

467. For leatherback turtles, based on the noise criteria for continuous noise (Popper *et al.*, 2014), there is a low risk of mortality and potential mortal injury, or recoverable injury, in the near (<100m), intermediate fields (>100m and <1,000m), and far field (>1,000m). For TTS, there is a moderate risk in the near field (<100m), and a low risk of TTS in the intermediate (>100m and <1,000m) and far fields (>1,000m).

468. Given the low number of leatherback turtles in the area, and the low risk of mortality and potential mortal injury, or recoverable injury, at any distance it is unlikely that any individuals would at risk of these effects occurring. Likewise, for the potential for TTS, within the moderate risk of effect area (of less than 100m), it is unlikely that there would be significant presence of the species in the localised area for the species to be at risk of TTS in any individuals. Within the low area of effect for TTS (or more than 100m), it remains unlikely for any leatherback turtles to be present given the rarity in the area. Therefore, the magnitude of effect, without any mitigation, is assessed as **negligible**, for underwater noise effects (injury) due to other construction activities.

Table 12.68 Maximum Number of Individuals (and % of Reference Population) that Could be at Risk of TTS (SEL_{cum}) as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for Each Individual Activity and For All Activities Taking Place at the Same Time

Species	Activity	Maximum Number of Individuals (% of Reference Population) for TTS for Each Individual Activity	Magnitude (Temporary Effect)	Activity	Maximum Number of Individuals (% of Reference Population) for TTS for all Activities at the Same Time	Magnitude (Temporary Effect)
Harbour porpoise	• Drag embedment anchors • Cable laying • Trenching • Backhoe dredging.	0.0003 based on the APEM summer density (0.0000005% of CIS MU) 0.0002 based on the APEM annual density (0.0000003% of CIS MU)	**Negligible**	All construction activities (other than impact piling) undertaken at the same time	4.7 based on the APEM summer density (0.005% of CIS MU) 3.1 based on the APEM annual density (0.008% of CIS MU)	**Negligible**
	• Suction pile installation.	1.8 based on the APEM summer density (0.003% of CIS MU) 1.1 based on the APEM annual density (0.002% of CIS MU)	**Negligible**			
	• Suction dredging.	0.15 based on the APEM summer density (0.0002% of CIS MU)	**Negligible**			

Species	Activity	Maximum Number of Individuals (% of Reference Population) for TTS for Each Individual Activity	Magnitude (Temporary Effect)	Activity	Maximum Number of Individuals (% of Reference Population) for TTS for all Activities at the Same Time	Magnitude (Temporary Effect)
		0.10 based on the APEM annual density (0.0002% of CIS MU)				
	• Rock placement.	2.8 based on the APEM summer density (0.005% of CIS MU) 1.8 based on the APEM annual density (0.003% of CIS MU)	**Negligible**			
Bottlenose dolphin	• Drag embedment anchors • Cable laying • Trenching • Backhoe dredging • Suction pile installation • Suction dredging • Rock placement.	0.00002 (0.0000002% of CIS MU)	**Negligible**		0.0001 (0.000001% of CGNS MU)	**Negligible**
Common dolphin		0.002 based on the APEM winter density (0.000002% of CGNS MU) 0.001 based on the APEM winter density (0.000001% of CGNS MU)	**Negligible**		0.01 based on the APEM winter density (0.00001% of CGNS MU) 0.008 based on the APEM winter density (0.000008% of CGNS MU)	**Negligible**
Striped dolphin		0.0002 (0.000001% of reference population)	**Negligible**		0.001 (0.000008% of the reference population)	**Negligible**

Species	Activity	Maximum Number of Individuals (% of Reference Population) for TTS for Each Individual Activity	Magnitude (Temporary Effect)	Activity	Maximum Number of Individuals (% of Reference Population) for TTS for all Activities at the Same Time	Magnitude (Temporary Effect)
Minke whale		0.000004 (0.00000002% of CGNS MU)	**Negligible**		0.00002 (0.0000001% of CGNS MU)	**Negligible**
Grey seal		0.00004 based on the ECC density (0.000002% of SW MU; 0.0000003% of combined MU) 0.000002 based on the ECC density (0.0000001% of SW MU; 0.00000001% of combined MU)	**Negligible**		0.0003 based on the ECC density (0.00001% of SW MU; 0.000002% of combined MU) 0.00001 based on the ECC density (0.0000005% of SW MU; 0.0000001% of combined MU)	**Negligible**

12.7.3.1.2 Potential for Effect from Disturbance

469. The noise level generated by the construction activities are barely audible above the predicted vessel noise (**Section 12.7.3.5**). If the response is displacement from the area, it is predicted that marine mammals and marine turtles will return once the activity has been completed, and therefore any effects from underwater noise as a result of construction activities other than piling noise will be both localised and temporary.

470. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources).

471. Southall *et al.* (2007) present a review of behavioural response studies in marine mammals, according to the behavioural severity scores. For continuous noise sources, the lowest SPL at which a score of five or more was recorded for whale species was 90dB to 100dB re 1 μPa (rms). However, this relates to a study involving migrating grey whales.

472. One study recorded a significant behavioural response on a single harbour seal at a received level of 100 to 110dB re 1 μPa (rms), although other studies found no response much higher received levels of up to 140dB re 1 μPa (rms) (Southall *et al.,* 2007).

473. The noise levels generated by the majority of the other construction activities are not significantly higher than the noise levels associated with vessels (e.g. drag embedment anchor installation, cable laying, trenching, backhoe dredging, and rock placement have source levels of <172dB re 1 μPa @ 1m (rms), compared to a source level of 168dB re 1 μPa@ 1m (rms) for a large vessel (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**).

474. In 2012, 21 grey seals on the UK coast of the Southern North Sea were tagged (Russell, 2016b). Of those, 18 of the tags were in place for sufficient time to determine key foraging areas of grey seals in the southern North Sea. The results of this study show foraging activity of grey seals off the east coast of the UK (**Figure 12.25;** Russell, 2016b). The results of this tagging study show foraging activity (in red) within Sheringham Shoal OWF which was undergoing construction, with turbine installation undertaken from 2011 to 2012, and cabling works from 2010 to 2012. This indicates that grey seals would still undertake foraging activity during windfarm construction activities.

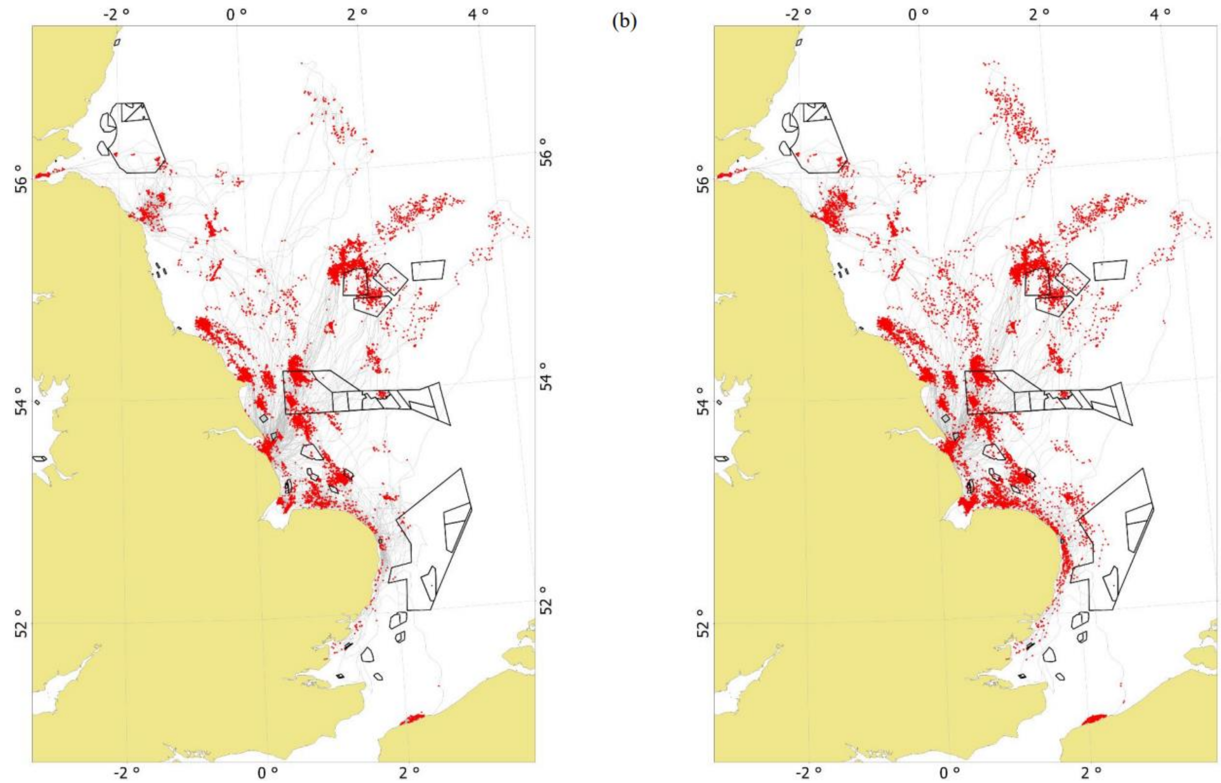

Figure 12.25 The Tracks (Grey) and Estimated Foraging Locations (Red) of Tagged Grey Seals in Geo- (a) and Hydro- (b) Space (Russell, 2016b).

475. Studies undertaken during the construction of two Scottish windfarms (Beatrice OWF and Moray East OWF) (Benhemma-Le Gall *et al.,* 2021), found that the probability of harbour porpoise being present increased with distance from the vessels and construction activities, and decreased with increasing vessel presence and background noise. During the period of turbine installation at Beatrice OWF, a significant reduction in harbour porpoise presence was detected even while no piling was taking place. Various construction activities were undertaken during this turbine installation phase, including jacket installation, turbine and cable installations, with some activities occurring simultaneously, which led to high levels of vessel traffic within the OWF site.

476. A reduction in porpoise presence was detected at up to 12km from pile driving, and up to 4km from construction related vessels (**Figure 12.26**; Benhemma-Le Gall *et al.,* 2021). With construction vessels at 2km from CPOD locations, harbour porpoise activity decreased by up to 35.2%, with construction vessels at 3km from the CPODs, there was a decrease of up to 24%, and at 4km from construction vessels, there was an increase of 7.2%. Outside of the piling period, the study found that

the presence of harbour porpoise decreased by 17% with SPLs of 57dB (above ambient noise). It was not possible to determine what activities were being undertaken by the construction vessels in order to determine what activity was causing this effect (Benhemma-Le Gall *et al.,* 2021).

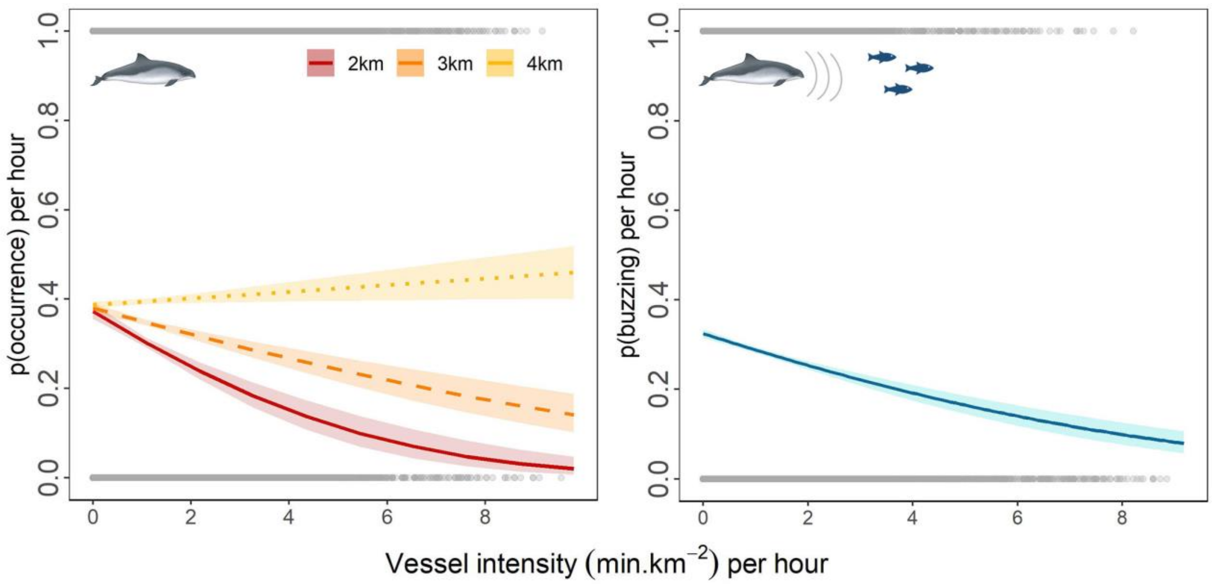

Figure 12.26 [Left] The Probability of Harbour Porpoise Presence in Relation to Vessel Activity (Red = Mean Vessel Distance of 2km, Orange = Mean Vessel Distance of 3km, Yellow = Mean Vessel Distance of 4km, and [Right] the Probability of Buzzing Activity Per Hour in Relation to Vessel Activity (Benhemma-Le Gall et al., 2021)

477. While the study did not define which activities were taking place to cause the disturbance, it was while a number of construction vessels were on site (Benhemma-Le Gall *et al.,* 2021). Therefore, this reported 4km reduction in harbour porpoise presence has been used as a potential disturbance range for other construction activities in this assessment. As harbour porpoise are the most sensitive marine mammal species, this 4km potential disturbance range (with a potential effect area of 50.27km^2) has been used to also inform the assessment for minke whale and grey seal, due to the absence of any other data to inform an assessment.

478. All related construction activities are considered to be a moving source, and therefore once the activity / vessel moves past a certain area, the marine mammals would return to baseline numbers.

479. An assessment of the maximum number of harbour porpoise, minke whale, and grey seal that could be at risk of disturbance due to other construction activities, based on the 4km potential disturbance range (with an effect area of 50.3km^2) is presented in **Table 12.69**.

480. This is a precautionary approach as it is unlikely that all marine mammal species would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place.

481. The magnitude of the potential effect is assessed as **negligible** for all marine mammal species, for any of the construction activities (**Table 12.69**).

482. In the case that multiple construction activities were to take place at the same time, the magnitude of effect would be **negligible** for harbour porpoise, minke whale and grey seal (**Table 12.69**).

483. For grey seal, the assessment assumes that three of these activities may take place within the ECC at any one time, and the remainder (four) may take place within the Windfarm Site. It is unlikely that all seven activities would take place in only one of the Offshore Project areas.

484. As noted in **Section 12.7.1.1.3.5**, for dolphin species, there is very little information on the potential disturbance ranges due to construction activities. However, it is likely that dolphin species are less sensitive to noisy activities than other marine mammal species, given their significantly lower PTS and TTS effect ranges (e.g. **Table 12.49** and **Table 12.50**), and potential disturbance ranges (e.g. **Section 12.7.1.1.3.6**), than is seen for other marine mammal species.

485. Therefore, in the absence of any further information, for dolphin species, the assessment as undertaken for TTS / fleeing response (**Table 12.68**) is used to inform the potential for a disturbance effect for all dolphin species, and represents the worst-case for currently available information. Therefore, for all dolphin species, the potential magnitude of effect is **negligible** for disturbance from other construction activities.

Table 12.69 Maximum Number of Harbour Porpoise, Minke Whale, and Grey Seal (and % of Reference Population) that could be Disturbed During Other Construction Activities

Species	One Activity			All Activities at the Same Time		
	Estimated Disturbance Range for Other Construction Activities for (and Area (km^2))	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Estimated Disturbance Area for All Other Construction Activities (km^2)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Harbour porpoise	4km (50.3km^2)	46.1 (0.07% of CIS MU based on the APEM summer density estimate) 29.9 (0.05% of CIS MU based on the APEM annual density estimate)	**Negligible**	351.86km^2	323.0 (0.52% of CIS MU based on the APEM summer density estimate) 209.0 (0.33% of CIS MU based on the APEM annual density estimate)	**Negligible**
Minke whale	4km (50.3km^2)	0.6 (0.003% of CGNS MU)	**Negligible**	351.86km^2	3.9 (0.02% of CGNS MU)	**Negligible**

Species	One Activity			All Activities at the Same Time		
	Estimated Disturbance Range for Other Construction Activities for (and Area (km^2))	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)	Estimated Disturbance Area for All Other Construction Activities (km^2)	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
Grey seal	4km (50.3km^2)	6.0 based on the ECC density estimate (0.30% of SW MU; 0.05% of the combined MU) 0.24 based on the Windfarm Site density estimate (0.01% of SW MU; 0.002% of the combined MU)	**Negligible**	351.86km^2	19.0 based on three activities within the ECC, and four activities within the Windfarm Site (0.95% of SW MU; 0.15% of the combined MU)	**Negligible**

486. Under the Popper *et al.*, (2014) criteria for continuous noise, there is a high risk of masking / behavioural response in the near field (<100m). Within the intermediate field (>100m and <1,000m), there is a high risk of masking and a moderate risk of behavioural response, and in the far field (>1,000m), there is a low risk of masking and behavioural response.

487. Within the high risk area for both masking and behavioural response (of less than 100m), given the low number of leatherback turtles in the area, it is highly unlikely that any individuals would be present, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. For the potential for a masking effect, there is also a high risk within the intermediate field (of between 100m and 1,000m). However, it remains highly unlikely that any individual would be present, and therefore highly unlikely that any individual would be exposed to a potential masking effect.

488. Within the moderate risk of effect area for a potential behavioural response (of between 100m and 1,000m), it is also highly unlikely that any individual would be present, and therefore highly unlikely that any individual would be exposed to the effect. Within the low risk of masking/behavioural response effect area (of more than 1,000m), it is unlikely that any individual would be present, and therefore unlikely that any individual would be exposed to a potential masking/behavioural response effect. Therefore, given the very low potential for presence in the high and moderate risk of masking and behavioural response area, as well as low potential for presence in the low risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

12.7.3.1.2.1 Duration of Other Construction Activities

489. The potential for disturbance that could result from underwater noise during other construction activities would be temporary in nature, not consistent throughout the offshore construction period, and would be limited to only part of the overall construction period and area at any one time.

490. The maximum duration for the offshore construction period, including piling and export cable installation, is up to 16 months for the Offshore Project. However, construction activities would not be underway constantly throughout this period. Further details on the construction schedule are provided in **Chapter 5: Project Description**.

491. The duration of offshore ECC installation and trenching activities is expected to take over a two to six month period, with an estimated 91 days on site for each construction year (**Table 12.14**).

12.7.3.2 Sensitivity of the Receptor

492. All species of marine mammals and marine turtles are considered to have a high sensitivity to PTS due to construction activities if they are within the potential effect ranges for physical injury or PTS. Marine mammals and marine turtles within the potential effect area are considered to have very limited capacity to avoid such effects, and unable to recover from physical injury or auditory injury.

493. The sensitivity of marine mammals and marine turtles to TTS and disturbance as a result of underwater noise during construction activities, other than piling, is considered to be medium in this assessment as a precautionary approach (**Table 12.43**). Marine mammals and marine turtles within the potential disturbance area are considered to have limited capacity to avoid such effects (**Table 12.6**), although any disturbance to marine mammals and marine turtles would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

12.7.3.3 Underwater Noise Modelling

494. Underwater noise modelling was undertaken to assess the potential effect ranges of construction activities, other than impact piling, on marine mammals, and this has been used to determine the potential effect on marine mammal species. The underwater noise propagation modelling was undertaken using a simple modelling approach for a number of offshore construction activities; using measured sound source data scaled to relevant parameters for the Offshore Project (see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** for further information). The activities that were assessed include:

- Foundation installation methods (other than piling):
  - Noise from drag embedment anchors for WTG mooring (with a source level of 171 dB re 1 µPa @1m (note that vessel noise is likely to be the dominant noise source with this foundation installation method))
  - Noise from suction pile installation for the OSP (with a source level of 192 dB re 1 µPa @1m)
- Cable installation methods:
  - Noise from a cable laying vessel (with a source level of 171 dB re 1 µPa @1m)
  - Noise from trenching (with a source level of 172 dB re 1 µPa @1m)

- Seabed preparation methods:
  - Two types of dredging, backhoe (with a source level of 165 dB re 1 µPa @1m) and suction (with a source level of 186 dB re 1 µPa @1m)
- Cable protection:
  - The noise from rock placement (with a source level of 172 dB re 1 µPa @1m).

495. For SEL_{cum} calculations, the duration of the noise is also considered, with all sources operating for a worst-case of 12-hours in a day for non-impulsive noise.

496. To account for the weightings required for modelling using the Southall *et al.* (2019) criteria, reductions in source level have been applied to the various noise sources (see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** for further information).

497. The cumulative effect ranges are to the nearest 10m. However, they are likely to be less than 10m, especially for PTS impact ranges.

12.7.3.3.1 Results

498. The results of the underwater noise modelling (**Table 12.70**) indicate that any marine mammal would have to be less than 10m (precautionary maximum range) from the continuous noise source for 24 hours, to be exposed to noise levels that could induce PTS or TTS, with the exception of harbour porpoise, and the predicted impact ranges for TTS of 990m for rock placement, 230m for suction dredging, and 780m for suction pile installation based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

499. As a worst-case approach, there is the potential for all activities to be undertaken at the same time, and therefore an assessment will also be undertaken for all areas of effect, based on the total area of effect for all activities provided in **Table 12.70**.

Table 12.70 Predicted Effect Ranges (and Areas) for PTS and TTS from Cumulative Exposure of Other Construction Activities

Southall *et al.*, (2019) Weighted SEL_{cum}	Harbour Porpoise	Bottlenose Dolphin, Common Dolphin And Striped Dolphin	Minke Whale	Grey Seal
PTS				

Southall *et al*., (2019) Weighted SEL_{cum}	Harbour Porpoise	Bottlenose Dolphin, Common Dolphin And Striped Dolphin	Minke Whale	Grey Seal
• **Drag embedment anchors** • **Suction pile installation** • **Cable laying** • **Trenching** • **Backhoe dredging** • **Suction dredging** • **Rock placement.**	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)
Total area for all seven activities at one time	0.002km^2	0.002km^2	0.002km^2	0.002km^2
TTS				
• **Drag embedment anchors** • **Cable laying** • **Trenching** • **Backhoe dredging.**	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)
Suction pile installation	780m (1.911km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)
Suction dredging	230m (0.166km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)
Rock placement	990m (3.079km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)	<10m (0.0003km^2)
Total area for all seven activities at one time	5.158km^2	0.002km^2	0.002km^2	0.002km^2

12.7.3.4 Significance of Effect

500. Taking into account the marine mammal and marine turtle sensitivity to TTS and disturbance (**Table 12.43**) and the potential magnitude of the effect, as assessed in **Table 12.69**, the significance of effect for construction activities other than piling has been assessed as **minor adverse** (not significant) for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle (**Table 12.71**).

501. The underwater noise impacts from non-piling noise will be significantly less than that of impact piling and will be localised and short term. Any potential disturbance would be temporary and therefore unlikely to significantly affect marine mammal populations.

Table 12.71 Assessment of impact significance for TTS from construction activities other than piling

Potential Impact	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
TTS during other construction activities	All marine mammals and marine turtles	Medium	Negligible	Minor adverse	None required	**Minor adverse**
Disturbance during other construction activities	All marine mammals and marine turtles	Medium	Negligible	Minor adverse		**Minor adverse**

12.7.3.5 Further Mitigation

502. As mentioned in **Table 12.71**, no mitigation is proposed for underwater noise from construction activities other than piling, as the risk of any impact is **negligible**.

12.7.4 Impact 4: Underwater Noise and Disturbance from Vessels

503. During the construction phase there will be an increase in the number of vessels; this is estimated to be up to a total of five vessels at the Windfarm Site including the ECC area, at any one time (**Table 12.14**). The number, type and size of vessels will vary depending on the activities taking place.

504. Vessel movements to and from any port will be incorporated within existing vessel routes, and therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the Windfarm Site and offshore ECC area.

505. **Chapter 15: Shipping and Navigation** provides a description of the baseline conditions. The main vessel types in the vicinity of the Offshore Project were fishing and tanker vessels, with cargo vessels and recreation vessels also being present. Vessel traffic analysis undertaken for April 2021 to March 2022 showed a total of between 20 and 80 vessel transits through the Windfarm Site, and between 250 and 500 vessels transited through the Study Area, per month (or up to nine and up to 17 vessel transits per day, respectively).

506. Within the ECC, there were up to 600 vessel transits per month in the summer period (or 20 vessel transits per day), which was significantly more than during the winter period, with less than 350 transits per month (or up to 12 vessel transits per day). As described within **Appendix 15.1: Navigational Risk Assessment**, there is an existing relatively high level of vessel traffic within the navigational Study Area (See **Appendix 15.1** for a description of the navigational Study Area), including the area close to the coastline. Shipping and navigation data indicate ten existing main routes within the navigational Study Area, with three intersecting the Windfarm Site (see **Chapter 15: Shipping and Navigation**).

507. During construction, existing vessel traffic could be displaced due to the presence of buoyed construction areas (including 500m rolling active safety zones around fixed structures where work is being undertaken), construction vessels and partially completed or pre-commissioned structures. These displaced vessels may then detour away from existing vessel routes that marine mammals and marine turtles are more accustomed to (see **Chapter 15 Shipping and Navigation**).

508. With a peak of five vessels (or up to ten vessel transits) expected to be on site at any one time during the construction period, there will be approximately a 56% increase in the daily vessel presence within the Study Area, as a worst-case, and approximately a 25% increase or 42% of the ECC vessel presence during the summer and winter periods respectively.

12.7.4.1 Magnitude of Effect

12.7.4.1.1 Potential for Effect from Permanent or Temporary Injury (Auditory)

509. Noise measurements indicate that the most intense sound emissions from a cargo ship are typically low frequencies, up to and including 1kHz (Robinson *et al.,* 2011) travelling at modest speed (between 8 and 16 knots) (Theobald *et al.,* 2011). Underwater noise from construction vessels of a similar size also has the potential to disturb marine mammals in the short-term, in areas of increased vessel traffic, but are unlikely to produce any permanent auditory injury (PTS) (Pirotta *et al.,* 2013).

510. The vessels will be slow moving (or stationary) and most noise emitted is likely to be of a lower frequency. Noise levels reported by Malme *et al.* (1989) and Richardson *et al.* (1995) for transiting large surface vessels indicate that physiological damage to auditory sensitive marine mammals and marine turtles is unlikely. The potential risk of permanent auditory injury (PTS) in marine mammals as a result of vessel activity is highly unlikely, as the sound levels that are produced by vessels is well below the threshold for permanent injury (Southall *et al.,* 2019). Trigg *et al.* (2020) found the predicted exposure of grey seals to shipping noise did not exceed thresholds for TTS. Thomsen *et al.* (2006) reviewed the effects of ship noise on harbour porpoise and seal species and concluded that ship noise around 0.25kHz could be detected at distances of 1km; and ship noise around 2kHz could be detected at around 3km.

511. A study of the noise source levels from several different vessels (Jones *et al.,* 2017) shows that for a cargo vessel of 126m in length (on average), travelling at a speed of 11 knots (on average) would generate a mean sound level of 160 dB re 1 µPa @ 1m (with a maximum sound level recorded of 187 dB re 1 µPa @ 1m). The levels could be sufficient to cause local disturbance to marine mammals and marine turtles in the immediate vicinity of the vessel, depending on ambient noise levels.

512. As noted above, PTS is considered unlikely to occur in marine mammals and marine turtles. The results of the underwater noise modelling support this, and indicate that a marine mammal would have to remain less than 10m from the source for 24 hours

for any potential risk of PTS (**Table 12.73**). Therefore, PTS due to vessel presence is highly unlikely to occur and has not been assessed further.

513. The number of marine mammals and marine turtles that could be impacted from TTS as a result of underwater noise due to vessels presence has been assessed based on the maximum effect area for large and medium sized vessels and for up to five vessels at each site, including in the ECC area (**Table 12.73**).

514. The magnitude of the potential impact of TTS as a result of construction vessel noise is **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale and grey seal (**Table 12.72**).

515. For leatherback turtles, the potential magnitude of effect due to the underwater noise associated with vessels is based on the noise criteria for continuous noise (Popper *et al.*, 2014), as has been used to assess the potential effects due to other construction activities, as discussed in **Section 12.7.4.1.1**. Therefore, the magnitude of effect, without any mitigation, is assessed as **negligible**, for underwater noise effects (injury) due to other construction activities.

Table 12.72 Maximum Number of Individuals (and % of Reference Population) that Could Be Impacted as a Result of Underwater Noise Associated with All Construction Vessels, Using Large Vessels as a Worst-Case

Potential Effect	Species	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
TTS from cumulative SEL, based on 24 hour exposure for large vessels, per vessel	Harbour porpoise	0.0003 based on the APEM summer density (0.0000005% of CIS MU) 0.0002 based on the APEM annual density (0.0000003% of CIS MU)	**Negligible**
	Bottlenose dolphin	0.00002 (0.0000002% of CIS MU)	**Negligible**
	Common dolphin	0.002 based on the APEM winter density (0.000002% of CGNS MU) 0.001 based on the APEM winter density (0.000001% of CGNS MU)	**Negligible**
	Striped dolphin	0.0002 (0.000001% of reference population)	**Negligible**
	Minke whale	0.000004 (0.00000002% of CGNS MU)	**Negligible**

Potential Effect	Species	Maximum Number of Individuals (% of Reference Population)	Magnitude (Temporary Effect)
	Grey seal	0.00004 based on the ECC density (0.000002% of SW MU; 0.0000003% of combined MU) 0.000002 based on the ECC density (0.0000001% of SW MU; 0.00000001% of combined MU)	**Negligible**
TTS from cumulative SEL, based on 24 hour exposure for large vessels, for up to five vessels	Harbour porpoise	0.001 based on the APEM summer density (0.000002% of CIS MU) 0.0009 based on the APEM annual density (0.000001% of CIS MU)	**Negligible**
	Bottlenose dolphin	0.0001 (0.000001% of CIS MU)	**Negligible**
	Common dolphin	0.008 based on the APEM winter density (0.000008% of CGNS MU) 0.006 based on the APEM winter density (0.000006% of CGNS MU)	**Negligible**
	Striped dolphin	0.001 (0.000005% of reference population)	**Negligible**
	Minke whale	0.00002 (0.0000001% of CGNS MU)	**Negligible**
	Grey seal	0.0002 based on the ECC density (0.000009% of SW MU; 0.000001% of combined MU) 0.000008 based on the ECC density (0.0000004% of SW MU; 0.0000001% of combined MU)	**Negligible**

12.7.4.1.2 Potential for Effect from Disturbance

516. Construction vessel activity may generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals. Whilst the main focus of concern remains on the loudest noise sources such as impact piling,

dredging etc., intense vessel activity during construction may also alter the acoustic habitat and disturb marine mammal species (Merchant *et al.,* 2014).

517. There is the potential for sensitive species with high metabolic requirements, such as the harbour porpoise, to be more vulnerable to anthropogenic stressors such as vessel noise, forcing individuals to make trade-off decisions between using energy to leave the area or remaining in exposed areas (Benhemma-Le Gall *et al.,* 2021). This additional energy use may have biological consequences in the short and long-term (Pirotta *et al.,* 2014), and harbour porpoise have been shown to be displaced by vessel activity up to 7km away depending on vessel type (Wisniewska *et al.,* 2018).

518. In a 2012 study, high-speed planing vessels (small boats, jet skis etc.) caused the most negative reactions in this species (Oakley *et al.,* 2017). Whilst short to medium term behavioural responses have been recorded from vessel disturbance, there are no long-term or population level effects recorded to date; therefore, harbour porpoise are deemed to have a medium sensitivity to disturbance from construction vessels.

519. Other cetacean species may also be disturbed by construction vessels, however, this is expected to a lesser degree than harbour porpoise. Minke whale have been shown to decrease foraging behaviour around wildlife tour boats, displaying horizontal avoidance behaviour and increased swimming speeds which may incur an energy cost (Machernis *et al.,* 2018). The sensitivity of minke whale to disturbance as a result of underwater noise due to construction vessels is considered to be medium in this assessment as a precautionary approach.

520. A study of the effect of a tour boat of the behaviour of common dolphins found that the likelihood of individuals remaining foraging decreased by 6.9% in the presence of the tour boat, and the time it took for the dolphins to return to foraging increased by 54% (to 13.9 minutes) (Stockin *et al.,* 2008). The total amount of time that common dolphins forage reduced when in the presence of tour boats, with an estimated reduction from a 33.5% foraging rate in control periods, to 23.5% during exposure periods (Stockin *et al.,* 2008).

521. New *et al.* (2013), used a model to calculate the potential consequences of an increase in vessels of 70 to 470 and the disturbance this may have on a bottlenose dolphin population. The model found no noticeable change in the dolphin group size, distribution, or activity budget, as individuals are able to avoid the disturbance, and travel to an undisturbed area (New *et al.,* 2013). However, due to the impractical nature of models with ecological features, the sensitivity of all dolphin

species to disturbance as a result of underwater noise due to construction vessels is considered to be low to medium in this assessment as a precautionary approach.

522. Pinnipeds vary in their reaction to vessels depending on vessel type and proximity to haul out sites; however, disturbance (flushing behaviour) has been demonstrated at haul-out sites in the UK up to 200m away if there are pups present (Cates *et al.,* 2017). Land-based disturbance has been shown to cause higher levels of disturbance compared to marine sources, and smaller, quiet vessels like kayaks can cause the highest levels of flushing behaviour (Bonner, 2021). In areas of high vessel traffic, there are habituation effects and disturbance behaviour is generally reduced (Strong *et al.,* 2010). A 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% four hours after disturbance (Paterson, 2019). Seals are therefore considered to have a low sensitivity to disturbance from construction vessel traffic.

523. As outlined in **Section 12.7.1**, Brandt *et al.* (2018) found that at seven German offshore windfarms in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice Offshore Wind Farm, indicate higher vessel activity within 1km was associated with an increased probability of response in harbour porpoise (Graham *et al*., 2019).

524. Studies in the Moray Firth indicate that at a mean distance of 2km from construction vessels, harbour porpoise occurrence decreased by up to 35.2% as vessel intensity increased. Harbour porpoise responses decreased with increasing distance to vessels, out to 4km where no response was observed (Benhemma-Le Gall *et al*., 2021).

525. During the periods when piling is underway, vessel noise is unlikely to add an additional impact to those assessed for piling, as the vessels and vessel noise would be within the maximum impact areas assessed.

526. The distance at which marine mammals and marine turtles may react to vessels is difficult to predict and behavioural responses can vary a great deal depending on species, location, type and size of vessel, vessel speed, noise levels and frequency, ambient noise levels, and environmental conditions.

527. Modelling by Heinänen and Skov (2015) indicates that the number of ships represents a relatively important factor determining the density of harbour porpoise in the North Sea MU during both seasons, with markedly lower densities with

increasing levels of traffic. A threshold level in terms of impact seems to be approximately 20,000 ships per year (approximately 80 vessels per day within a 5km^2 area).

528. Taking into account the maximum number of vessels that could be onsite during construction, the site area and the displacement of other vessels from the area, the number of vessels would not exceed the Heinänen and Skov (2015) threshold level of 80 vessels per day in a 5km^2 area for harbour porpoise.

529. For example, five vessels in the Windfarm Site (49.4km^2) would equate to approximately 0.1 vessels per km^2 (approximately 0.5 vessel per 5km^2). In addition, due to safety and logistical considerations during piling, it is likely that the number of vessels in a small area, for example, around a pile location during pile installation would be limited to a very low number of essential vessels only.

530. Studies on bottlenose dolphin found that boat physical presence, and not just noise, can result in disturbance (Pirotta *et al.,* 2015). However, disturbance and any reduction in foraging activity was short-term. The boat effect did not persist following boat passage and was limited to the time when the boat was physically present (Pirotta *et al.*, 2015).

531. Jones *et al.* (2017) produced usage maps characterising densities of grey seals and ships around the British Isles, which were used to produce risk maps of seal co-occurrence with shipping traffic. The analysis indicates that rates of co-occurrence were highest within 50 km of the coast, close to seal haul outs. When considering exposure to shipping traffic in isolation, the study found no evidence relating to declining seal population trajectories with high levels of co-occurrence between seals and vessels. For example, in areas of east England where the grey seal population is increasing there are high intensities of vessels (Duck and Morris, 2016; Jones *et al.*, 2017).

532. If the behavioural response is displacement from the area, it is predicted that marine mammals and marine turtles will return once the activity has been completed. Therefore, any impacts from underwater noise as a result of construction vessels will be both localised and temporary. There is unlikely to be the potential for any significant impact on marine mammals and marine turtles. As a precautionary approach, the magnitude for the disturbance of all marine mammals as a result of underwater noise and presence of vessels has been assessed as **low**.

533. For leatherback turtles, the potential magnitude of effect due to the underwater noise associated with vessels is based on the noise criteria for continuous noise (Popper *et al.*, 2014), as has been used to assess the potential effects due to other

construction activities, as discussed in **Section 12.7.4.1.1**. Therefore, the magnitude of effect, without any mitigation, is assessed as **negligible**, for underwater noise effects (disturbance) due to vessel presence.

12.7.4.1.2.1 Duration of Vessel Presence

534. The maximum duration for the offshore construction period, including piling and export cable installation, is up to 16 months. Therefore, it is assumed that construction vessels for the Windfarm Site, including the offshore ECC areas, will be present for up to 16 months, however, it is likely that construction activity will only take place on approximately 90 days within that period.

12.7.4.2 Sensitivity of the Receptor

535. The sensitivity of marine mammals and marine turtles to TTS and disturbance is considered to be **medium** as a precautionary approach, and **high** for PTS (see **Section 12.7.1.1**).

12.7.4.3 Underwater Noise Modelling

536. Underwater noise modelling was undertaken to assess the potential effect ranges of vessels at the Offshore Project, and this has been used to determine the potential effect on marine mammal species. The underwater noise propagation modelling was undertaken as described in **Section 12.7.3.3**. The two types of vessels assessed, and the associated noise source levels, are:

- Medium vessels:
  - Noise from medium sized vessels (vessels of less than 100m, with an assumed vessel speed of 10 knots), with a source level of 161 dB re 1 µPa @1m
- Large vessels:
  - Noise from large sized vessels (vessels of more than 100m such as container ship, floating production storage and FPSOs, with an assumed vessel speed of 10 knots), with a source level of 168 dB re 1 µPa @1m).

537. For SEL_{cum} calculations, the duration of the noise is also considered, with all sources operating for a worst-case of 24-hours in a day for non-impulsive noise.

538. To account for the weightings required for modelling using the Southall *et al.* (2019) criteria, reductions in source level have been applied to the various noise sources (see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** for further information).

539. The cumulative effect ranges are to the nearest 10m. However, they are likely to be less than 10m, especially for PTS impact ranges.

12.7.4.3.1 Results

540. The results of the underwater noise modelling (**Table 12.73**) indicate that any marine mammal would have to be less than 10m (precautionary maximum range) from a vessel for 24 hours, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}. As noted above, there is the potential for up to five vessels to be present at the Offshore Project at one time, and therefore an assessment will also be undertaken for five potential areas of effect at any one time, based on the area of effect provided in **Table 12.73**.

Table 12.73 Predicted Effect Ranges (and Areas) for PTS and TTS from Cumulative Exposure of Vessels

Southall *et al.*, (2019) Weighted SEL_{cum}	Harbour Porpoise	Bottlenose Dolphin, Common Dolphin And Striped Dolphin	Minke Whale	Grey Seal
PTS				
• **Medium vessels** • **Large vessels.**	<10m ($0.0003km^2$)	<10m ($0.0003km^2$)	<10m ($0.0003km^2$)	<10m ($0.0003km^2$)
Total area for up to five vessels present at one time	$0.0016km^2$	$0.0016km^2$	$0.0016km^2$	$0.0016km^2$
TTS				
• **Medium vessels** • **Large vessels.**	<10m ($0.0003km^2$)	<10m ($0.0003km^2$)	<10m ($0.0003km^2$)	<10m ($0.0003km^2$)
Total area for up to five vessels present at one time	$0.0016km^2$	$0.0016km^2$	$0.0016km^2$	$0.0016km^2$

12.7.4.4 Significance of Effect

541. Taking into account the marine mammal and marine turtle sensitivity to TTS and disturbance (**Table 12.43**) and the potential magnitude of the effect, as assessed in **Table 12.72** and **Section 12.7.4.1.1**, the effect significance for TTS and disturbance for underwater noise from construction vessels has been assessed as

minor adverse (not significant) for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle (**Table 12.74**).

Table 12.74 Assessment of Effect Significance for Underwater Noise and Disturbance From Construction Vessels

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
TTS from cumulative SEL for construction vessels (up to five vessels at any one time)	All marine mammals and marine turtles	Medium	Negligible	Negligible	None required, however best practice measures will be applied (**Section 12.1.1.1**).	**Negligible**
Disturbance from construction vessels	Harbour porpoise, minke whale	Medium	Low	Minor adverse		**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin	Low to medium	Low	Minor adverse		**Minor adverse**
	Grey seal	Low	Low	Minor adverse		**Minor adverse**
	Leatherback turtle	Medium	Negligible	Negligible		**Negligible**

12.7.4.5 Further Mitigation

542. No mitigation is proposed for underwater noise from construction vessels, as the risk of any effect is not significant.

543. Vessel movements where possible, will be incorporated into recognised vessel routes and hence to areas where marine mammals and marine turtles are accustomed to vessels, in order to reduce any impacts, including increased disturbance. All vessel movements will be kept to the minimum number that is required to reduce any potential impacts, including increased disturbance. Additionally, vessel operators will use best practice measures to reduce effects on marine mammals (see **Appendix 12.C: Draft MMMP**).

12.7.5 Impact 5: Barrier Effects Caused by Underwater Noise

544. Underwater noise during construction could have the potential to create a barrier effect, preventing movement or migration of marine mammals and marine turtles between important feeding and/or breeding areas, or potentially increasing swimming distances if marine mammals and marine turtles avoid the site and go around it. However, the Offshore Project, including the ECC, are not located on any known migration routes for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, grey seal, or leatherback turtle. Minke whale abundance is known to peak during the summer months due to their migrations (Paxton *et al*., 2016).

545. The relatively low seal at sea usage (Carter *et al.,* 2022) in and around the Offshore Project does not indicate any regular seal foraging routes through the sites. **Section 12.7.2.6** indicates that grey seal will still undertake foraging activity during wind farm construction activities, based on a study by Russell (2016b).

546. The Offshore Project is located approximately 52km from the coast. The nearest main seal haul out site is at Lundy Island, approximately 3.75km from the ECC and 43.5km from the Windfarm Site at the closest point (**Section 12.6.6**).

12.7.5.1 Sensitivity of the Receptor

547. All marine mammals and marine turtles are assessed as having medium sensitivity due to the disturbance of underwater noise during piling, as shown in **Table 12.43**.

12.7.5.2 Magnitude of Effect

548. The greatest potential barrier effect for marine mammals could be from underwater noise during piling (**Section 12.7.1**). As outlined in **Section 12.7.1.1**, piling would not be constant during the construction periods. There will be gaps between the installations of individual piles, and if installed in groups there could be time periods

when piling is not taking place as piles are brought out to the site. There will also be potential delays for weather or other technical issues.

549. The maximum duration of any barrier effects would be for the maximum piling duration, based on worst-case scenarios, including soft-start, ramp-up and ADD activation, as assessed in **Table 12.44**. The maximum duration of piling, based on worst case scenarios, including soft-start, ramp-up and ADD activation would be:

- Piling of up to 48 mooring pin piles (including soft-start, ramp-up and 31 minute ADD activation) = up to 131 hours (up to 5.5 days)
- Piling of up to four OSP jacket piles (including soft-start, ramp-up and 62 minute ADD activation) = up to 23 hours (0.95 days).

550. There is unlikely to be the potential for any barrier effects from underwater noise for other construction activities (**Section 12.7.2.6**) and vessels (**Section 12.7.3.5**), as it is predicted that marine mammals and marine turtles will return once the activity has been completed. Therefore, any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of marine mammals and marine turtles during the construction phase.

551. Marine mammals and marine turtles are wide ranging. For example, grey seals have a maximum foraging range of 448km (Carter *et al*., 2022). Therefore, if there are any potential barrier effects from underwater noise, marine mammals and marine turtles would be able to compensate by travelling to other foraging areas within their range.

552. There is unlikely to be any significant long-term impacts from any barrier effects, as any areas affected would be relatively small in comparison to the range of marine mammals and marine turtles and would not be continuous throughout the offshore construction period. The impacts are also temporary in nature. The magnitude of effect for any potential temporary barrier effects, based on worst-case, is assessed as **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle (**Table 12.75**).

12.7.5.3 Significance of Effect

553. Taking into account the **medium** marine mammal sensitivity and the potential magnitude of the impact, the impact significance for any potential barrier effects as a result of underwater noise during construction has been assessed as **minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common

dolphin, striped dolphin, minke whale, grey seal and leatherback turtle (**Table 12.75**).

Table 12.75 Assessment of Effect Significance for Any Barrier Effects from Underwater Noise

Potential Effect	Receptor	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Barrier effects caused by underwater noise	All marine mammals and marine turtles	Medium	Negligible	Minor adverse	None required	**Minor adverse**

12.7.5.4 Further Mitigation

554. Due to the significance of the impact being minor adverse, no mitigation is proposed. However, while not proposed, the measures in SIP will reduce potential barrier effects.

12.7.6 Impact 6: Interactions and Collision Risk with Vessels

555. During the offshore construction phase there will be an increase in vessel traffic within the Windfarm Site and ECC. However, it is anticipated that vessels would follow an established shipping route to the relevant port in order to minimise vessel traffic in the wider area. **Appendix 12.C: Draft MMMP** provides a protocol for minimising collision risk of marine mammals and marine turtles with vessels.

556. Construction related vessels are expected to be travelling at a slow speed while within the Offshore Project undertaking work, and for the WTG towing vessels, speeds would be limited.

12.7.6.1 Sensitivity of the Receptor

557. Marine mammals and marine turtles in and around the Offshore Project and in the wider Celtic Sea area would typically be habituated to the presence of vessels (given the existing levels of marine traffic, see **Chapter 15 Shipping and Navigation**) and would be able to detect and avoid vessels. However, as a precautionary approach, the sensitivity of marine mammals and marine turtles to collision risk with vessels during construction is considered to be high.

558. For both grey seal and harbour porpoise, bycatch is a significant cause of population loss within the wider populations, and for the CIS harbour porpoise population and Welsh grey seal population, bycatch is causing a significant level of mortality (NRW, 2020). The limit of which a population can withstand permanent removal of individuals, without reducing the overall population level, is the Potential Biological Removal (PBR) rate.

559. An alternative approach to assessing whether the loss of individuals from a population is significant is through using the 1% threshold, as used within the FCS assessments, which refers to a 1% change per year being significant (NRW, 2020). For both harbour porpoise and grey seal, the current evidence suggests that bycatch is causing an exceedance of both the PBR and 1% thresholds for the CIS and Welsh populations respectively (NRW, 2020). The advice from NRW is currently that an additional small level of population loss should not cause a significant effect to the populations (NRW, 2020).

560. Therefore, harbour porpoise and grey seal, for the potential for any permanent loss from the relevant populations, should be considered to be highly sensitive to the loss of individuals. However, as noted above, all marine mammal species are already considered to have a high sensitivity to collision risk.

561. For grey seal and harbour porpoise, the magnitude levels have been weighted to account for the already at risk harbour porpoise and grey seal populations due to bycatch. For these two species, the magnitude of effect will be assessed as high for any potential mortality effect that would affect more than 0.01% of the population (as per **Table 12.8**, the standard magnitude of effect would be high for any permanent effect to more than 1% of the population, and medium for any permanent effect to more than 0.01%). This would therefore allow for a small loss to the population as suggested by NRW (2020) but would indicate a high magnitude of effect for any more than a small change.

562. For all other marine mammal and marine turtle species, the magnitudes of effect as outlined in **Table 12.8** apply.

12.7.6.2 Magnitude of Effect

563. The approximate number of vessels on site at any one-time during construction is estimated to be five vessels, with an expected number of vessel movements during construction to be 101 (**Table 12.14**).

564. As outlined in **Chapter 15: Shipping and Navigation**, the baseline conditions indicate an already relatively high level of shipping activity in and around the Windfarm Site and the offshore ECC. Shipping and navigation data indicate 10 existing main routes within the navigational Study Area.

565. As described within **Chapter 15 Shipping and Navigation**, there is an existing relatively high level of vessel traffic within the navigational Study Area, including areas close to the coastline. Within the Shipping and Navigation Study Area, there is approximately 9-17 vessel transits per day. Within the ECC, in summer, an average of 20 vessel transits were recorded per day, and in winter an average of 12 vessel transits per day were recorded.

566. In total, for the construction of the Offshore Project, the daily construction vessel trips represent approximately a 56% increase in the daily vessel presence within the navigational Study Area, as a worst-case, and approximately a 25% increase or 42% of the ECC vessel presence during the summer and winter periods respectively.

567. Marine mammals and marine turtles are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and

socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al.,* 2007). Therefore, increased vessel movements, especially those outwith recognised vessel routes, can pose an increased risk of vessel collision to marine mammals and marine turtles.

568. Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80m in length causing the most damage to marine mammals and marine turtles (Laist *et al.,* 2001). Vessels travelling at high speeds are considered to be more likely to collide with marine mammals and marine turtles, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al.,* 2001).

569. Harbour porpoise are small and highly mobile and given their responses to vessel noise (e.g. Thomsen *et al.*, 2006; Polacheck and Thorpe, 1990) are expected to largely avoid vessel collisions. The Heinänen and Skov (2015) report indicates a negative relationship between the number of ships and the distribution of harbour porpoise, suggesting that the species could exhibit avoidance behaviour which reduces the risk of strikes.

570. In 2016, SMRU conducted a study to determine the likelihood of harbour seal injury occurring due to co-presence with large vessels within the Moray Firth (Onoufriou *et al.,* 2016). This study used telemetry data of harbour seal within the Moray Firth, alongside vessel AIS data. The data indicated vessel and seal co-occurrence was high (defined as over 2,500 co-occurrence minutes per year) in very localised areas. However, there appeared to be no relationship between areas in high co-occurrence and incidences of injury (Onoufriou *et al.,* 2016). While this study is focused on harbour seal rather than grey seal, it has been included as additional background as could provide an indication as to the relationship between vessels and collision with grey seal.Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.,* 2001, Lusseau, 2003, 2006).

571. Approximately 4% of all harbour porpoise post-mortem examinations from the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS area) are thought to have evidence of interaction with vessels (Evans *et al.,* 2011).

572. Analysis of the cause of death for loggerhead turtles in Italian waters found that boat strikes were confirmed as the cause of death for 3.9% of individuals. When including possible boat strikes, a total of 6.4% of individuals could have died as a result of vessel collision (Casale *et al.*, 2010), although it should be noted that this varied greatly between each region studied. Other studies found much higher

mortality rates for vessel collision. For example, 23.66% of turtle strandings in the Canary Islands were found to be due to vessel strike (Oros *et al*., 2005).

573. Both the Scottish Marine Animal Stranding Scheme (SMASS), Cetacean Strandings Investigation Programme (CSIP) and Cornwall Wildlife Trust (CWT) record strandings of marine mammals and undertake investigations to determine causes of fatalities where possible. SMASS record and investigate all marine mammal strandings reported to them in Scotland, and the CSIP record and investigate all recorded strandings of cetacean species in the UK. Data for RoI is also available from the Marine Institute (2022). **Table 12.76** below summarises the data for the relevant species, for the most recent available data of both schemes, and details the number of deaths caused by either vessel strike, or physical trauma with an unknown cause (which could be attributed to vessel strike).

574. For harbour porpoise, the cause of death was identified for a total of 1,615 of the reported strandings around the UK. Of these, 75 died from physical trauma of an unknown cause, and 16 died as a result of physical trauma following probable impact from a ship or boat (**Table 12.76**). This results in a collision risk rate of 0.056 (this is the proportion of the total harbour porpoise population at risk of collision due to vessels).

575. SMASS and CSIP identified the cause of death for a total of 45 bottlenose dolphin strandings, for 628 common dolphin, 109 striped dolphin, and for a total of 992 dolphins. Of these, 14 common dolphin, and 15 total dolphins, died as a result of physical trauma following probable impact from a ship or boat (**Table 12.76**). This results in collision risk rates of 0.022, 0.049, 0.028, and 0.044 for bottlenose dolphin, common dolphin, striped dolphin, and all dolphin species, respectively. As a precautionary approach, the collision risk rate used to inform the assessments will be the species specific rate, or the dolphin rate, whichever is highest.

576. A total of 86 stranded minke whale were investigated with a cause of death established; six of those were found to have been due to physical trauma following impact from a vessel. For all whale species, a total of 110 stranded individuals had a determined cause of death, with eight being a result of physical trauma following impact from a vessel. This results in a collision risk rate of 0.070 for minke whale, and 0.073 for all whale species (**Table 12.76**).

577. For grey seal, there were a total of 417 individuals where there was a cause of death established. Of these, none were as a result of physical trauma following probable impact from a ship or boat (**Table 12.76**). A total of 634 seals had an established cause of death, with none being as a result of physical trauma following impact from

a ship or boat. There were however a total of 18 grey seal and 24 seals that had a cause of death of unknown physical trauma. This results in a collision risk rate of 0.043 for grey seal, and 0.038 for all seals.

578. For leatherback turtles, there were a total of nine individuals where there was a cause of death established. Of these, none were as a result of physical trauma following probable impact from a ship or boat, and one had a cause of death of unknown physical trauma (**Table 12.76**). A total of 45 turtles had an established cause of death, with none being as a result of physical trauma following impact from a ship or boat, with one due to unknown physical trauma. This results in a collision risk rate of 0.111 for leatherback turtles, and 0.022 for all turtles.

579. The stranding's data collated (**Table 12.76**) shows that mortality of cetaceans from vessel collisions can occur. Although it accounts for a relatively small number of the strandings where cause of death was established. Whereas the proportion of individuals of leatherback turtle that could have died as a result of vessel collision is relatively high. This indicates that leatherback turtle are the most sensitive species to vessel collision that have been assessed. It is also important to note that the strandings data are biased to those carcasses that wash ashore for collection, and therefore may not be representative.

Table 12.76 Summary of UK Cetacean Strandings (2011-2017) and Causes of death From Physical Trauma of Unknown Cause and Physical Trauma Following Probable Impact from a Ship or Boat (Data from CSIP[13], SMASS[14], CWT[15], MEM[16], Marine Institute[17])

Species	Number of Post-Mortems Where Cause of Death Established	Cause of Death: Physical Trauma of Unknown Cause	Cause of Death: Physical Trauma Following Probable Impact From a Ship or Boat	Collision Risk Rate (Number Attributed to Vessels Strike / Other Physical Trauma as Proportion of Total Number Necropsied)
Harbour porpoise	1,615	75	16	0.056

[13] CSIP (2004); CSIP (2005); CSIP (2011); CSIP (2018) [available from: https://ukstrandings.org/csip-reports/]
[14] SMASS (2010); SMASS (2011); SMASS (2013); SMASS (2014); SMASS (2015); SMASS (2016); SMASS (2017); SMASS (2018); SMASS (2019); SMASS (2020); SMASS (2021) [available from: https://stranding's.org/publications/]
[15] CWT (2021), CWT (2020), CWT (2019), CWT (2018), CWT (2017), CWT (2016)
[16] MEM & CSIP (2019), MEM & CSIP (2020)
[17] Marine Institute, 2022

Species	Number of Post-Mortems Where Cause of Death Established	Cause of Death: Physical Trauma of Unknown Cause	Cause of Death: Physical Trauma Following Probable Impact From a Ship or Boat	Collision Risk Rate (Number Attributed to Vessels Strike / Other Physical Trauma as Proportion of Total Number Necropsied)
Bottlenose dolphin	45	1	0	0.022
Common dolphin	628	17	14	0.049
Striped dolphin	109	3	0	0.028
All dolphin species	*992*	*29*	*15*	*0.044*
Minke whale	86	0	6	0.070
All large whale species	*110*	*0*	*8*	*0.073*
Grey seal	417	18	0	0.043
All seal species	*634*	*24*	*0*	*0.038*
Leatherback turtle	9	1	0	0.111
All turtle species	*45*	*1*	*0*	*0.022*

580. To estimate the potential collision risk of vessels associated at the Offshore Project during construction, the potential risk rate per vessel has been calculated for all relevant species (**Table 12.77**). Which is then used to calculate the total risk to marine mammal species due to the presence of an additional five vessels at any one time during construction (**Table 12.77**).

581. To inform this assessment, the total number of each marine mammal species in UK waters has been compared against the total vessels present in UK waters, as well as the potential collision risk rate of each species based on the SMASS and CSIP data (as presented in **Table 12.76**). The total UK populations are taken from IAMMWG (2022) for all cetacean species, with the exception of striped dolphin,

which uses the reference population as presented in **Table 12.34**, and the total UK populations for grey seal species are taken from SCOS (2021). The total presence of vessels in UK waters is taken from the total vessel transits within the 2015 AIS data, which is the latest publicly available.

582. The number of marine mammals at risk of collision, per vessel in UK waters, has been calculated from the above-described datasets, and has been used to calculate the number of each marine mammal species at risk of collision from the approximate 101 vessel transits per year.

583. This is a highly precautionary assumption, as it is unlikely that marine mammals in the Offshore Project would be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number of vessel movements in the area, and that vessels within the Offshore Project area would be stationary for much of the time or very slow moving.

584. The magnitude for potential increased collision risk with construction vessels, based on a precautionary worst-case scenario, has been assessed as **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, and minke whale, and **low to high** for grey seal (**Table 12.77**).

Table 12.77 Predicted Number of Marine Mammals at Risk of Vessel Collision During Construction, Based on Current UK Collision Rates and Vessel Presence

Marine Mammal Species	Collision Risk Rate (Table 12.76)	Estimated Total Number of Individuals in UK Waters	Estimated Number of Individuals at Risk Within UK Waters (Collision Risk Rate x Total UK Population)	Annual Number of Vessel Transits in UK and RoI for 2015	Number of Marine Mammals at Risk of Collision per Vessel in UK Waters	Number Annual Vessel Transits Associated with Construction	Additional Marine Mammals at Risk Due to Increase in Vessel Number (Number of Vessels * Number at Risk per Vessel)	Additional Marine Mammals at Risk Due to Increase in Vessel Number as Proportion of the Offshore Project Reference Populations	Magnitude of Effect (Permanent Effect)
Harbour porpoise	0.056	200,714	11,309.6	3,852,030	0.0029	101	0.30	0.0005% of CIS MU	Negligible18
Bottlenose dolphin	0.044*	7,545	334.7	3,852,030	0.00009	101	0.009	0.0001% of OCSW MU	Negligible
Common dolphin	0.049	57,417	2,834.3	3,852,030	0.0007	101	0.07	0.00007% of CGNS MU	Negligible
Striped dolphin	0.044*	19,253	854.0	3,852,030	0.0002	101	0.02	0.0001% of reference population	Negligible
Minke whale	0.073*	10,288	748.2	3,852,030	0.0002	101	0.02	0.0001% of CGNS	Negligible
Grey seal	0.043	157,300	6,789.9	3,852,030	0.0018	101	0.18	0.009% of SW MU; 0.001% of combined MU	Low (less than 0.01%)19

** using the collision risk rate of the species group as a worst-case*

[18] Based on the weighted magnitude levels as set out in **Paragraph 561**
[19] Based on the weighted magnitude levels as set out in **Paragraph 561**

585. For leatherback turtles, there is little evidence available to accurately quantify the risk to marine turtles, most likely due any collision events being unreported or unknown (e.g. Schoeman *et al*., 2020), however, any vessel collision has the potential to cause significant effect to the individuals.

586. One study found that small vessels would need to reduce speeds to 7.5 knots to reduce the potential for lethal injury in loggerhead sea turtles (Work *et al*., 2010). Other studies have found that sea turtles are more likely to flee a vessel with speeds of less than 2 knots (with 60% of observed turtles fleeing a vessel at a speed of 2 knots), and less likely at higher speeds (with 22% of observed turtles fleeing a vessel at a speed of 6 knots, and 4% of observed turtles fleeing a vessel at a speed of 10 knots). with the potential for mortal injury reducing by 60% with vessel speeds of less than 4 knots (Hazel *et al*,. 2007).

587. While leatherback turtles are considered to have a high sensitivity to collision risk, and as described above, a low capacity to avoid collision, the potential for a leatherback turtle to be present in line with the vessel transit is very low, considering the rarity in the area, and the limited number of vessel transits expected. Therefore, it is not expected that there would be any risk of vessel collision to leatherback turtles. Therefore, the magnitude of effect has been assessed as **negligible**.

12.7.6.3 Significance of Effect

588. Taking into account the high marine mammal sensitivity and the potential magnitude of the effect, as assessed in **Table 12.77**, the effect significance for any potential increased collision risk as a result of vessels during construction has been assessed as **minor adverse** for harbour porpoise, bottlenose dolphin, common dolphin and striped dolphin, **moderate to major adverse** for grey seal, and **minor adverse** for leatherback turtle (**Table 12.78**).

Table 12.78 Assessment of Effect Significance for Any Increased Collision Risk with Vessels During Construction

Potential Impact	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Increased Collision Risk	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale	High	Negligible	Minor adverse	Recommended good practice in **Appendix 12.C: Draft MMMP**	**Minor adverse**
	Grey seal		Low[20]	Moderate adverse		**Minor adverse**
	Leatherback turtle		Negligible	Minor adverse		**Minor adverse**

[20] Based on the weighted magnitude levels as set out in **Paragraph 561**

12.7.6.4 Further Mitigation

589. As outlined in **Appendix 12.C: Draft MMMP** and the **Outline Project Environmental Management Plan (PEMP)**, vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where marine mammals and marine turtles are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and within a vessel speed of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals and marine turtles, such as following the Cornwall Marine and Coastal Code for Vessels[21].

12.7.7 Impact 7: Disturbance at Seal Haul Out Sites

590. Increased activity around landfall, including an increase in vessel and human activity, has the potential to disturb seals at haul out sites, particularly during sensitive periods, such as the breeding season and moult period. The grey seal moult period is between December and April, and their pupping occurs mainly between early November and mid-December (see **Section 12.6.6**).

591. Disturbance from vessel transits to and from the Windfarm Site also has the potential to disturb seals at haul out sites, depending on the route and proximity to the haul out sites.

592. The Lundy Island haul out site is located closest to the ECC at approximately 4km away at the closest point. As outlined in **Section 12.6.6**, the Lundy Island haul out site has a significant number of grey seals. Other haul out sites further from the Windfarm Site and ECC are at Tintagel/Boscastle (50km at closest point), Stockholm Island (60km at closest point), Ramsey Island (80km at closest point) and St Agnes (80km at closest point). Given the distances between the Windfarm Site / ECC and the nearest known seal haul out sites; there is very little potential for any direct disturbance as a result of construction activities.

593. Whilst the construction port(s) to be used for the Offshore Project is not yet confirmed, it is likely that vessel movements to and from any port will be incorporated within existing vessel routes. Taking into account the proximity of shipping channels to and from existing ports, seals hauling-out along these routes

[21] https://www.cornwallwildlifetrust.org.uk/sites/default/files/2019-03/Cornwall%20Marine%20and%20Coastal%20Code%20Guidelines.pdf

and in the area of the ports would be habituated to the noise, movements and presence of vessels.

594. There is an existing relatively high level of vessel traffic within the navigational Study Area, including close to the coastline. An average of 20 to 80 vessels were recorded per month within the Study Area (**Chapter 15: Shipping and Navigation**). High density navigation routes (Lands End to Bristol Channel (South Lundy)) show an average of up to 184 vessels per month travelling along an existing vessel route within 12nm from the Windfarm Site. A total of three routes intersected the Windfarm Site accounting for 625 transits across the year, which accounts for two percent of the total vessels (33,554) tracked into classified routes (**Chapter 15: Shipping and Navigation**).

12.7.7.1 Sensitivity of the Receptor

595. Grey seals may become disturbed from haul out sites due to the presence of vessels, which, if occurring in the breeding season, can result in the abandonment of pups. Due to this, grey seals are considered to be sensitive to vessel disturbance at haul out sites, particularly if that occurs within the breeding season.

596. The response of seals to disturbance at haul out sites can range from increased alertness to moving into the water (Wilson, 2014). The potential impact on pupping groups can include temporary or permanent pup separation, disruption of suckling, energetic costs and energetic deficit to pups, physiological stress and sometimes enforced move to distant or suboptimal habitat. Potential impacts on moulting groups can include energy loss and stress, while impacts on other haul out groups can cause loss of resting and digestion time and stress (Wilson, 2014). The potential impacts will be determined by the response of the seals, the duration and proximity of the disturbance to the seals.

597. For grey seal, mothers responded by moving into the water more due to boat speed than as a result of the distance, although movement into the water was generally observed to occur at distances of between 20 and 70m, with no detectable disturbance at 150m (Wilson, 2014; Strong and Morris, 2010). However, grey seals have also been reported to move into the water when vessels are at a distance of approximately 200m to 300m (Wilson, 2014).

598. A study was carried out by SMRU (Paterson *et al.,* 2015) using a series of controlled disturbance tests at grey seal haul out sites, consisting of regular (every three days) disturbance through direct approaches by vessel and effectively 'chasing' the seals into the water. The seal behaviour was recorded via GPS tags and found that even intense levels of disturbance did not cause seals to abandon their haul out sites

more than would be considered normal (for example seals travelling between sites). The seals were found to haul out at nearby sites or to undertake a foraging trip in response to the disturbance (but would later return).

599. Further studies on the effects of vessel disturbance on grey seals when they are hauled out suggest that even with repeated disturbance events that are severe enough to cause individuals to flee into the water, the likelihood of grey seals moving to a different haul out site would not increase. Furthermore, this appeared to have little effect on their movements and foraging behaviour (Paterson *et al.*, 2019).

600. The sensitivity of grey seals to disturbance from seal haul out sites is therefore **low**, and as a very precautionary approach, it is proposed that sensitivity during the breeding season and annual moult could be slightly higher and has therefore been considered as **medium** in this assessment.

12.7.7.2 Magnitude of Effect

601. The Windfarm Site and offshore ECC is located 4km at closest point to any seal haul out site (**Sections 12.6.6**), there is therefore no potential for any direct disturbance as a result of construction activities within the Offshore Project areas (Windfarm Site, landfall and offshore ECC).

602. A study of the reactions of harbour seal from cruise ships found that, if a cruise ship was less than 100m from a harbour seal haul out site, individuals were 25 times more likely to flee into the water than if the cruise ship was at a distance of 500m from the haul out site (Jansen *et al.,* 2010). At distances of less than 100m, 89% of individuals would flee into the water, at 300m this would fall to 44% of individuals, and at 500m, only 6% of individuals would flee into the water (Jansen *et al.,* 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal. Similar information is not readily available for grey seal, although it is likely that grey seal are less sensitive to vessel presence at haul-out sites than harbour seal have been reported to be (based on the information provided in **Section 12.7.7.1**), and therefore this potential disturbance distance of 600m has been used to inform the assessment for grey seal.

603. Therefore, it is considered that, for grey seal, vessels travelling within 300m of a haul out site, a grey seal may flee into water, but significant disturbance would only be expected at a distance of less than 150m. At a distance of 600m, it is expected that there would be no effect to seals hauled-out. Therefore, the potential for any increase in disturbance to seal haul out sites as a result of construction activities at

the Windfarm Site, activities along the offshore ECC and at landfall site, or vessels in these areas during construction will be **negligible**.

604. Vessel movements to the Windfarm Site from the chosen construction port(s) would use direct established routes and are unlikely to be close to the shore, or within the distance required to cause a disturbance impact, based on the distance thresholds as noted above (of 600m), except when near the port to avoid the risk of collision and grounding.

605. In addition, taking into account the proximity of shipping channels to and from existing ports, it is likely that any seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels.

606. As outlined in **Section 561**, in total, for the construction of the Offshore Project, the daily construction vessel trips represent approximately a 56% increase in the daily vessel presence within the navigational Study Area, as a worst-case, and approximately a 25% increase or 42% of the ECC vessel presence during the summer and winter periods respectively. This represents a relatively significant increase in the current number of vessels in the area.

607. Given the minimum distance of 4km from the nearest haul-out site to the Offshore Project (of 4km) and given that the area is already used by similar vessels, there is not expected to be any disturbance to seals hauled out. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels, and would be affected at that distance. Therefore, the magnitude of impact of grey seals at haul out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be **negligible**.

12.7.7.3 Significance of Effect

608. Taking into account the **low** to **medium** sensitivity, and the potential magnitude of **negligible** for the temporary effect, the effect significance for disturbance at seal haul out sites during construction of the Offshore Project has been assessed as **negligible** to **minor adverse** (not significant) for grey seals (**Table 12.79**).

609. **There are a number of designated SSSI sites nearby to the** Offshore Project that are designated for grey seals; **Table 12.33** summarises these areas. Given the location of the Offshore Project, the key potential effect to designated sites are likely to be to hauled-out seals, and this potential effect is considered further within the

assessments of disturbance to hauled-out seals during construction (**Section 12.7.7**), operation and maintenance (**Section 12.8.6**) and decommissioning (**Section 12.9**).

610. Designated SACs for marine mammals are assessed within the **RIAA**.

611. Table 12.33 lists the SSSIs near the Windfarm Site that are designated for grey seals. As the nearest SSSI is Lundy Island, this will be taken as the worst-case example. As shown in **Figure 12.21** and described in **Section 12.6.6.4**, grey seal at Lundy haul-out to the south of Lundy, closest to the ECC, and north of the Island. Lundy Island at its closest point is approximately 4km away from the cable corridor and 44km form the Windfarm Site itself, therefore the grey seal haul-out sites at Lundy are further from the Offshore Project than the expected disturbance range of 600m as described in **Section 12.7.6.4**, therefore, the assessment as outlined above for grey seal would apply, and there would be a **negligible** effect to the grey seal hauled-out at Lundy SSSI.

Table 12.79 Assessment of Effect Significance for Disturbance at Seal Haul Out Sites During Construction

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Disturbance at seal haul out sites	Grey seal	Low to Medium	Negligible	Negligible to minor adverse	Recommended best practice as outlined in **Appendix 12.C: Draft MMMP**	**Negligible to Minor adverse**

12.7.7.4 Further Mitigation

612. No mitigation is required for the disturbance of seals at haul out sites. However, as outlined in the **Outline CEMP**, where possible and safe to do so, transiting vessels would maintain distances of 600m or more off the coast, particularly in areas near known seal haul out sites (Lundy Island) during sensitive periods. All vessel movements will be kept to the minimum number that is required to reduce any potential for disturbance. Additionally, vessel operators will follow best practice guidance to reduce any risk of collisions with marine mammals and marine turtles, such as following the Cornwall Marine and Coastal Code for Vessels[22].

12.7.8 Impact 8: Entanglement

613. Entanglement is the potential risk of marine mammals and marine turtles getting caught within the WTG mooring lines and dynamic cables as a primary cause, and fishing gear that have been caught themselves within the WTG mooring lines and dynamic cables as a secondary cause. The worst-case scenario for entanglement is during the operational and maintenance phase of the Offshore Project due to the length of time the structures will be in place, creating a higher probability of receptors to get caught within the WTG mooring lines and dynamic cables. However, there is the potential for a short period of time within the construction period where the WTGs will be installed before the operational period commences, and therefore a short period of time where there may be a risk of entanglement to marine mammals and marine turtles. Entanglement during the construction period is therefore a temporary effect. While the effect would continue into the operational phase, this assessment focuses solely on the construction phase.

614. Further detail into the potential effect is outlined in **Section 12.8.6**. The construction phase of the effect is considered to the worst-case for this effect, and therefore the potential effect during construction would the same (or less) as during the operational period.

12.7.8.1 Sensitivity of the Receptor

615. As outlined in **Section 12.8.6.3**, the sensitivity for all marine mammal and marine turtle species is **medium**, with the exception of minke whale, which have a sensitivity of **high** to secondary (and tertiary) entanglement.

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[22] https://www.cornwallwildlifetrust.org.uk/sites/default/files/2019-03/Cornwall%20Marine%20and%20Coastal%20Code%20Guidelines.pdf

12.7.8.2 Magnitude of Effect

616. As outlined in **Section 754**, the magnitude for all species is predicted to be **negligible**, except for minke whale, where the magnitude is considered to be **low**, due to their increased rates of entanglement with fishing gear.

12.7.8.3 Significance of Effect

617. The effect significance for the possible entanglement with the mooring system and cables has been assessed as **negligible** to **minor adverse** for all marine mammals and marine turtles, except for minke whale, which is **negligible** to **moderate adverse**, see **Section 12.8.7.3** for more details.

12.7.8.4 Further Mitigation

618. **Section 12.8.7.4** details further mitigation that will be used for the potential risk of entanglement.

12.7.9 Impact 9: Effects due to Electromagnetic Fields

619. EMFs occur as a result of electricity transmission through conductive objects, such as transmission cables, and comprises an electric field (E field) and a magnetic field (B field). The electromagnetic attributes of EMFs have the potential to disrupt organs used for navigation and foraging within a number of species. EMFs can have attractive and repulsive effects, that can cause barrier effects dependent on the species and the spatial scale of EMF. In the context of submarine transmission cables, it is well known that EMF strength dissipates rapidly, from 7.85μT at 0m, to 1.47μT at 4m, from the average windfarm inter-array cable buried 1m below the seabed (Normandeau *et al*., 2011). Little is known on the potential for effects to marine mammals and marine turtles from dynamic cables in the water column (Gill & Desender, 2020).

620. For perspective, the earth's magnetic field has an estimated background magnitude of 25-65μT (Hutchinson *et al*, 2020). EMF interaction with solids such as the seabed sediment introduces a localised heating effect which, potentially, introduces both positive and negative barrier and fish aggregation effects. However, this will be of small magnitude (maximum of 5.5°C), dissipated within tens of centimetres from the cable's outer insulating layer, and is therefore unlikely to present additional impact (Boehlert and Gill, 2010; National Grid and Energinet, 2017; Moray Offshore Windfarm Ltd, 2018). There is no E field present outside the insulating layer of all cables.

12.7.9.1 Sensitivity of the Receptor

621. As outlined in **Section 12.8.9.1**, the sensitivity for all marine mammal and marine turtle species to EMF effects is **low**.

12.7.9.2 Magnitude of Effect

622. The worst-case maximum EMF magnitude and spatial extent are explained further in **Section 12.8.8** and **Table 12.96**, as the operational phase will see the worst-case potential effect for the Offshore Project. The magnitude and sensitivity for EMF during the construction phase will align with the operational phase assessment, which is **low**.

12.7.9.3 Significance of Effect

623. As assessed for the operational phase, the overall effect significance for EMF effects is **minor adverse** for all marine mammal and marine turtle species assessed (see **Table 12.96** for further information).

12.7.9.4 Further Mitigation

624. No mitigation is required for the potential for an EMF effect.

12.7.10 Impact 10: Barrier Effects Due to Physical Presence

625. As the Offshore Project is constructed, there is the potential for a barrier effect to occur due to the physical presence of the Offshore Project's infrastructure. As for the risk of entanglement, the worst-case scenario for effects from the physical presence of the windfarm is during the operational and maintenance phase of the Offshore Project, due to the length of time the infrastructure would be in place. However, there is the potential for a short period of time within the construction period where some Offshore Project infrastructure being in place prior to the start of the operational period, and therefore a short period of time where there may be a risk of a barrier effect due to the physical presence of the windfarm. This is therefore a temporary effect. While the effect would continue into the operational phase, this assessment focuses solely on the construction phase.

626. Further detail into the potential effect is outlined in **Section 12.8.8**. The construction phase of the effect is considered to be the worst-case for this effect, and therefore the potential effect during construction would the same (or less) as during the operational period.

12.7.10.1 Sensitivity of the Receptor

627. As outlined in **Section 12.8.8.1**, the sensitivity for all marine mammal and marine turtle species is **negligible**.

12.7.10.2 Magnitude of Effect

628. As outlined in **Section 12.8.8.2**, the magnitude for all species if predicted to be **negligible**.

12.7.10.3 Significance of Effect

629. The effect significance for a barrier effect due to the physical presence of the windfarm, during construction, has been assessed as **negligible** for all marine mammals and marine turtles; see **Section 12.8.8.3** for more details.

12.7.10.4 Further Mitigation

630. No mitigation is required for the potential for a barrier effect due to the physical presence of the windfarm, during construction.

12.7.11 Impact 11: Changes to Prey Availability

631. As outlined in **Chapter 11: Fish and Shellfish Ecology**, the potential impacts on fish species during construction can result from:

- Temporary habitat loss / physical disturbance
- Temporary increased SSCs and sediment deposition
- Underwater noise and vibration
- Barrier effects.

632. Any effect on fish species has the potential to indirectly affect marine mammals and marine turtles through changes to their prey availability.

12.7.11.1 Sensitivity of the Receptor

633. The diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.*, 1997). Harbour porpoise are therefore considered to have **low** to **medium** sensitivity to changes in prey resources.

634. Bottlenose dolphin, common dolphin, and striped dolphin are opportunistic feeders, feeding on wide range of prey species and have large foraging ranges and are therefore considered to have **low** sensitivity to changes in prey resources.

635. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species at the population level. Therefore, minke whale are considered to have a **low** to **medium** sensitivity to changes in prey resource.

636. Grey seal feed on a variety of prey species, both are considered to be opportunistic feeders, feeding on wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges. Grey seal are therefore considered to have **low** sensitivity to changes in prey resources.

637. Leatherback turtles feed exclusively on gelatinous zooplankton, which play a role in coastal and pelagic food webs (Dodge *et al*., 2014). They are highly migratory and can travel vast distances with the ocean currents to forage in other locations. Leatherback turtles are therefore considered to have **low** sensitivity to changes in prey resources.

12.7.11.2 Magnitude of Effect

638. The following sections summarise the potential effects to fish species, based on the assessments provided in **Chapter 11: Fish and Shellfish Ecology**. For more information on any these potential effects, see **Section 11.5** of **Chapter 11: Fish and Shellfish Ecology**.

12.7.11.2.1 Temporary Habitat Loss / Physical Disturbance

639. Temporary habitat loss/physical disturbance has the potential to occur via a number of pathways throughout construction of the Offshore Project. Anchor and mooring line installation (including drag embedment anchors), cable burial, cable protection installation, and associated seabed clearance may result in impacts to a range of fish and shellfish receptors. The worst-case area of seabed predicted to be impacted by temporary disturbance during the construction phase of the Offshore Project is presented within **Table 11:17** of **Chapter 11: Fish and Shellfish Ecology**).

640. The worst-case area of 6,112,354m² (6.11km²) represents approximately 0.12% of the Fish and Shellfish Ecology Study Area (of 7,426km²), and 11.3% of the Maximum Footprint Area (of 54.08km²).

641. The disturbance would be temporary during the approximate 16 months of construction activity (**Table 12.14**) with the majority of disturbance occurring during installation of foundations and cables. Some components of disturbance, such as that caused by jack-up vessel legs, will be highly localised and only occur over a short period.

642. The magnitude of effect of physical disturbance to seabed habitat during construction has been assessed as **low** in **Chapter 10: Benthic and Intertidal Ecology**. In **Chapter 11: Fish and Shellfish Ecology** the magnitude of physical disturbance during construction activities is considered to be **negligible** for all species, based on the availability of similar suitable habitat both in the offshore development areas and in the wider context of the Celtic Sea together with the intermittent and reversible nature of the effect. The effect significance for fish species is assessed as negligible to minor adverse.

643. Therefore, any potential changes to prey availability, as a result of physical disturbance and temporary habitat loss is assessed as **negligible** for marine mammals and marine turtles.

644. Temporary habitat loss during construction has not been assessed as having a direct effect on marine mammals and marine turtles, as any impacts of habitat loss would only cause an indirect effect in terms of changes in prey availability.

12.7.11.2.2 Temporary Increased Suspended Sediments and Sediment Deposition

645. The construction phase of the Offshore Project is predicted to result in an increase in SSC and increased sediment deposition due to installation activities related to foundations, mooring lines, cable/scour protection, and export and array cables (including pre-cable works such as pre-lay grapnel run (PLGR) or sand wave levelling).

646. Works at the landfall site may also increase SSCs, through potential open-cut trenching or the construction of nearshore floatation pits. Of these, the activities most likely to cause direct physical disturbance of the seabed are the installation/burial of cables, and installation of anchors.

647. Increases in SSC are expected to cause localised and short-term increases in SSC at the point of discharge. Released sediment may then be transported by tidal currents in suspension in the water column. Due to the small quantities of fine-sediment released, the fine-sediment is likely to be widely and rapidly dispersed. This would result in only low SSCs and low changes in seabed level when the sediments are deposited. In **Chapter 10: Benthic and Intertidal Ecology**, the impact magnitude is considered to be **negligible**. The magnitude of effect in **Chapter 11: Fish and Shellfish Ecology** is assessed as low for all species. The impact significance for fish species is assessed as minor adverse.

648. Therefore, any potential changes to prey availability as a result of increased SSCs and sediment deposition is assessed as **negligible** for marine mammals and marine turtles.

12.7.11.2.3 Underwater Noise and Vibration

649. Potential sources of underwater noise and vibration during construction include UXO clearance, piling, increased vessel traffic, seabed preparation, rock placement and cable installation. Of these, UXO clearance and piling are considered to produce the highest levels of underwater noise and therefore has the greatest potential to result in adverse impacts on fish.

650. High levels of underwater noise can cause physiological (mortality, permanent injury or temporary injury), behavioural (startled movements, swimming away from noise source, change migratory patterns or cease reproductive activities) and environmental (changes to prey species or feeding behaviours) impacts on fish species (**Chapter 11: Fish and Shellfish Ecology**).

651. Underwater noise modelling (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**), assessed the following fish groups (based on Popper *et al.,* 2014):

- No swim bladder (e.g. sole, plaice, lemon sole, mackerel and sandeels)
- Swim bladder not involved in hearing (e.g. sea bass, salmon and sea trout)
- Swim bladder which is involved in hearing (e.g. cod, whiting, sprat and herring).

652. The underwater noise modelling results (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**) indicates that fish species in which the swim bladder is involved in hearing are the most sensitive to the impact of underwater noise, therefore the worst-case scenario assessment uses these species as an indicator of overall effects.

12.7.11.2.3.1 Piling

653. It should be noted that while the potential for impact piling represents the worst-case in terms of underwater noise effects to prey species, there is the potential that no piling will be needed for the construction of the Offshore Project (i.e. if no OSP was required, or if impact piling was not required to install either the OSP or the mooring anchors).

654. **Chapter 11: Fish and Shellfish Ecology** summarises some of the maximum effect ranges and areas for fish species during piling, with further details provided

in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.

655. Marine turtle prey predominately consists of jellyfish, of which there is no evidence to suggest the impacts of noise. However, as a precautionary measure, the effects of noise on jellyfish will be assessed the same as fish species.

656. The maximum predicted cumulative effect range for TTS of 51km for fish species based on stationary model (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**), is less than the TTS SEL_{cum} range of 54km for minke whale, but greater than the TTS SEL_{cum} range of 37km for harbour porpoise, less than 100m for bottlenose dolphin, common dolphin and striped dolphin, and 16km for grey seal (**Table 12.49**). However, it is important to note that the SEL_{cum} modelling for fish species is based on a stationary model. This is considered to be a highly precautionary approach, as it is unlikely that an individual would remain within the vicinity of the high noise levels for the period of time required to reach those noise levels.

657. Therefore, modelling assuming a fleeing animal in response to noise, especially fish with a swim bladder involved in hearing, is more realistic and has been used to assess the potential impact on marine mammals. As for dolphin species, the TTS effect range is assumed to be the same as a behavioural fleeing response in fish species (and the TTS impact ranges are used as a proxy for disturbance impacts on fish species).

658. The maximum predicted cumulative effect range for TTS of 24km for fish species based on the fleeing response model (**Table 12.80**), is less than the TTS SEL_{cum} range of 54km for minke whale, less than the 37km for harbour porpoise, and more than 100m for bottlenose dolphin, common dolphin and striped dolphin, and 16km for grey seal (**Table 12.49**).

659. Piling duration would be the same as assessed from marine mammals in **Table 12.80**.

Table 12.80 Predicted Maximum Impact Ranges (and Areas) for OSP Jacket Pile and Mooring Pin Pile Maximum Hammer Energies for Fish Species with a Swim Bladder Involved in Hearing

Species	Potential Effect	Criteria and Threshold (Popper *et al.*, 2014)	Mooring Pin Pile (Maximum Hammer Energy 800kJ)	OSP Jacket Pile (Maximum Hammer Energy 2,500kJ)
Fish: swim		207 dB SPL_{peak}	0.12km (0.04km^2)	0.26km (0.21km^2)

Species	Potential Effect	Criteria and Threshold (Popper *et al.*, 2014)	Mooring Pin Pile (Maximum Hammer Energy 800kJ)	OSP Jacket Pile (Maximum Hammer Energy 2,500kJ)
bladder involved in hearing	Mortality and potential mortal injury	207 dB SEL_{cum}	3.7km (41km^2)	8.6km (230km^2)
	Recoverable injury	203 dB SEL_{cum}	6.3km (120km^2)	14km (550km^2)
	TTS	186 dB SEL_{cum} stationary model	34km (3,200km^2)	51km (6,500km^2)
		186 dB SEL_{cum} fleeing model	12km (380km^2)	24km (1,400km^2)

660. For assessing behavioural response in prey during piling, Hawkins *et al.* (2014), gives unweighted SPL_{peak}, $SPL_{peak\text{-}to\text{-}peak}$, and SEL_{ss} levels where a 50% response level was recorded in sprat and mackerel for an impulsive noise source, simulating pile driving. In the absence of reliable numerical criteria for behavioural disturbance in fish, observed levels from Hawkins *et al.* (2014) have been used, even though the authors of the paper themselves do not recommend use of the values as criteria for EIA. It should be noted that the study was conducted under conditions in quiet inland waters which are unlikely to be equivalent to those around the Windfarm Site.

661. Consideration of potential behavioural response ranges and areas (up to 6,500km^2), in reference to Hawkins *et al.* (2014), are provided **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** and **Chapter 11: Fish and Shellfish Ecology**. The duration of active piling for the OSP and mooring anchors (6.25 days) has also been taken into account in the overall assessments for fish species.

662. It is highly unlikely that there would be significant changes to prey over the entire area. It is more likely that effects would be restricted to an area around the working sites. It is also important to note that there is unlikely to be any additional displacement of marine mammals and marine turtles as a result of any changes in prey availability during piling, as marine mammals and marine turtles would also be disturbed from the area.

663. The significance of effect to fish species as a result of piling has been assessed as **minor adverse** (**Section 11.5.3.4.2** of **Chapter 11: Fish and Shellfish**

Ecology). Additionally, the wide foraging ranges of marine mammals and marine turtles and the availability of prey in nearby areas has been taken into account and therefore the magnitude of any impact from the potential response of fish during piling is assessed as negligible for all marine mammal and marine turtle species. Therefore, the magnitude of any changes in prey availability as a result of underwater noise during piling has been assessed as **low**.

12.7.11.2.3.2 UXO Clearance

664. For the potential for UXO clearance, the potential effect ranges modelled for fish species as a result of underwater noise is less than 120m for mortality and potential mortal injury (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**), which is less than the predicted effect ranges for marine mammals (**Table 12.70**). The assessment of underwater noise due to other UXO clearance on fish species has been assessed as minor adverse (**Section 11.5.3.4.1** of **Chapter 11: Fish and Shellfish Ecology**).

665. Therefore, any potential changes to prey availability as a result of other construction activities and vessels is assessed as **low** for marine mammals and marine turtles.

12.7.11.2.3.3 Other Construction Activities and Vessels

666. The potential effect ranges modelled for fish species as a result of underwater noise during cable laying, trenching, rock placement, drilling, dredging and for vessels is less than 60m (**Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**), which is less than the precited effect ranges for marine mammals (**Table 12.70**). The assessment of underwater noise due to other construction activities on fish species has been assessed as negligible (**Section 11.5.3.4.3** of **Chapter 11: Fish and Shellfish Ecology**).

667. Therefore, any potential changes to prey availability as a result of other construction activities and vessels is assessed as **negligible** for marine mammals and marine turtles.

12.7.11.2.4 Barrier Effects

668. Barrier effects occur from a number of sources, including suspended sediment plumes, noise, electromagnetic fields, and anthropogenic structures within the water column. As such, the barrier effects due to suspended sediment plumes, noise, and EMF have been assessed in **Section 11.5.4** of **Chapter 11: Fish and Shellfish Ecology**.

669. Barrier effects due to anthropogenic structures in the water column have the potential to occur via a number of potential pathways throughout construction of the Offshore Project. Anchor and mooring line installation, cable protection installation, OSP installation, floating turbine platform structure installation, and associated seabed clearance may result in impacts to a range of fish and shellfish receptors.

670. The magnitude of effect associated with barrier effects is based on the worst-case scenario of water volume lost within Offshore Development Area. This represents approximately 356,139.39m³, constituting 0.0098% of the Offshore Development Area (**Table 11.23** of **Chapter 11: Fish and Shellfish Ecology**). The significance of barrier effects on fish species has been assessed as having a **minor adverse** effect (**Section 11.5.4.3** of **Chapter 11: Fish and Shellfish Ecology**). Therefore, the magnitude of effect for indirect effects to marine mammals and marine turtles to through barrier effects to prey species is **low**.

12.7.11.3 Significance of Effect

671. Taking into account the marine mammal and marine turtle sensitivity of low to medium for changes in prey availability, and the potential magnitude of effect of negligible to low, the effect significance for any potential changes in prey availability during construction has been assessed as **negligible** to **minor adverse** (not significant) for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle (**Table 12.81**).

Table 12.81 Assessment of Effect Significance for Any Potential Changes in Prey Availability During Construction

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Change in prey availability	Harbour porpoise, minke whale	Low to medium	Negligible to low	Negligible to minor adverse	No mitigation required. However, measures in MMMP and SIP will also reduce potential effects of underwater noise on prey species.	**Negligible to minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal	Low	Negligible to low	Negligible to minor adverse		**Negligible to minor adverse**
	Leatherback turtle	Low	Negligible to low	Negligible to minor adverse		**Negligible to minor adverse**

12.7.11.4 Further Mitigation

672. No mitigation is required or proposed in relation to any changes in prey availability, however, the mitigation outlined in both **Appendix 12.C: Draft MMMP** and **Appendix 12.D: In Principle SIP for the BCA SAC** to reduce the potential effects of underwater noise for marine mammals and marine turtles, would also reduce the potential effects on prey species.

12.7.12 Impact 12: Indirect Effects due to Changes in Water Quality

673. As outlined in **Chapter 9: Marine Water and Sediment Quality** potential changes in water quality during construction could occur through:

- Deterioration in water quality due to localised temporary increases in SSCs due to cable burial
- Deterioration in water quality due to remobilisation of existing contaminated sediments.

12.7.12.1 Sensitivity of the Receptor

674. Marine mammals and marine turtles often inhabit turbid environments and cetaceans utilise sonar to sense the environment around them and there is little evidence that turbidity affects cetaceans directly (Todd *et al.,* 2014). Pinnipeds are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision. Studies have shown that vision is not essential to seal survival, or ability to forage (Todd *et al.,* 2014).

675. Leatherback turtles do not utilise sonar and can respond to a wide range of light wavelengths and are capable of colour vision (Horch *et al*., 2008). However, leatherback turtles can dive to depths beyond 1,000 meters, where the environments are devoid of light (Hays *et al*., 2004; Doyle *et al*., 2008).

676. Increased turbidity is unlikely to have a substantial direct impact on marine mammals and marine turtles that often inhabit naturally turbid or dark environments. This is likely because other senses are utilised, and vision is not relied upon solely. Therefore, harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle have **negligible** sensitivity to increases in SSC during construction.

677. Any direct impacts to marine mammals and marine turtles as a result of any contaminated sediment during construction activities are unlikely as any exposure is more likely to be through potential indirect impacts via prey species. However,

sediment samples collected in site-specific surveys indicated little to no evidence of contamination. Therefore, there is no potential impact on prey species, as discussed in **Table 11.12** of **Chapter 11: Fish and Shellfish Ecology.** Therefore, marine mammals and marine turtles are considered to have **negligible** sensitivity to any direct impacts from contaminated sediment during construction activities.

12.7.12.2 Magnitude of Effect

678. The magnitude for the indirect effect to marine mammals and marine turtles, due to the potential changes in water quality, have been based on the results of the assessments for water quality in **Chapter 9: Marine Water and Sediment Quality** (**Table 12.82**).

679. As the significance of effect has been assessed as negligible, the indirect effect to marine mammals and marine turtles is considered to be **negligible**.

Table 12.82 Magnitude of Potential Changes in Water Quality During Construction, Based on Assessments in Chapter 7: Marine Water and Sediment Quality

Potential Significance of Effect to Changes in Water Quality (Chapter 9: Marine Water and Sediment Quality)	Magnitude of the Indirect Effect to Marine Mammals and Marine Turtles (Temporary Effect)
Deterioration in water quality due to localised temporary increases in **SSC**s due to cable burial	**Negligible**
Deterioration in water quality due to remobilisation of existing contaminated sediments	**Negligible**

12.7.12.3 Significance of Effect

680. Taking into account the **negligible** marine mammal and marine turtle sensitivity to changes in water quality, and the potential magnitude of the effect, as assessed in **Table 12.82**, the overall significance for any potential changes in water quality during construction has been assessed as **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle (**Table 12.83**).

12.7.12.4 Further Mitigation

681. No mitigation is required or proposed, other than the embedded mitigation for water quality as outlined in **Table 12.15**.

Table 12.83 Assessment of Impact Significance for Any Changes in Water Quality During Construction

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Changes in water quality	Harbour porpoise	Negligible	Negligible	Negligible	None required.	**Negligible**
	Bottlenose dolphin	Negligible	Negligible	Negligible		**Negligible**
	Common dolphin	Negligible	Negligible	Negligible		**Negligible**
	Striped dolphin	Negligible	Negligible	Negligible		**Negligible**
	Minke whale	Negligible	Negligible	Negligible		**Negligible**
	Grey seal	Negligible	Negligible	Negligible		**Negligible**
	Leatherback turtle	Negligible	Negligible	Negligible		**Negligible**

12.8 Potential Effects During Operation and Maintenance

682. Potential impacts during operation and maintenance assessed for marine mammals and marine turtles are:

- Impact 1: Underwater noise from operational wind turbines
- Impact 2: Underwater noise from maintenance activities such as cable repairs and rock placement
- Impact 3: Underwater noise and disturbance from vessels
- Impact 4: Barrier effects from underwater noise from operational wind turbines
- Impact 5: Interaction and collision risk with vessels
- Impact 6: Disturbance at seal haul out sites
- Impact 7: Entanglement
- Impact 8: Barrier effects due to physical presence
- Impact 9: Electromagnetic fields direct and indirect effects
- Impact 10: Changes to prey availability
- Impact 11: Changes to water quality.

12.8.1 Impact 1: Underwater Noise from Operational Wind Turbines

683. The operational turbines will operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The Offshore Project's design life is 25 years. Therefore, there is concern that underwater noise from operational turbines could contribute a consistent, long duration of sound to the marine environment. However, the underwater noise levels emitted during the operation of the turbines are low and not expected to cause physiological injury to marine mammals and marine turtles but could cause behavioural reactions if the animals are in the immediate vicinity of the wind turbine (Tougaard *et al.,* 2009a; Sigray and Andersson, 2011).

684. The main sources of sound generated during the operation of wind turbines are aerodynamic and mechanical. The mechanical noise is from the nacelle at the top of the wind turbine tower. As the wind turbine blades rotate, vibrations are generated that travel down the turbine tower and radiate into the surrounding water column and seabed (Tougaard *et al.,* 2009a; 2020; Nedwell *et al.,* 2003). The resulting sound is described as continuous and non-impulsive and is characterized by one or more tonal components that are typically at frequencies below 1kHz. The frequency content of the tonal signals is determined by the mechanical properties of the wind turbine and does not change with wind speed (Madsen *et al.,* 2006).

Noise levels generated above the water surface are low enough that no significant airborne sound will pass from the air to the water (Godin, 2008).

685. Measurements made at three different wind turbines in Denmark and Sweden at ranges between 14m and 40m from the turbine foundations found that the sound generated due to turbine operation was only detectable over underwater ambient noise at frequencies below 500Hz (Tougaard *et al.,* 2009a).

686. Tougaard *et al*. (2020), reviewed the available measurements of underwater noise from different wind turbines during operation and found that source levels were at least 10–20 dB lower than ship noise in the same frequency range. A simple multi-turbine model indicated that cumulative noise levels could be elevated up to a few kilometres from a wind farm under very low ambient noise conditions. However, the noise levels were well below ambient levels unless very close to the individual turbines in locations with high ambient noise from shipping or high wind speeds (Tougaard *et al.,* 2020).

687. However, as there are few studies into the sound levels associated with floating wind farms, and whether they differ to the noise levels associated with fixed foundations, ongoing research is currently being conducted (e.g. Offshore Renewable Energy (ORE) Catapult and Xodus Group, 2022). For example, the FORTUNE (Floating Offshore Wind Turbine Noise) project aims to obtain systematic, long-term measurements of underwater noise generated by floating turbines; where relevant and possible, this analysis would be supported by in-situ monitoring during both construction and operation within pilot scale and early commercial floating farms (ORE Catapult and Xodus Group, 2022).

688. Detail on the process for the estimation of operational WTG source noise levels are provided in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**, based on a formula provided by Tougaard *et al*. (2020). However, this is based on the noise levels of a fixed foundation, which are likely significantly different to the operational noise levels of floating foundations. This is due to there being no large foundation structure within the water column that may radiate noise. There is also the potential for a noise that has been associated with 'cable snaps' to be present during the operation of the WTGs. It should be noted that it is likely this cable snap noise is likely to be isolated to the particular environmental conditions of where it was recorded, and would likely not occur at the Offshore Project, however, as the source of this 'cable snap' noise is as of yet not well understood as to the source or the cause, it is not possible to rule out that it will occur during the operational phase.

689. As outlined in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**, noise measurements made at operational wind farms have demonstrated that the operational noise produced was at such a low level that it was difficult to measure relative to background noise at distances of a few hundred metres.

690. The estimated noise levels from the operational floating WTGs at the Offshore Project have been estimated to be 160 dB (SPL_{RMS}) at 10m from the largest turbine. **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report** predicts the potential noise level associated with the 'cable snaps' mentioned above, and summarises that it would be an estimated 159 dB re 1 µPa^{2}s (SEL) for all eight WTGs at the Offshore Project, and is therefore below any SPL peak injury thresholds for marine mammals and marine turtles.

12.8.1.1 Underwater Noise Modelling

691. Underwater noise modelling was undertaken to assess the potential impact ranges for operational wind turbines (see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**). The cumulative effect ranges are to the nearest 10m.

692. The results of the underwater noise modelling (**Table 12.84**) indicate that any marine mammal would have to be less than 10m for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

Table 12.84 Predicted Effect Ranges (and Areas) for PTS and TTS from Cumulative Exposure of Operational Turbines

Species	Effect	Criteria and Threshold (Southall *et al.*, 2019)	Operational Wind Turbines (18+ MW)
Harbour porpoise	PTS	SEL_{cum} Weighted (173 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)
	TTS	SEL_{cum} Weighted (153 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)
Bottlenose dolphin, common dolphin, and striped dolphin	PTS	SEL_{cum} Weighted (198 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)
	TTS	SEL_{cum} Weighted (178 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)

Species	Effect	Criteria and Threshold (Southall *et al.*, 2019)	Operational Wind Turbines (18+ MW)
Minke whale	PTS	SEL_{cum} Weighted (199 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)
	TTS	SEL_{cum} Weighted (179 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)
Grey seal	PTS	SEL_{cum} Weighted (201 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)
	TTS	SEL_{cum} Weighted (181 dB re 1 µPa^{2}s) Non-impulsive	<0.01km (<0.003km^2)

12.8.1.2 Sensitivity of the Receptor

693. Current available data indicates that there is no lasting disturbance or exclusion of harbour porpoise or seals around Windfarm Sites during operation (Diederichs *et al.,* 2008; Lindeboom *et al.*, 2011; Marine Scotland, 2012; McConnell *et al.*, 2012; Russell *et al.,* 2014; Scheidat *et al.*, 2011; Teilmann *et al.*, 2006; Tougaard *et al.*, 2005, 2009a, 2009b). Data collected suggests that any behavioural responses for harbour porpoise and seal may only occur up to a few hundred metres away (Touggard *et al.*, 2009b; McConnell *et al.*, 2012).

694. Monitoring was carried out at the Horns Rev and Nysted windfarms in Denmark during the operation between 1999 and 2006 (Diederichs *et al.*, 2008). Numbers of harbour porpoise within Horns Rev were slightly reduced compared to the wider area during the first two years of operation. However, it was not possible to conclude that the wind farm was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard *et al.,* 2009a). Later, studies by Diederichs *et al.* (2008), recorded no noticeable effect on the abundances of harbour porpoise at varying wind velocities at both of the offshore windfarms studied, following two years of operation.

695. Monitoring studies at Nysted and Rødsand have also indicated that operational activities have had no impact on regional seal populations (Teilmann *et al.,* 2006; McConnell *et al.,* 2012). Both harbour porpoise and seals have been shown to forage within operational Windfarm Sites (e.g. Lindeboom *et al.*, 2011; Russell *et al.*, 2014), indicating no restriction to movements in operational offshore Windfarm Sites.

696. There is currently limited information for other marine mammal species, however, bottlenose dolphins are frequently observed in and around the Aberdeen Offshore Wind Farm (European Offshore Wind Deployment Centre).

697. Modelling of noise effects of operational offshore wind turbines suggest that grey seals and bottlenose dolphins are not considered to be at risk of displacement by the operational wind farms (Marmo *et al.*, 2013).

698. As a precautionary approach, harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, and grey seal, are likely to have **low** sensitivity (rather than negligible) to disturbance from underwater noise as a result of operational wind turbines.

699. Taking into account that minke whales are more sensitive to low frequency noise, it is probable that they could be more sensitive to operational wind turbine noise (Marmo *et al.,* 2013). Therefore, as a precautionary approach minke whale are classed as having **medium** sensitivity.

700. Leatherback turtles are able to detect sound between 50 - 1,200Hz in water and 50 – 1,600Hz in air, with a maximum sensitivity between 100 – 400 Hz in water (84 dB re: 1 µPa-rms at 300 Hz) (Dow Piniak *et al.*, 2012). As a precautionary approach, leatherback turtles are classed as having a **medium** sensitivity.

701. The sensitivity of marine mammals and marine turtles to PTS is considered to be **high**, and for TTS is considered to be **medium** (**Table 12.43**).

12.8.1.3 Magnitude of Effect

702. PTS due to the noise associated with the noise of operational WTGs is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal and marine turtles would have to remain less than 10m for 24 hours in any given 24-hour period for any potential risk of PTS to occur (**Table 12.84**). Therefore, PTS as a result of operational wind turbine noise, is highly unlikely and has not been assessed further.

703. Similarly, there is unlikely to be any significant risk of TTS, as again the modelling indicates that any individual would have to remain less than 10m for 24 hours in any given 24-hour period (**Table 12.84**). Therefore, TTS as a result of operational wind turbine noise, is also highly unlikely, and has not been considered further.

704. For marine mammals, a fleeing response is assumed to occur at the same noise levels as TTS. Therefore, the potential range and areas for TTS presented in **Table 12.84**, with the estimated number and percentage of reference populations in

Table 12.85 providing an indication of possible fleeing response / displacement. This assessment has been undertaken for all eight WTGs operating at the same time, with a resultant affect area of 0.0025km^2.

705. The magnitude of the potential impact for TTS / fleeing response as a result of underwater noise from all operational wind turbines is **negligible** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle (**Table 12.85**), with less than 0.01% of the reference populations exposed to any long term impact (see **Table 12.8**).

706. The indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.1km (maximum of 2.62km) therefore there would be no overlap in the potential impact range of less than 10m around each turbine.

Table 12.85 Maximum number of individuals (and % of reference population) that could be at risk of TTS / fleeing response from cumulative exposure for all operational turbines

Species	Potential Fleeing Response for all Operational Turbines	
	Maximum number of individuals (% of reference population)	Magnitude (long-term impact)
Harbour porpoise	0.002 based on APEM summer density estimate (0.000004% of CIS MU); 0.001 based on APEM summer density estimate (0.000002% of CIS MU).	**Negligible**
Bottlenose dolphin	0.0002 (0.000001% of OCSW MU)	**Negligible**
Common dolphin	0.01 based on the APEM winter density estimate (0.00001% of CGNS MU); 0.01 based on the APEM annual density estimate (0.00001% of the CGNS MU)	**Negligible**
Striped dolphin	0.002 (0.000009% of reference population)	**Negligible**
Minke whale	0.00003 (0.0000001% of CGNS MU)	**Negligible**
Grey seal	0.00001 (0.0000006% of SW MU; 0.0000001 of combined MU)	**Negligible**

707. As described above, studies have shown that there is no lasting disturbance or exclusion of marine mammals around Windfarm Sites during operation, and

therefore the potential magnitude of effect due to disturbance on marine mammals is assessed as **negligible**.

708. For leatherback turtles, the potential magnitude of effect due to the underwater noise associated with operational turbines is based on the noise criteria for continuous noise (Popper et al., 2014), as has been used to assess the potential effects due to construction activities (**Section 12.7.3.1.1**). Therefore, the magnitude of effect, without any mitigation, is assessed as **negligible**, for underwater noise effects (disturbance) due to the operational noise associated with WTGs.

12.8.1.4 Significance of Effect

709. Taking into account medium sensitivity and the potential magnitude of the temporary effect, the significance for any disturbance of harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin and grey seal has been assessed as **negligible**. For minke whale and leatherback turtle the significance of effect has been assessed as **minor adverse** (not significant) (**Table 12.86**).

Table 12.86 Assessment of Effect Significance for Underwater Noise from Operational Turbines

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Disturbance due to operational wind turbines	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin	Low	Negligible	Negligible	None required	**Negligible**
	Minke whale	Medium	Negligible	Minor adverse		**Minor adverse**
	Grey seal	Low	Negligible	Negligible		**Negligible**
	Leatherback turtle	Medium	Negligible	Minor adverse		**Minor adverse**

12.8.1.5 Further Mitigation

710. No mitigation is required or proposed for underwater noise effects associated with operational ETG noise, as the effects are **minor adverse to negligible** and not significant.

12.8.2 Impact 2: Underwater Noise from Maintenance Activities such as Cable Repairs and Rock placement

711. Operational activities such as cable repairs and rock placement are considered to be of a lesser scale than those seen during construction (**Section 12.7.3**). However, as a precautionary approach, this assessment will consider the effects to be on a similar scale to those presented in **Section 12.7.3.4**.

12.8.2.1 Sensitivity of the Receptor

712. As set out in **Section 12.7.3.1.1**, as the potential effect range for PTS is less than 10m, and any individual would have to remain with 10m for a period of 24 hours to be at risk of PTS, it is considered highly unlikely that PTS could occur due to the activities associated with operation and maintenance, and therefore, PTS is not considered further.

713. The sensitivity of marine mammals and marine turtles to TTS and disturbance as a result of underwater noise during maintenance activities is considered to be **medium** in this assessment as a precautionary approach (**Table 12.43**).

714. As outlined in **Section 12.7.3.1**, the sensitivity of marine mammals to disturbance as a result of underwater noise during activities such as cable laying, trenching or rock placement, is considered to be **medium** for disturbance (**Table 12.43**) in this assessment as a precautionary approach.

12.8.2.2 Magnitude of Effect

715. The requirements for any potential maintenance work, such as additional rock placement or cable re-burial, are currently unknown. However, the work required, and associated impacts would be less than those during construction. **Table 12.14** provides estimates (as outlined in **Chapter 5: Project Description**) for potential cable repairs and reburial.

716. As outlined in **Section 12.7.3.1.1**, for most species, the potential for TTS is only likely in very close proximity to cable laying or rock placement activities and if the marine mammal remains within close proximity for 24 hours. All marine mammals are predicted to be at risk of TTS within 10m of cable laying, dredging, and rock placement, with the exception of harbour porpoise which would have to remain

within 230m for a period of 24 hours to be at risk of TTS from suction dredging, and within 990m for 24 hours to be at risk of TTS from rock placement. It is unlikely that more than one maintenance activity would take place at the same time, and therefore the assessment for TTS due to rock placement, as provided in **Table 12.68**, is considered to represent a realistic worst-case for the potential for TTS due to maintenance activities.

717. Any potential effect from additional cable laying and protection are temporary in nature, and will be limited to relatively short periods during the operation and maintenance phase. Disturbance responses are likely to occur at significantly shorter ranges than construction noise. Any disturbance is likely to be limited to the area in and around where the actual activity is taking place. As a worst-case, the same assessments for the potential for disturbance of other constriction activities (as provided in **Section 12.7.3.1.2**, would also apply to the potential for disturbance due to maintenance activities, which would be similar in nature.

718. Therefore, the underwater noise from maintenance activities is considered to be the same or less than those assessed for underwater noise from other construction activities (including rock placement, trenching and cable laying) (**Section 12.7.3.4**).

719. The magnitude for all marine mammal species is assessed as **negligible**.

720. For leatherback turtles, the potential magnitude of effect due to the underwater noise associated with maintenance activities is based on the noise criteria for continuous noise (Popper *et al.*, 2014), as has been used to assess the potential effects due to construction activities (**Section 12.7.3.1.2)**. Therefore, the magnitude of effect, without any mitigation, is assessed as **negligible**, for underwater noise effects (disturbance) due to the operational noise associated with WTGs.

12.8.2.3 Significance of Effect

721. Taking into account medium sensitivity and the potential magnitude of the temporary impact, the impact significance for any disturbance of harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle has been assessed as **negligible** (not significant) (**Table 12.87**).

Table 12.87 Assessment of Effect Significance for Underwater Noise from Maintenance Activities

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
TTS during maintenance activities	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle	Medium	Negligible	Negligible	None required	**Negligible**
Disturbance during maintenance activities	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle	Medium	Negligible	Negligible		**Negligible**

12.8.2.4 Further Mitigation

722. No mitigation is required or proposed for underwater noise for maintenance activities, such as rock placement, trenching and cable laying, as the effects are **negligible** and not significant.

12.8.3 Impact 3: Underwater Noise and Disturbance from Vessels

723. The vessel movement during the operation and maintenance stage will be to a lesser extent than the construction stage, but as a precautionary approach, the potential for effect during the operation and maintenance phase will be based on the assessments as provided in **Section 12.7.4**.

12.8.3.1 Sensitivity of the Receptor

724. As outlined in **Section 12.7.4.2**, the sensitivity of marine mammals and marine turtles to vessel noise and presence is assessed as a precautionary **medium** for TTS and disturbance, and **high** for PTS.

12.8.3.2 Magnitude of Effect

725. As outlined in **Section 12.7.4.1**, the potential for PTS or TTS is only likely in very close proximity to vessels, and if the marine mammal and marine turtle remains within close proximity (less than 10m) for 24 hours. Therefore, the only potential effect from underwater noise from vessels is disturbance.

726. The requirements for any potential maintenance work are currently unknown. However, the work required, and impacts associated with underwater noise and disturbance from vessels during operation and maintenance would be less than those during construction.

727. It is estimated that the maximum number of vessels that could be required on site at any one-time during operation and maintenance could be one, which is less than the five vessels that could be on each site during construction. However, as a precautionary approach the assessment for construction has been used for the operation and maintenance assessment, as a worst-case scenario.

728. For the operation of the Windfarm Site, there could be up to 40 vessel movements per year (approximately 0.1 vessel movements per day), representing an increase of up to 1.1% compared to average daily vessels currently within the Windfarm Site, and an increase of approximately 0.6% to the current number of vessel movements within the navigation Study Area. This is less than the number of vessel movements within the construction period, and therefore the assessments for TTS and

disturbance as presented in **Section 12.7.4.1** would represent a worst-case scenario.

729. The magnitude for all marine mammal and marine turtle species is assessed as **negligible** for TTS, and based on maximum areas of effect for all vessels and the operation and maintenance stage requiring less vessels than during construction (**Table 12.72**). For the potential for a disturbance effect, the magnitude would be **low** for marine mammals, and **negligible** for leatherback turtle, based on the assessments as presented in **Section 12.7.4.1.2**.

12.8.3.3 Significance of Effect

730. Taking into account medium sensitivity and the potential magnitude of the temporary impact, the effect significance for TTS and disturbance from underwater noise from operation and maintenance vessels is assessed as **negligible** to **minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherhead turtle (**Table 12.88**).

Table 12.88 Assessment of Effect Significance for Underwater Noise and Disturbance from Operation and Maintenance Vessels

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
TTS due to underwater noise from maintenance vessels	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle	Medium	Negligible	Negligible	None required	**Negligible**
Disturbance due to underwater noise from maintenance vessels	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, and grey seal	Medium	Low	Minor adverse	None required	**Minor adverse**
	Leatherback turtle	Medium	Negligible	Negligible	None required	**Negligible**

12.8.3.4 Further Mitigation

731. No mitigation is required or proposed for underwater noise or disturbance from operation and maintenance vessels.

12.8.4 Impact 4: Barrier Effects from Underwater Noise from Operational Wind Turbines

732. No barrier effects as a result of underwater noise during operation and maintenance are anticipated.

733. As assessed in **Section 12.8.1**, the magnitude for displacement (based on TTS / fleeing response) as a result of underwater noise from operational turbines has been assessed as **negligible** for all marine mammal and marine turtle species, with a resultant effect significance of **negligible** to **minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle.

734. As outlined in **Section 12.8.1**, the indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.1km (maximum of 2.62km). Therefore, there would be no overlap in the potential impact range of less than 10m (<0.01km) around each turbine, and there would be adequate room for marine mammals and marine turtles to move through the wind farm arrays. **Section 12.8.1.2** also outlines that marine mammals are not deterred from utilising these areas within operational wind farms.

735. Therefore, any potential barrier effects as a result of underwater noise during operation and maintenance has not been assessed further.

12.8.5 Impact 5: Interaction and Collision Risk with Vessels

736. During the operation and maintenance phase there will be an increase in vessel traffic within the Windfarm Site and ECC, and from vessels enroute from the chosen port. However, it is anticipated that vessels would follow an established shipping route to the relevant port in order to minimise vessel traffic in the wider area. **Appendix 12.C: Draft MMMP** provides a protocol for minimising collision risk of marine mammals and marine turtles with vessels.

12.8.5.1 Sensitivity of the Receptor

737. As outlined in **Section 12.7.6.1**, marine mammals and marine turtles are considered to have a **high** sensitivity to the risk of a vessel strike.

12.8.5.2 Magnitude of Effect

738. It is estimated that there would be approximately 40 vessel movements, to and from the Offshore Project, for each year of the operation and maintenance phase (**Table 12.14**). An assessment of the potential increase in risk to marine mammals as a result of the 40 vessel movements per year has been undertaken following the same approach as undertaken for the construction phase (**Section 12.7.6**).

739. The number of marine mammals at risk of collision, per vessel, in UK waters has been calculated, and has been used to calculate the number of each marine mammal species at risk of collision from the 40 yearly vessel transits associated with the Offshore Project's operation and maintenance phase. For all species except grey seal, there is less than 0.001% at risk of the permanent impact, and therefore a **negligible** magnitude of effect (**Table 12.89**). For grey seal, the magnitude of effect is **negligible to low**.

740. For leatherback turtles, the magnitude of effect would be the same or less than as assessed for construction (**Section 12.7.6.2**), therefore, the magnitude would be **negligible**.

Table 12.89 Predicted Number of Marine Mammals at Risk of Vessel Collision During operation and maintenance, Based on Current UK Collision Rates and Vessel Presence

Marine Mammal Species	Collision Risk Rate (Table 12.76)	Estimated Total Number of Individuals in UK Waters	Estimated Number of Individuals at Risk Within UK Waters (Collision Risk Rate x Total UK Population)	Annual Number of Vessel Transits in UK and RoI for 2015	Number of Marine Mammals at Risk of Collision per Vessel in UK Waters	Number Annual Vessel Transits Associated with operation and maintenance	Additional Marine Mammals at Risk Due to Increase in Vessel Number (Number of Vessels * Number at Risk per Vessel)	Additional Marine Mammals at Risk Due to Increase in Vessel Number as Proportion of the Offshore Project Reference Populations	Magnitude of Effect (Permanent Effect)
Harbour porpoise	0.056	200,714	11,309.6	3,852,030	0.0029	40	0.12	0.0002% of CIS MU	**Negligible**[23]
Bottlenose dolphin	0.044*	7,545	334.7	3,852,030	0.00009	40	0.004	0.00003% of OCSW MU	**Negligible**
Common dolphin	0.049	57,417	2,834.3	3,852,030	0.0007	40	0.03	0.00003% of CGNS MU	**Negligible**
Striped dolphin	0.044*	19,253	854.0	3,852,030	0.0002	40	0.009	0.00005% of reference population	**Negligible**
Minke whale	0.073*	10,288	748.2	3,852,030	0.0002	40	0.008	0.00004% of CGNS	**Negligible**
Grey seal	0.043	157,300	6,789.9	3,852,030	0.0018	40	0.07	0.004% of SW MU; 0.0006% of	**Negligible to low**

[23] Based on the weighted magnitude levels as set out in **Paragraph 561**

Marine Mammal Species	Collision Risk Rate (Table 12.76)	Estimated Total Number of Individuals in UK Waters	Estimated Number of Individuals at Risk Within UK Waters (Collision Risk Rate x Total UK Population)	Annual Number of Vessel Transits in UK and RoI for 2015	Number of Marine Mammals at Risk of Collision per Vessel in UK Waters	Number Annual Vessel Transits Associated with operation and maintenance	Additional Marine Mammals at Risk Due to Increase in Vessel Number (Number of Vessels * Number at Risk per Vessel)	Additional Marine Mammals at Risk Due to Increase in Vessel Number as Proportion of the Offshore Project Reference Populations	Magnitude of Effect (Permanent Effect)
								combined MU	(less than 0.01%)[24]

** using the collision risk rate of the species group as a worst-case*

[24] Based on the weighted magnitude levels as set out in **Paragraph 561**

12.8.5.3 Significance of Effect

741. The significance for potential increased collision risk from vessels during the operation and maintenance phase considers the high marine mammal and marine turtle sensitivity, and potential magnitude of the effect (**Table 12.89**). The significance of effect has been assessed as **minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale and leatherback turtle, and **minor to moderate adverse** for grey seal (**Table 12.90**). However, the residual effect, taking into account good practice to reduce any risk of collisions with marine mammals and marine turtles (see **Section 12.4.4.2**), would be **minor adverse** for all species.

Table 12.90 Assessment of Effect Significance for Any Increased Collision Risk with Vessels During Construction

Potential Impact	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Increased Collision Risk	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale	High	Negligible	Minor adverse	Recommended good practice in **Appendix 12.C: Draft MMMP**	**Minor adverse**
	Grey seal		Negligible to low[25]	Minor to moderate adverse		**Minor adverse**
	Leatherback turtle		Negligible	Minor adverse		**Minor adverse**

[25] Based on the weighted magnitude levels as set out in **Paragraph 561**

12.8.5.4 Further Mitigation

742. As previously touched upon, the Outline CEMP (**Appendix 5.A**) and **Appendix 12.C: Draft MMMP** will ensure vessel movements, where possible, are incorporated into recognised vessel routes. This will also include areas where marine mammals and marine turtles are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required, and within a vessel speed of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals and marine turtles, such as following the Cornwall Marine and Coastal Code for Vessels[26].

12.8.6 Impact 6: Disturbance at Seal Haul Out Sites

743. As previously outlined in **Section 12.7.7**, increased activity around landfall, including an increase in vessel and human activity, has the potential to disturb seals at haul out sites, particularly during sensitive periods, such as the breeding season and moult period. Disturbance from vessel transits to and from the Windfarm Site also has the potential to disturb seals at haul out sites, depending on the route and proximity to the haul out sites.

12.8.6.1 Sensitivity of the Receptor

744. The sensitivity of disturbance to grey seals at haul out sites would be the same for the operational period as for the construction period (**Section 12.7.7.1**). Therefore, the sensitivity is **low**, and is increased to **medium** during the pupping and moult periods, to account for the increased sensitivity of grey seal during that time.

12.8.6.2 Magnitude of Effect

745. The magnitude of effect through operation and maintenance would the same (or less than) as that for the construction period, as provided in **Section 12.7.7.2**. The potential for any increase in disturbance to seal haul out sites as a result of operation and maintenance activities at the offshore Windfarm Site, along the ECC, and at the landfall site, or from vessel movements, would therefore be **negligible**.

746. Whilst the operation and maintenance base to be used for the Offshore Project is not yet confirmed, it is likely that vessel movements to and from the operation and maintenance base would be incorporated within existing vessel routes wherever possible. It is therefore likely that seals hauled-out along these routes and in the

[26] https://www.cornwallwildlifetrust.org.uk/sites/default/files/2019-03/Cornwall%20Marine%20and%20Coastal%20Code%20Guidelines.pdf

area of the ports would be habituated to the noise, movements and presence of vessels. Vessel movements to the Windfarm Site from the operation and maintenance based would use direct established routes and are unlikely to be close to the shore, or within the distance required to cause a disturbance impact, based on the distance thresholds as noted in **Section 12.7.7.2** (of 600m for grey seal). Therefore, the magnitude of effect for grey seals at haul out sites to disturbance from vessels at or near the operation and maintenance base or transit route is assessed as **negligible**.

12.8.6.3 Significance of Effect

747. Taking into account the **low to medium** sensitivity and **negligible** magnitude of the temporary effect, the significance for disturbance at seal haul out sites has been assessed as **negligible** to **minor adverse** (not significant) for grey seals (**Table 12.91**).

748. **There are a number of designated SSSI sites nearby to the** Offshore Project that are designated for grey seals; **Table 12.33** summarises these areas. Given the location of the Offshore Project, the key potential effect to designated sites are likely to be to hauled-out seals, and this potential effect is considered further within the assessments of disturbance to hauled-out seals during construction (**Section 12.7.7**), operation and maintenance (**Section 12.8.6**) and decommissioning (**Section 12.9**).

749. Designated SACs for marine mammals are assessed within the **RIAA**.

750. Table 12.33 lists the SSSIs near the Windfarm Site that are designated for grey seals. As the nearest SSSI is Lundy Island, this will be taken as the worst-case example. The potential for effect during the operation and maintenance phase would the same (or less than) as that for the construction period, as provided in **Section 12.7.7.3**. Therefore, there would be a **negligible** effect to the grey seal hauled-out at Lundy SSSI due to vessel presence and maintenance activities.

Table 12.91 Assessment of Effect Significance for Disturbance at Seal Haul Out Sites During operation and maintenance

Potential Effect	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Disturbance at seal haul out sites	Grey seal	Low to Medium	Negligible	Negligible to minor adverse	Recommended best practice as outlined in **Appendix 12.C: Draft MMMP**	**Negligible to Minor adverse**

12.8.6.4 Further Mitigation

751. No mitigation is required for the disturbance of seals at haul out sites. However, where possible and safe to do so, transiting vessels would maintain distances of 600m or more off the coast, particularly in areas near known seal haul out sites (such as Lundy Island) during sensitive periods. All vessel movements will be kept to the minimum number that is required to reduce any potential for disturbance.

12.8.7 Impact 7: Entanglement

752. Depending on the method used, there is the perceived potential for entanglement in the mooring systems and dynamic cables for floating offshore wind turbines. To date, there have been no recorded instances of marine mammal and marine turtle entanglement from mooring systems of renewable devices (Isaacman and Daborn, 2011; Harnois *et al.*, 2015), or for anchored floating production storage offloading (FPSO) vessels in the oil and gas industry (Benjamins *et al.*, 2014), with similar mooring lines as proposed for floating turbine structures. However, entanglement in fishing gear is known to occur, and therefore means potential for a risk of secondary entanglement.

753. Discarded fishing gear, or 'ghost gear' can act as an attractor to fish species, and therefore attract larger marine species such as marine mammals and marine turtles (Filmalter *et al.* 2013; Wilcox *et al.* 2013). For marine turtles, entanglement in ghost gear is one of the key threats, however, there is little information on entanglement rates and the potential effect to marine turtle populations (Duncan *et al.*, 2017). A global review by Duncan *et al.* (2017) of marine turtle entanglements found that an average of 5.5% of all stranded marine turtle species were entangled, the majority of which were due to ghost fishing gear.

754. For the Offshore Project, there will be a maximum of 48 mooring lines (up to six per WTG). The mooring lines will be either catenary, taught, or semi-taught, and comprised of anchor chain, mooring cables or polyester mooring line, and extend up to 760m from the WTG. The mooring lines will be between 175mm and 300mm in diameter, depending in the type of mooring, and material used. It is expected that the full length of each mooring line will be suspended in the water column, with temporary surface buoys used during construction. See **Figure 12.27** below for an example of each of these mooring systems, and **Section 5.4.6** of **Chapter 5: Project Description** for further detail on each of these types of mooring lines.

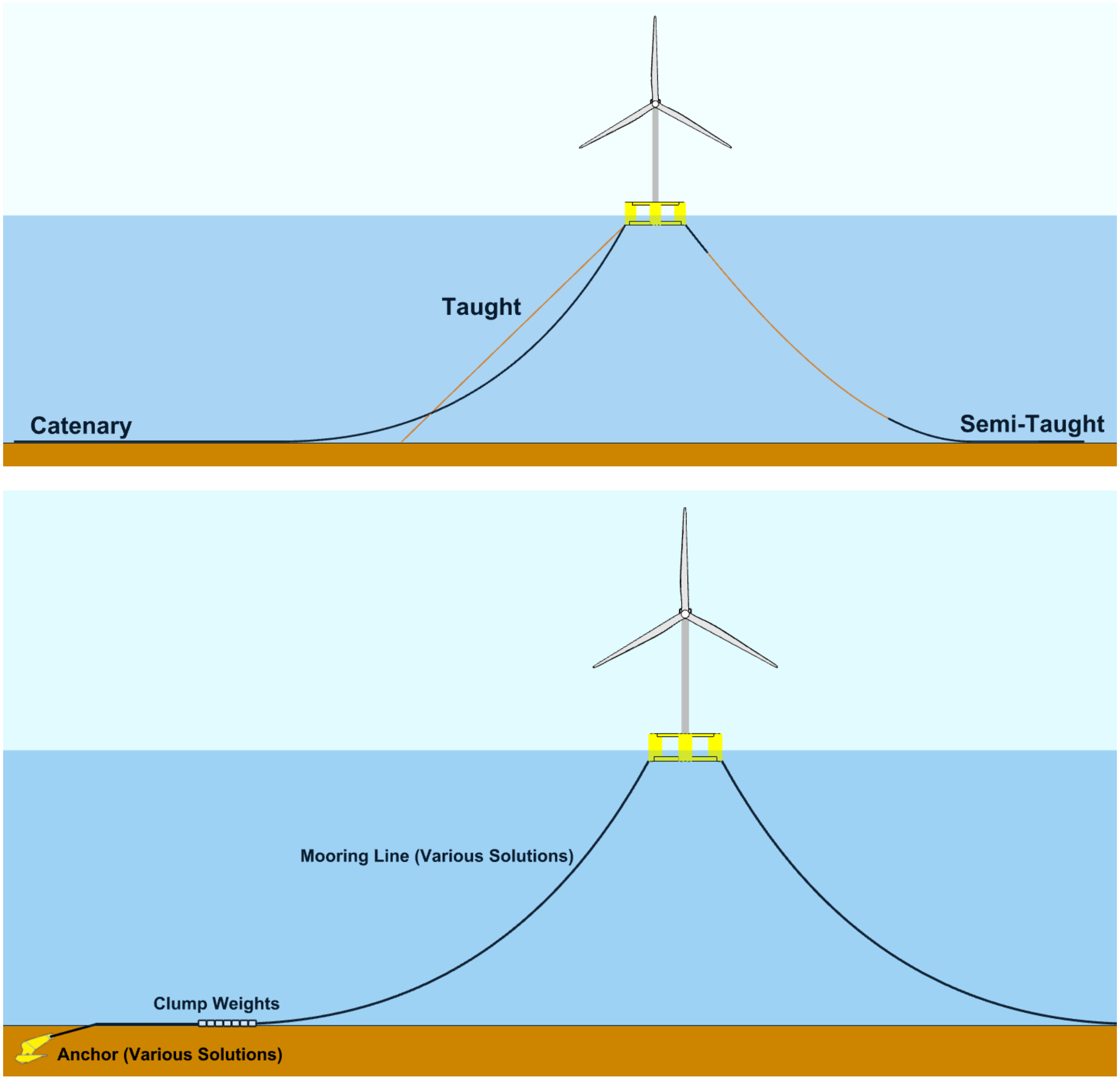


Figure 12.27 Mooring Configurations and Components

755. There will also be up to ten dynamic inter-array cables. The dynamic section of each cable will be freely suspended in the water column in a lazy wave configuration, with buoyancy modules attached to the mid-portion of the cable, creating a mid-water arch. See **Figure 12.28** below for an example of the dynamic cable system, and **Section 5.5.1** of **Chapter 5: Project Description** for further detail.

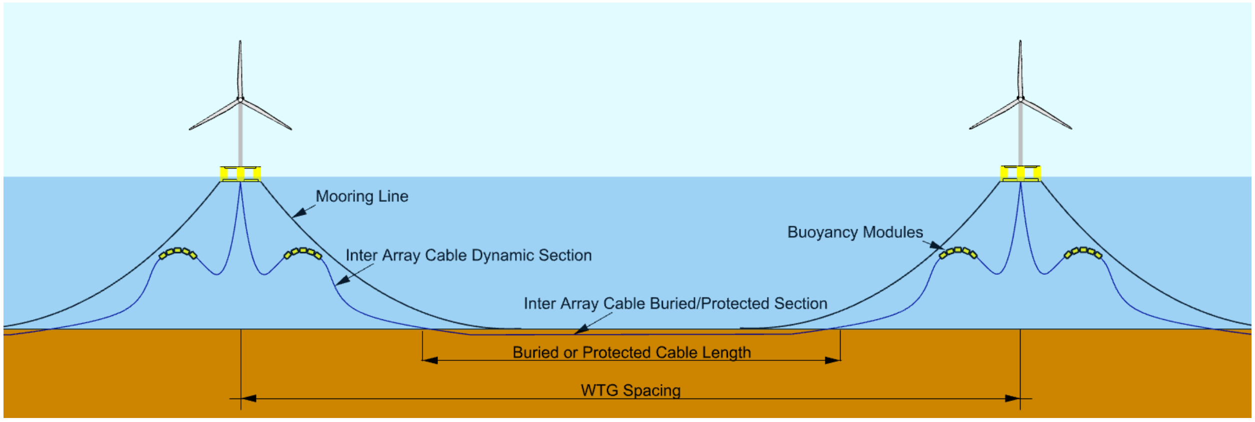


Figure 12.28 Inter-array cable schematic

12.8.7.1 Sensitivity of the Receptor

756. Impacts to marine mammals and marine turtles due to entanglement include fatalities from drowning, infection and tissue damage if the animal escapes. Also, emaciation if entanglement stops the animal from feeding effectively, and increased drag and energy use if the animal is entangled but able to move freely.

757. Marine mammal and marine turtle entanglement risk will likely be influenced by the type of mooring system employed (slack or taut-moored systems), mooring characteristics, and turbine array configuration (Farr *et al*., 2021). Benjamins *et al.* (2014) provided an in-depth qualitative assessment of relative entanglement risk, taking into consideration both biological risk parameters (e.g. body size, flexibility, and ability to detect moorings) and physical risk parameters of mooring components (e.g., tension characteristics, swept volume, and mooring curvature).

758. Results of a risk assessment on different mooring types by Benjamins *et al.* (2014) indicated a higher risk of entanglement based on mooring stiffness for the most compliant mooring arrangements. This was specifically catenary with chain and nylon, catenary with accessory buoys and taut with accessory buoys. The risk was reduced for the catenary configuration with chain, and catenary configuration with chain and polyester. The risk was lowest for the stiffer taut configuration.

759. Benjamins *et al.* (2014) provides a qualitative assessment of relative entanglement risk across different marine megafauna groups, taking into account both biological risk factors such as animal size, sensory capabilities and foraging methods, and physical risk factors such as mooring flexibility, pre-tension and footprint. **Table 12.92** summarises the results of this assessment. Baleen whales appear to be at

greatest risk, due to their size and distinctive foraging techniques (i.e. rapidly engulfing dense prey aggregations). Lunge feeding baleen whales are thought to be more susceptible when feeding and exposing themselves to entanglement (Johnson *et al.*, 2005). Mooring systems can also attract marine mammals due to potential increases in prey species around the mooring lines and devices. Small-toothed cetaceans incur the least risk, primarily due to their small size and manoeuvrability. Seal species have a similar risk level to small-toothed cetaceans, with an increase in manoeuvrability (Benjamins *et al.*, 2014).

Table 12.92 Relative Risk Assessment for Marine Mammals with Mooring Scenarios Relevant to the Offshore Development Area (Based on Biological and Physical Risk Parameters; Benjamins et al., 2014)

Species	Catenary & Chain	Taut & Accessory Buoy
Harbour porpoise	Low	Low
Bottlenose dolphin	Low	Low
Common dolphin	Low	Low
Striped dolphin	Low	Low
Minke whale	High	High
Grey seal	Low	Low

760. Given the size and physical characteristics of the mooring systems required for floating OWF, it is unlikely that upon encountering them, a marine mammal of any size would become directly entangled in the moorings themselves. Note that the mooring system will remain under tension at all times and no loops, as seen in fishing gear, will ever be formed to allow entanglement with the mooring system. Mooring systems in the offshore renewables industry typically have greater diameter (Benjamins *et al.*, 2014), compared to fishing gear, which has been identified as a major entanglement risk for whales (Lynch *et al.*, 2018).

761. The Cornwall Wildlife Trust reports on marine strandings in Cornwall and the Isles of Scilly annually. As part of this scheme, from 2017 to 2021, a total number of strandings of cetaceans came to 1,081 and the scheme conducted examination on 702 (65%) of these via post-mortem or using the Bycatch Evidence Evaluation Protocol (BEEP) technique. Of the examined cetaceans, entanglement with fishing gear can be attributed to 165 (24%) of individuals. When estimated as 24% of the entire stranding population this can be seen as 254 individuals, with the majority of these cetaceans being common dolphin or harbour porpoise (Cornwall Wildlife Trust, 2017; 2018; 2019; 2020; 2021; **Table 12.93**).

762. The same report also notes the number of grey seal strandings in Cornwall and the Isles of Scilly. The number of grey seals stranded between the years of 2017 to 2021 came to 1,080. Of these, 107 (10%) were examined either by post-mortem of the BEEP technique. Of the examined grey seals, entanglement with fishing gear can be attributed to seven (7%) of individuals. When estimated as 7% of the entire stranding population this can be seen as 70 individuals (Cornwall Wildlife Trust, 2017; 2018; 2019; 2020; 2021; **Table 12.93**).

Table 12.93 Summary of the Cornwall Wildlife Trust's report on marine strandings in Cornwall and the Isles between 2017 to 2021 for cetaceans and grey seals (Cornwall Wildlife Trust, 2017; 2018; 2019; 2020; 2021)

Year	Total Strandings	Post-mortem and BEEP	Entangled from Post-mortem and BEEP examinations
Cetaceans			
2017	250	178	37
2018	177	113	34
2019	245	143	38
2020	202	126	26
2021	207	142	30
Total	1081	702	165
Grey seal			
2017	161	15	4
2018	179	19	1
2019	246	20	0
2020	203	18	1
2021	291	35	1
Total	702	107	7

763. Scottish Marine Animal Stranding Scheme (SMASS) reported on entanglements of marine mammal species with fishing gear as part of the strandings scheme. In total, from 2009 to 2020, a total of 29 minke whale were reported with a cause of death attributed to entanglements, out of a total 70 known causes of death for minke whale. Therefore, entanglement with fishing gear can be attributed to an estimated 41.4% of minke whale deaths, respectively. In addition, 17 grey seal (out of 470 known causes of death), and four harbour seal (of 180 known causes of death) were found stranded, with entanglement as the cause of death. This equates to

entanglement causing an estimated 3.6% of grey seal deaths, and 2.2% of harbour seal deaths. One harbour porpoise and one short-beaked common dolphin were also reported to have been entangled. The above reported entanglements are all with fishing gear.

764. Whale species were the most commonly reported species to become entangled, further supporting that they are the most sensitive species to the risk of entanglement. It should be noted that there have been no reports of marine mammal entanglements with mooring systems or cables associated with either floating wind farm infrastructure, or FPSOs, despite both being present in Scottish waters for the same period as the SMASS scheme has been in place. Indicating, as noted above, that the risk of entanglement with floating turbines is from that of secondary entanglement, where fishing gear becomes caught in the mooring system or cables associated with the floating turbine infrastructure, and marine mammals and marine turtles would be at risk of entangling with the caught fishing gear, rather than the mooring system or cables themselves.

765. Therefore, the greatest risk is most likely to be from indirect (or secondary) entanglement in anthropogenic debris, such as the lost, abandoned or discarded fishing gear and other marine debris, caught in the mooring system or cables, known as 'ghost fishing' gear (Benjamins *et al.*, 2014). Tertiary entanglement is also a potential risk (although is considered to be unlikely unless in areas of high fishing and high whale presence), and refers to the potential for marine animals, who are trailing fishing gear, to swim in close proximity to mooring lines, allowing the trailing gear to become entangled.

766. The entanglement risk of marine megafauna (e.g. marine mammals and marine turtles), with floating wind systems is relatively unknown, mainly due to the lack of focused studies and monitoring (including on the potential for ghost fishing gear to become entangled in the mooring lines).

767. Taking into account that there have been no recorded instances of marine mammal and marine turtle entanglement from mooring systems of marine renewable devices or similar mooring lines, and neither dynamic cables or the mooring lines and cables have loose ends or sufficient slack (Copping *et al.*, 2020), the sensitivity of marine mammals and marine turtles to potential entanglement at the Windfarm Site is assessed to be **negligible** for all species due to direct entanglement. All marine mammal and marine turtle species, due to the increased risk and sensitivity of secondary (or tertiary) entanglement, have a sensitivity of **medium**, with the exception of minke whale, which have a sensitivity of **high** to secondary (and tertiary) entanglement.

12.8.7.2 Magnitude of Effect

768. As a precautionary approach, the potential magnitude of effect has been based on the relative risk assessment for marine mammals by Benjamins *et al.* (2014) for the catenary and chain mooring system. However, it should also be noted that the potential for avoidance of fishing gear is likely to be higher at the Windfarm Site, due to the infrastructure that would be present, which would have the likely effect of providing marine mammals and marine turtles with a higher ability to detect the presence of structures in the water column, and therefore increase their ability to avoid it.

769. It is difficult to determine whether marine mammals and marine turtles will be deterred from the WTGs by the operational noise, or potentially attracted if fish aggregations develop around the devices. However, given the relatively low density of marine mammals and marine turtles, including minke whale, in and around the Windfarm Site, the low risk of entanglement based on the information in Benjamins *et al.* (2014), and the potentially increased opportunity for avoidance of fishing gear, the magnitude of effect is predicted to be **negligible** for all species, except minke whale, for which the magnitude of effect is considered to be **low**, due to their increased rates of entanglement with fishing gear.

12.8.7.3 Significance of Effect

770. The significance of effect for the possible entanglement with the mooring system and cables has been assessed as **negligible** to **minor adverse** for harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, grey seal and leatherback turtle, and **negligible** to **moderate adverse** for minke whale.

771. The residual effect, taking into account management measures (see **Section 12.8.7.4**) to reduce any risk of entanglements, would be **negligible** to **minor adverse** (not significant) for all marine mammal and marine turtle species in the Windfarm Site.

772. Any entanglement risk during construction or decommissioning would be less than the assessment for the operational phase of the Offshore Project.

Table 12.94 Effect Significance for Risk of Entanglement to Marine Mammals and Marine Turtles

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Entanglement	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, grey seal, and leatherback turtle	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to minor adverse	Monitoring measures in **Outline CEMP**, and as set out in **Section 12.8.7.4**.	**Negligible**
	Minke whale	Negligible (direct entanglement) High (secondary entanglement)	Low	Negligible to moderate adverse		**Negligible to minor adverse**

12.8.7.4 Further Mitigation

773. **Appendix 12.C: Draft MMMP** will include monitoring for risk of entanglement, this will include:

- Monitoring for large strains on mooring lines:
  - It is expected that a similar method of monitoring would be undertaken as per Kincardine Offshore Windfarm. On Kincardine Offshore Windfarm this has to date been undertaken by load cells attached to the mooring devices and subsea cables, designed to alert if there is unexpected load on the devices which can then be examined. The monitoring method is in the process of changing to using position monitoring system, which will identify the associated drag function on the structures outside the normal operating range
- Surveys: the turbines and mooring systems would be regularly checked by ROV (during both planned and unplanned maintenance activities):
  - This would ensure that there was no material such as discarded nets, ropes or other debris which could increase the risk of entanglement for marine mammals and marine turtles or interfere with the optimal operation of the turbines. Surveys would be caried out according to American Bureau of Shipping (ABS) rules and standards. This technique is currently being used on Kincardine Offshore Windfarm, which has not found any entanglement events to date.

774. The final monitoring design will be agreed with the MMO and Natural England. It will take account results of the methods being used at Kincardine Offshore Windfarm to inform the most appropriate technique, at the time of deployment of the Offshore Project.

775. In the event that any entanglement of a marine mammal or marine turtle does occur during the operation of the Offshore Project. Additional mitigation and monitoring measures may be required to ensure it does not happen again.

12.8.8 Impact 8: Barrier Effects Due to Physical Presence

776. Once the Offshore Project is operational, there is the potential for a barrier effect to occur due to the physical presence of the Offshore Project's infrastructure.

12.8.8.1 Sensitivity of the Receptor

777. The presence of a wind farm could be perceived as having the potential to create a physical barrier, preventing movement or migration of marine mammals between important feeding and / or breeding areas, or potentially increasing swimming

distances if marine mammals avoid the site and go round it. The Windfarm Site is not located on any known migration routes for marine mammals or within any known key foraging areas.

778. As outlined in **Section 12.8.1.2**, information from operational (fixed foundation) windfarms show no evidence of exclusion of harbour porpoise or seals (for example, Diederichs *et al*., 2008; Lindeboom *et al*., 2011; Marine Scotland, 2012; McConnell *et al*., 2012; Russell *et al*., 2014; Scheidat *et al*., 2011; Teilmann *et al*., 2006; Tougaard *et al*., 2005, 2009a, 2009b). Based on the review of marine mammal presence within operational wind farms, the sensitivity of all marine mammal and marine turtle species to a barrier to movement due to the physical presence of the windfarm is **negligible**.

12.8.8.2 Magnitude of Effect

779. The minimum spacing between wind turbines will be 1,100m, and maximum spacing would be 2,620m. The mooring line radius around each turbine would be 600m. Therefore, there would be at least 1,100m between turbine locations, and between 500m and 2,020m between the mooring line configurations, depending on final turbine design and turbine spacings. This means that animals can be expected to move between devices and through the operational windfarm, irrespective of layout.

780. The maximum footprint of turbine moorings is approximately 2,400m^2 per WTG (based on total area for anchor length and width, maximum number of anchors per WTG (of six), the mooring chain width and the mooring line radius around each anchor; **Table 12.14**), and the footprint of the OSP would be 1,257m^2. This equates to a total footprint of 20,457m^2 (or 0.02km^2). Therefore, the physical footprint of structures that could present a physical barrier is a very small area (0.04%) of the total Windfarm Site area (49.35km^2).

781. There is currently no information on the potential for the physical presence of a floating offshore wind farm site to cause a barrier to movement for marine mammal species, however, it is assumed to cause a similar level of effect to that of fixed foundation wind farms. It is therefore not expected that the locations of the turbines and infrastructure themselves will be positioned in a location to cause a barrier to movement, with room for marine mammal to transit through the Windfarm Site. Therefore, the magnitude of effect for all marine mammals is **negligible**.

12.8.8.3 Significance of Effect

782. The significance of effect for a possible barrier effect due to the physical presence of the windfarm has been assessed as **negligible** for harbour porpoise, bottlenose

dolphin, common dolphin, striped dolphin, minke whale, grey seal and leatherback turtle (**Table 12.95**).

783. Any physical barrier effect during construction or decommissioning would be less than the assessment for the operation and maintenance phase of the Offshore Project.

Table 12.95 Effect Significance for the Potential for a Barrier Effect (Due to the Physical Presence of the Windfarm) to Marine Mammals and Marine Turtles

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Potential for a barrier effect (due to the physical presence of the windfarm)	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle	Negligible	Negligible	Negligible	None required	**Negligible**

12.8.8.4 Further Mitigation

784. No mitigation is proposed (or required) for physical barrier effects, and therefore the residual effect would be **negligible** (not significant) for all species.

12.8.9 Impact 9: Electromagnetic Fields (Direct and Indirect Effects)

785. EMFs occur as a result of electricity transmission through conductive objects, such as transmission cables, and comprises an electric field (E field) and a magnetic field (B field). Many marine organisms have evolved sensory abilities to use electric and magnetic cues in essential aspects of life history, such as prey detection, predatory behaviour, and navigation and these behaviours may be impacted by EMF emissions in the water column (Hutchinson *et al.,* 2020).

786. The significance of EMF effects on the surrounding environment depends on the voltage and current passing through the cables, and as voltage increases the electric field increases. For submarine transmission cables, EMF strength decreased rapidly with distance from the cable, from 7.85μT at 0m, to 1.47μT at 4m, based on the average windfarm inter-array cable buried 1m below the seabed (Normandeau *et al*., 2011).

787. The export cable (275kV AC) will be buried to an approximate 1m but could be between 0.5 and 3m. EMF impacts relating to export cables and marine mammals are therefore not discussed in further detail in this assessment.

788. The inter-array cables are expected to be 66KV to 275Kv alternating current (AC). Where present on the seabed, the inter-array cables will be buried typically to a depth of 1m, but could be between 0.5 and 3m, significantly reducing the levels of detectable EMF, and are not expected to have any impact on marine mammals. However, some portion of the inter-array cables will not be buried (part of the cable being suspended within the water column), and therefore have the potential to effect marine mammals both directly and indirectly through prey interaction pathways.

789. The number, length, and specification of the inter-array cables to be used in this project are as follows:

- Up to 10 inter-array cables
- 3.2km of dynamic inter-array cables (in total)
- 66KV to 275Kv rated capacity.

12.8.9.1 Sensitivity of the Receptor

790. Some marine mammals, such as cetaceans, are believed to use geomagnetic cues as a navigational tool (Ferrari, 2016). However, this aspect of their physiology is not well understood and much of the literature dealing with EMF effects on marine mammals is inconclusive (Dhanak *et al.*, 2016). Whilst other marine mammals including pinnipeds may be able to sense EMF in their environment, it is not considered a primary system for foraging or navigation. The overall sensitivity of marine mammals to EMF is therefore considered to be **low**.

791. Marine turtles can sense magnetic fields and use the Earth's magnetic field to long-range navigation and migration (Normandeau *et al.,* 2011). Leatherback turtles are known to be able to detect geomagnetic fields, however, there is limited information on their ability to detect EMF. The loggerhead turtle is able to detect EMF as low as 0.005μT, while the green turtle are able to detect EMF at 29.3-200μT (Normandeau *et al.,* 2011). It can be assumed that leatherback turtle may be able to detect EMF at similar levels to both loggerhead and green turtles. Marine turtles may be more sensitive than marine mammals to changes in EMF and are therefore considered to have a **medium** sensitivity.

12.8.9.2 Magnitude of Effect

792. It has been determined that EMF becomes undetectable at 4m from the cable in seawater, as per Normandeau *et al*. (2011), however, there is a lack of research specific to EMF in the water column.

793. Current information on the effects of EMF on marine mammals is limited, however, there is no evidence to date that marine mammal activity will change as a result of the presence of increased EMF in the environment from inter-array cables. Magnetic field intensities reduce as a function of distance from the source and are highly localised, reducing to 1uT at 4.3m from 66kV cables, well below a detectable level for magneto-receptive marine mammal species (5uT) (Normandeau *et al.,* 2011). EMF from inter-array cables is therefore unlikely to interfere with the navigation systems of these species.

794. A magnitude of **negligible** is given for all marine mammal species, as while it is not expected that the EMF of the inter-array cables would impact marine mammal species (which would result in a magnitude of negligible), there remain some unknowns of this potential effect.

795. It has been estimated that AC cables buried to a depth of 1m would emit EMF of less than 0.05μT up to 25m from the cable (Normandeau *et al.,* 2011). Studies have shown that marine turtles will alter their movement as a result of changes in EMF,

however, there remain many unknowns as to the effect that EMF may have on marine turtles. They are therefore assessed as having a **low** magnitude of effect, as while it is not expected that EMF would be detectable at long ranges for marine turtles, there are uncertainties associated with this species and potential effect. It should also be noted that the leatherback turtle is considered rare in the area, and it is therefore unlikely that there would be any significant effect to the leatherback population.

12.8.9.3 Significance of Effect

796. The significance of effect for EMF related to the Offshore Project has been assessed as a **negligible (not significant)** for all marine mammal species, and as **minor adverse (not significant)** for leatherback turtle (**Table 12.96**).

Table 12.96 Effect Significance EMF effects to Marine Mammals and Marine Turtles

Potential Impact	Species	Sensitivity	Magnitude	Significance	Mitigation	Residual Effect
Effect of EMF on marine mammals	Harbour porpoise, bottlenose dolphin, common dolphin Striped dolphin, minke whale, grey seal	Low	Low	Negligible	None required	**Negligible**
	Leatherback turtle	Medium	Low	Minor adverse		**Minor adverse**

12.8.9.4 Further Mitigation

797. No mitigation is proposed (or required) for EMF effects, and therefore the residual effect would be **negligible to minor adverse (not significant)** for all marine mammal and marine turtle species.

12.8.10 Impact 10: Changes to Prey Availability

798. As outlined in **Chapter 11: Fish and Shellfish Ecology**, the potential effects on fish species during operation and maintenance can result from:

- Permanent habitat loss
- Temporary increased SSC and sediment deposition
- Underwater noise and vibration
- EMF
- Barrier effects
- Fish aggregation effects
- Ghost fishing.

799. Any impacts on fish species have the potential to effect marine mammals and marine turtles through a loss of prey availability.

12.8.10.1 Sensitivity of the Receptor

800. As outlined in **Section 12.7.11.1**, harbour porpoise are considered to have **low to medium** sensitivity to changes in prey resources, bottlenose dolphin, common dolphin and striped dolphin have **low** sensitivity, minke whale have **low to medium** sensitivity, and grey seal and leatherback turtle have **low** sensitivity.

12.8.10.2 Magnitude of Effect

12.8.10.2.1 Permanent Habitat Loss

801. Permanent habitat loss has the potential to occur during the operational phase of the Offshore Project. Whilst the Offshore Projects infrastructure will prevent prey species from accessing some areas, this will not account for a significant loss in water column habitat. Therefore, this potential effect only refers to the area of seabed loss due to the placement of infrastructure (such as buried export cables, catenary chains on the seabed, and anchors/moorings within the seabed).

802. The worst-case area of seabed predicted to be impacted by permanent habitat loss during the operation and maintenance phase is presented within **Table 11.24** of **Chapter 11: Fish and Shellfish Ecology**. The total worst-case scenario area for permanent habitat loss is 950,384m² (0.95km²). This represents 0.01% of the Fish

and Shellfish Ecology Study Area (8,002km²), and 1.76% of the total area available to fish and shellfish within the Maximum Footprint Area (54.08km²).

803. The magnitude of effect associated with permanent habitat loss is based on the worst-case scenario of direct and permanent seabed and water column loss and is considered low (**Chapter 11: Fish and Shellfish Ecology**).

804. The low magnitude of impact, combined with the low to medium sensitivity of all fish and shellfish receptor groups, results in the impact of permanent habitat loss having a minor adverse effect to fish and shellfish species. Therefore, any potential changes to prey availability, as a result of permanent habitat loss is assessed as **negligible** for all marine mammals and marine turtles.

12.8.10.2.2 Temporary Increased Suspended Sediment Concentrations and Sediment Deposition

805. Seabed sediments have the potential to be temporarily suspended in the water column and re-deposited to the seabed as a result of operation and maintenance activities. However, the magnitude of effects of increased SSC and sediment deposition are determined to be less than those that are predicted to arise during the construction and installation phase of the Offshore Project.

806. As assessed in **Section 12.7.11.2.2**, the magnitude of SSC and sediment deposition is determined to be **low**.

807. Due to the low magnitude of impact and the low or medium sensitivities of fish and shellfish to the effects of SSC and sediment deposition, these activities are assessed as having a minor adverse effect on fish and shellfish species (**Chapter 11: Fish and Shellfish Ecology**). Therefore, any potential changes to prey availability as a result of increased SSCs and sediment deposition is assessed as **negligible** for marine mammals and marine turtles.

12.8.10.2.3 Underwater Noise and Vibration

808. During operation, underwater noise is expected to be produced via transit of service and maintenance vessels, through cable snapping, and through mechanically generated vibrations from moving turbines. A full assessment of these underwater noises can be found in **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**.

809. Based on criteria from Popper *et al.* (2014) for continuous noise, the TTS threshold of 158dB (SPL_{RMS}) would require an individual receptor to be present within 20m of the turbine for a period of 24hrs to be at risk of TTS due to operational turbine

noise. As the noise source is near the surface, and water depths within the array are in the order of 75m, this is considered a very low risk. Therefore, fish and shellfish species are considered to have a low sensitivity to operational and maintenance noise and vibration (**Chapter 11: Fish and Shellfish Ecology**).

810. Due to the low magnitude of impact, and the low sensitivities of fish and shellfish to the effects of underwater noise and vibration, these activities are assessed as having a minor adverse effect on fish and shellfish species. Therefore, any potential changes to prey availability as a result of operation and maintenance noise, including operational WTG noise and maintenance activities, is assessed as **negligible** for marine mammals and marine turtles.

12.8.10.2.4 EMF

811. EMF occurs as a result of electricity transmission through conductive objects, such as transmission cables, and comprises an electric field (E field) and a magnetic field (B field). The electromagnetic attributes of EMFs have the potential to disrupt organs used for navigation and foraging within a number of fish species. EMFs can have attractive and repulsive effects, that can cause barrier effects dependent on the species and the spatial scale of EMF, for further information, see **Chapter 11: Fish and Shellfish Ecology**.

812. The magnitude of impact associated with EMFs is based on the worst-case scenario of a 4m radius zone around all array cables, and a 4m radius semi-circular zone around both export cables within the Maximum Footprint Area. The greatest magnitude of impact will be in direct contact with cables, most likely the dynamic array cables within the water column, in which the maximum EMF magnitude is $<50\mu T$. As each turbine has an input and output array cable, the magnitude is compounded throughout the array, however the area of impact is very low in comparison to the total available space. The cable interacting with the seabed will be buried, either within the seabed or under rock protection, resulting in a negligible impact zone for fish and shellfish in this case. Therefore, the magnitude of EMF is considered **low** (**Chapter 11: Fish and Shellfish Ecology**).

813. Of the fish and shellfish species assessed, the following sensitivity has been assessed (For further information, see **Chapter 11: Fish and Shellfish Ecology**):

- Elasmobranchs – medium
- Demersal and pelagic – low
- Migratory species – low
- Shellfish species – negligible.

814. The low magnitude of impact, combined with the negligible to medium sensitivity of all fish and shellfish receptor groups, results in the impact of EMFs having a minor adverse effect on fish and shellfish species. Therefore, any potential changes to prey availability as a result of EMF is assessed as **negligible** for marine mammals and marine turtles.

12.8.10.2.5 Barrier Effects

815. Physical barrier effects due to operation and maintenance will be similar to those occurring during construction, with the exception of any future plans to lay additional cable protection on the seabed. This activity will decrease the opportunity of some prey species to move between sites straddling the protection and, therefore, present a slightly elevated risk of barrier effects for demersal fish and shellfish species. The worst-case scenario for barrier effects during the operation and maintenance phase of the Offshore Project is similar to the worst-case scenario for barrier effects during the construction phase, outlined in **Section 12.7.11.2.4**.

816. As determined within **Section 12.7.11.2.4**, the magnitude of effect associated with barrier effects is based on the worst-case scenario of water volume lost within the Offshore Development Area. This represents approximately 356,139.39m^3, constituting 0.0098% of the Offshore Development Area. Therefore, the magnitude of barrier effects is considered negligible (**Chapter 11: Fish and Shellfish Ecology**).

817. The negligible magnitude of effect, combined with the negligible to low sensitivity of all fish and shellfish receptor groups, results in the impact of barrier effects having a minor adverse effect on fish and shellfish species. Therefore, any potential barrier effect to prey species movement during the operation and maintenance phase is assessed as **negligible** for marine mammals and marine turtles.

12.8.10.2.6 Fish Aggregation Effects

818. The introduction of physical substructures associated with offshore windfarms will cause fish aggregation effects over time (Wilhelmsson *et al.*, 2006). Physical structures provide a foundation for settling invertebrates, which increase the organic matter surrounding the structure, and underpin artificial reef ecosystems through 'bottom-up' control of productivity. Increasing nutrient availability and biomass presents opportunities for all fish and shellfish species, from top predators to detritivores (Raoux *et al.*, 2017) (For further information, see **Chapter 11: Fish and Shellfish Ecology**).

819. The magnitude of effect associated with fish aggregation is based on the worst-case scenario of the volume of water column loss within the Offshore Development Area. This represents approximately 356,139.39m³, constituting 0.0098% of the Offshore Development Area. Due to the small scale of infrastructure that traverses the entire water column (the worst-case scenario being spar buoy structures), the 'absorption' of individuals from fringe habitats, particularly demersal and bentho-pelagic species, will be of negligible significance compared to the potential effects of other OSPs. There is greater opportunity for aggregation around the OSP's foundations, due to the lattice-like structure that provides shelter from larger predators. However, the use of only one OSP is unlikely to have a significant effect during the lifetime of the Offshore Project. Therefore, the magnitude of barrier effects and fish aggregation is considered negligible.

820. The negligible magnitude of effect, combined with the negligible to low sensitivity of all fish and shellfish receptor groups, results in the impact of fish aggregation effects having a negligible effect (beneficial) for fish species.

821. The increase in fish presence around the physical structures of the Offshore Project through the operation and maintenance phase could result in an indirect beneficial impact to marine mammal species, through the improvement of the quality of prey species in the area.

822. The benefit of this potential increase in prey availability to marine mammals has not yet been studied widely. However, the presence of an artificial reef does increase the abundance and biomass of species, and the increase in prey species availability increases the attractiveness of the area to predators (Devault *et al.,* 2017; Paxton *et al.,* 2022).

823. Seal species in particular have been shown to forage actively around submerged pipelines and wind turbine structures within a year of their construction (Russel *et al.,* 2014; Arnould *et al.,* 2015). A study of the use of marine structures in the North Sea by marine mammal species indicate that the structures are visited commonly by a range of species, including minke whale, harbour porpoise, and grey seal (Delefosse *et al.,* 2018). Note that this study uses incidental sightings only, and therefore no firm conclusions can be drawn from the use of the structures by marine mammals in comparison to the wider area.

824. While there is potential for a benefit to marine mammals through the improvement in the quality of prey, the effect of this on marine mammal species is not well understood. In addition, as the Offshore Project is to use floating WTG structures, the potential beneficial effect is likely reduced (as noted above for fish species). The

magnitude is therefore assessed as **negligible (beneficial)**, although this is considered uncertain due to the current lack of scientific knowledge on the subject.

12.8.10.2.7 Ghost Fishing

825. Ghost fishing refers to the trapping/entanglement of individuals within man-made debris, most commonly abandoned, lost, or discarded fishing gear (ALDFG) (Richardson *et al.,* 2019). In the context of the Offshore Project, ALDFG may drift onto suspended cables and chains that form the anchor/mooring system. Ghost nets are a well-known cause of mortality in all fish and shellfish receptor groups. However, the degree of impact is dependent on the size and location of ALDFG (for further information, see **Chapter 11: Fish and Shellfish Ecology**).

826. The magnitude of effect associated with ghost fishing is based on the continuous monitoring of the Offshore Project substructures for the presence of ALDFG and other potential entanglement hazards. If identified, these hazards will be removed as part of the maintenance of the Offshore Project's infrastructure during the operational phase. Therefore, the magnitude of ghost fishing is considered negligible for fish and shellfish species.

827. The negligible magnitude of impact, combined with the high sensitivity of all fish and shellfish receptor groups, results in the impact of ghost fishing having a minor adverse effect. Therefore, any potential effect to prey species due to ghost fishing gear during the operation and maintenance phase is assessed as **negligible** for marine mammals and marine turtles.

12.8.10.3 Significance of Effect

828. **Table 12.97** summarises the significance of effect for changes to prey availability during the operational and maintenance stage of the Offshore Project. The conclusion is an effect significance of **negligible** for all marine mammal and marine turtle species assessed, and for the effect to prey due to fish aggregation effects, this is a negligible beneficial effect.

Table 12.97 Effect Significance for an Indirect Effect to Marine Mammals and Marine Turtles due to Changes to Prey Availability

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Changes to prey availability • **Permanent habitat loss** • **Temporary increased SSC and sediment deposition** • **Underwater noise and vibration** • **EMF** • **Barrier effects** • **Ghost fishing.**	Harbour porpoise, minke whale	Low to medium	Negligible	Negligible	None required	**Negligible**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle	Low	Negligible	Negligible		**Negligible**
Changes to prey availability • **Fish aggregation effects.**	Harbour porpoise, minke whale	Low to medium	Negligible	Negligible beneficial		**Negligible beneficial**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle	Low	Negligible	Negligible beneficial		**Negligible beneficial**

12.8.10.4 Further Mitigation

829. Given the assessment of minor adverse (**Table 12.97**), no further mitigation is proposed.

12.8.11 Impact 11: Changes to Water Quality

830. As outlined in **Chapter 9: Marine Water and Sediment Quality** potential changes in water quality during the operation and maintenance phase are:

- Localised temporary increases in SSCs
- Remobilisation of existing contaminated sediments.

12.8.11.1 Sensitivity of the Receptor

831. As outlined in **Section 12.7.12.1**, marine mammals and marine turtles are considered to have **negligible** sensitivity to any changes in water quality.

12.8.11.2 Magnitude of Effect

832. As assessed in **Chapter 9: Marine Water and Sediment Quality**, any potential changes in water quality during operation and maintenance would be **negligible**.

12.8.11.3 Significance of Effect

833. Taking into account the negligible sensitivity of marine mammals and negligible magnitude of effect, the significance for any changes in water quality during operation and maintenance has been assessed as **negligible**.

12.8.11.4 Further Mitigation

834. No mitigation is required or proposed.

12.9 Potential Effects during Decommissioning

835. The potential impacts of the decommissioning of the Offshore Project have been assessed for marine mammals and marine turtles. A description of the potential effect caused by each identified impact is given in this section.

836. Potential impacts during decommissioning that have been considered for marine mammals and marine turtles are:

- Impact 1: Underwater noise from foundation and cable removal
- Impact 2: Underwater noise and disturbance from vessels
- Impact 3: Barrier effects caused by underwater noise
- Impact 4: Interaction and collision risk with vessels
- Impact 5: Disturbance at seal haul out sites

- Impact 6: Entanglement
- Impact 7: Electromagnetic fields direct and indirect effects
- Impact 8: Changes to prey availability
- Impact 9: Changes to water quality.

837. These potential effects on marine mammals and marine turtles associated with decommissioning have not been assessed in detail. Further assessments will be carried out ahead of any decommissioning works to be undertaken, including relevant guidelines and requirements, and detailed decommissioning activities and methods. At this stage, the full detail of the required decommissioning activities is not currently known. A decommissioning plan will be prepared during detailed design and developed and refined during the Offshore Project's lifetime and as decommissioning approaches. To reflect future best practice and new technologies, the approach and methodologies of the decommissioning activities will be compliant with the relevant legislation, guidance and policy requirements at the time of decommissioning.

838. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise which would not occur).

839. The potential impacts on marine mammals and marine turtles during decommissioning would be expected to be the same or less than those same relevant effects as assessed for construction in **Section 12.7**.

12.10 Potential Cumulative Effects

840. The approach to the cumulative effect assessment (CEA) is set out in **Chapter 6: EIA Methodology**. Only projects which are reasonably well described and sufficiently advanced to provide information on which to base a meaningful and robust assessment have been included in the CEA. Projects which are sufficiently implemented during the site characterisation for the Offshore Project have been considered as part of the baseline for the EIA.

12.10.1 CEA Screening of Potential Effects

841. As stated within the White Cross Scoping Report, the cumulative effects that have screened in for assessment are:

- Impact 1: Disturbance due to underwater noise
- Impact 2: Increased collision risk

- Impact 3: Entanglement
- Impact 4: Changes to prey availability.

Table 12.98 Potential Cumulative Effects at the Offshore Project

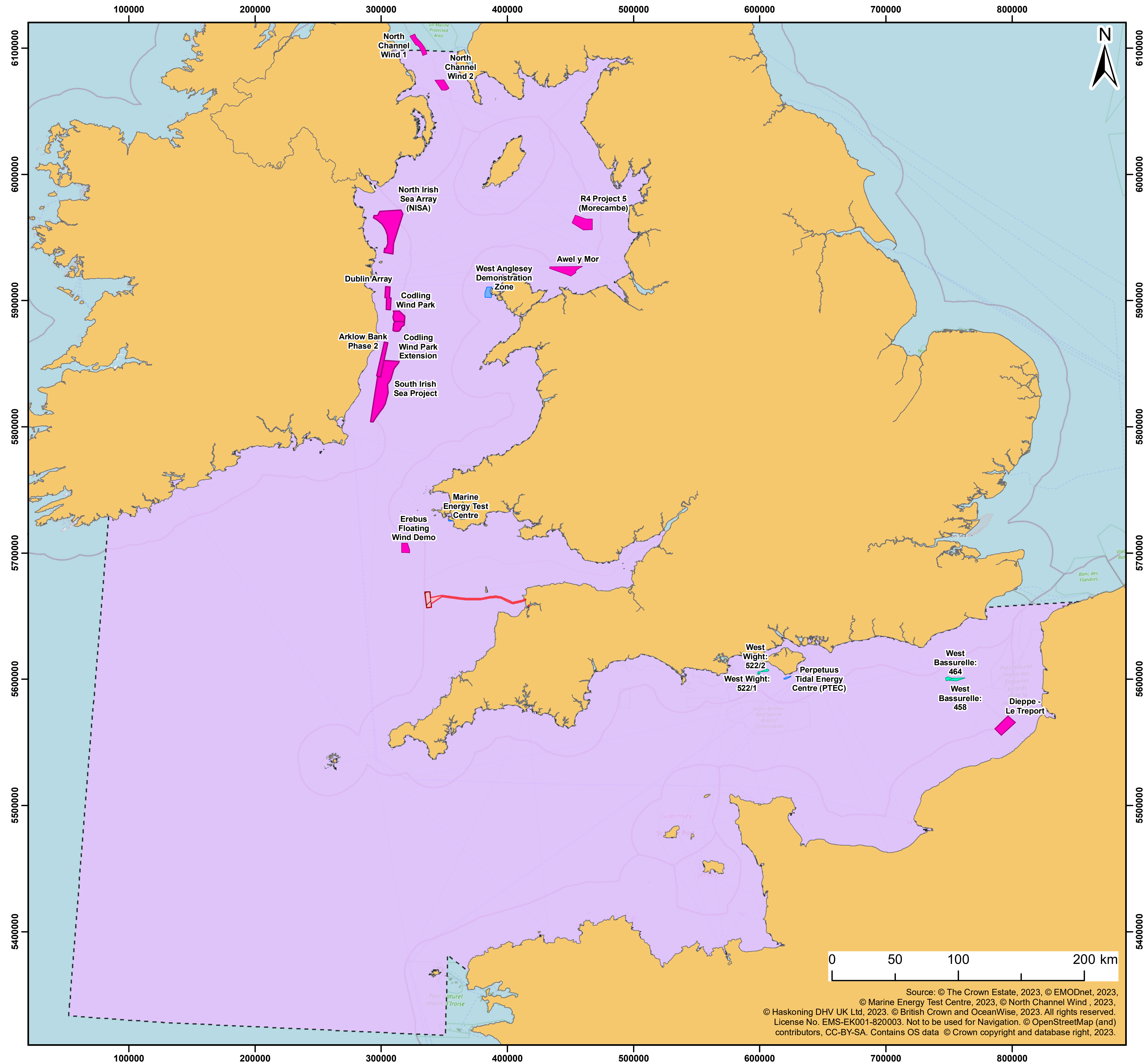
Cumulative Effect	Screened in For Further Assessment	Rationale
Underwater noise - risk of permanent change in hearing sensitivity (PTS)	No	PTS could occur as a result of pile driving during offshore wind farm installation, pile driving during oil and gas platform installation, underwater explosives (used occasionally during the removal of underwater structures and unexploded ordnance (UXO) clearance) and seismic surveys (JNCC, 2010a, 2017). However, if there is the potential for any PTS from any project, suitable mitigation would be put in place to reduce any risk to marine mammals. Other activities such as dredging, drilling, rock placement, vessel activity, operational windfarms, oil and gas installations or wave and tidal sites will emit broadband noise in lower frequencies and PTS from these activities is very unlikely. Therefore, the potential risk of PTS in marine mammals from cumulative projects has been screened out from further consideration in the CEA.
Underwater noise - risk of temporary change in hearing sensitivity (TTS)	No	Where there is little information on the potential disturbance ranges for marine mammals, TTS has been used to indicate possible fleeing response. It is acknowledged that disturbance is likely to have greater effect ranges than for TTS. The risk of TTS will be within disturbance ranges for marine mammals. The effects of TTS in marine mammals are temporary. As the potential for temporary effect due to underwater noise has higher potential effect ranges for disturbance than for TTS / fleeing response, the potential for disturbance has been assessed as results in the worst-case assessments. TTS / fleeing response has therefore been screened out of the CEA, but will be used to inform the assessment of disturbance effects where

Cumulative Effect	Screened in For Further Assessment	Rationale
		there is a lack of further relevant information for disturbance.
Underwater noise – disturbance	Yes	The potential for the disturbance to marine mammals from underwater noise has been screened in to the CEA. See Section 12.10.3.1 for the full assessment.
Vessel collision risk	Yes	The potential for cumulative projects to cause an increase in vessels collision risk has been considered further in Section 12.10.3.2.
Entanglement	Yes	The potential for cumulative projects to cause risk of entanglement has been considered further in Section 12.1.1.1.
Changes to prey availability	Yes	The potential for cumulative projects to cause a change to prey availability from has been considered further in Section 12.10.3.4.

842. All potential cumulative effects are detailed in **Table 12.98**, and a rationale for either screening in or out to the cumulative assessment is provided. For all cumulative effects screened in, further information and assessment is provided in the following sections. Further detail is also provided in **Appendix 12.B: Cumulative Effect Assessment (CEA) Screening for Marine Mammals and Marine Turtles**.

12.10.2 CEA Screening of Other Projects and Industries

843. The full CEA screening process for marine mammals is provided in **Appendix 12.B**. The below sections and tables provide the conclusions of the full screening. The Study Area used within the marine mammal (and marine turtle) CEA screening is that of the IS and OCSW bottlenose dolphin MU, as shown on **Figure 12.29**; this has been used for the CEA screening for all species. For grey seal, the Offshore Project within the CEA screening area are then refined to take account of the relevant MUs. This screening area chosen to provide a worst-case, but still precautionary, list of projects of which to assess against. Including projects outside of this area is considered to be over-precautionary, as it is unrealistic that projects at that distance would have the potential for any cumulative effect with the Offshore Project.



Legend:

- Windfarm Site
- Offshore Development Area
- Cumulatative Effect Assessment Study
- Other Offshore Windfarms
- Wave and Tidal Locations
- Aggregate Extraction Sites

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Marine Mammal and Marine Turtle CEA Study Screening Area with Other Projects and Industries Screened In

Figure: 12.29 Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0564

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P01	08/03/2023	GC	LA	A3	1:3,000,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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844. **Table 12.99** summarises the activities, plans and projects screened into the CEA with the potential for disturbance effects.

Table 12.99 Summary of Activities, Plans and Projects Screened into the CEA for Disturbance Effects

Cumulative Effect	Industry or Activity with Potential for Cumulative Effect	Project / Activity Screened in for Potential Cumulative Effect
Disturbance from underwater noise	Piling at other OWFs (**Section 1.3.2** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	The OWFs that could be piling at the same time as the Offshore Project, and therefore screened into the CEA for further assessment are: • Dieppe - Le Treport • Codling • Dublin Array • North Irish Sea Array • South Irish Sea • Awel y Môr Offshore Wind Farm • Morecambe.
	Other construction activities at OWFs (other than piling) including vessels, cable installation works, dredging, sea bed preparation and rock placement (**Section 1.3.2** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	The OWFs screened in for other construction activities that could have cumulative effects with other construction activities at the Offshore Project are: • Arklow Bank Phase 2 • Erebus • North Channel Wind 1 • North Channel Wind 2.
	Geophysical surveys at OWFs (**Section 1.3.2** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	Unknown. It is therefore assumed, as a worst-case scenario, that there could potentially be up to two geophysical surveys in the CEA Study Area at any one time, during construction of the Offshore Project.
	Marine Renewable Energy (MRE) projects (wave and tidal) – construction phase only (**Section 1.3.3** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	No MRE projects have been screened with potentially overlapping construction windows. Three MRE projects may have overlapping operational phases with the Offshore Project; • Morlais • Marine Energy Test Area • Perpetuus Tidal Energy Centre

Cumulative Effect	Industry or Activity with Potential for Cumulative Effect	Project / Activity Screened in for Potential Cumulative Effect
	Aggregate extraction and dredging (**Section 1.3.4** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	Aggregate extraction and dredging projects screened in for the potential for cumulative effects with the Offshore Project are: • West Bassurelle (Area 458) • West Bassurelle (Area 464) • West Wight (Area 522/1) • West Wight (Area 522/2).
	Oil and gas installation projects (**Section 1.3.6** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	No oil and gas installation projects have been screened in with potentially overlapping construction windows.
	Oil and gas seismic surveys (**Section 1.3.6** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	Unknown It is therefore assumed, as a worst-case scenario, that there could potentially be up to one seismic survey in the CEA Study Area at any one time, during construction of the Offshore Project.
	Subsea cable and pipelines (**Section xx** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	Subsea cables and pipelines projects screened in for harbour porpoise are: • X-Links Interconnector 1 • X-Links Interconnector 2.
	Other marine projects (gas storage, offshore mines and carbon capture) (**Section 1.3.8** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	The other marine projects screened in that could have cumulative effects with other construction activities for the Offshore Project are: • Hinkley Point C.
	UXO clearance (**Section 1.3.1** of **Appendix 12.B: Marine Mammal and Marine Turtle CEA Screening Report**)	Unknown. It is assumed UXO clearance would use low-order technique. However, as a worst-case scenario, CEA includes potential for one UXO high-order detonation (no mitigation) and one low-order detonation in the CEA Study Area at the same time as construction of the Offshore Project.

845. **Table 12.100** summarises the activities and types of projects screened out of the CEA.

Table 12.100 Summary of Activities and Types of Projects Screened Out of the CEA

Effect	Potential for Cumulative Effect	Activities and Types of Projects Screened Out
Disturbance from underwater noise	No	The activities and types of projects screened out of the CEA, as there is no potential for significant contribution to underwater noise cumulative effects during the Offshore Project's construction, are: • Operational WTG noise • Maintenance of operational OWFs • Decommissioning of OWFs • Marine renewable (wave and tidal) developments – operation and maintenance and decommissioning phases • Licensed disposal sites • Shipping • Oil and gas decommissioning • Commercial fisheries.

12.10.3 Assessment of Cumulative Effects with Other Projects and Industries

846. The CEA screening identified that there is the potential for cumulative effects on marine mammals and marine turtles as a result of disturbance from underwater noise during piling and other construction activities. Other potential effects, including PTS from underwater noise and TTS from underwater noise, were screened out of the CEA (see **Appendix 12.B**). All operational impacts have also been screened out of assessment.

847. The potential sources of cumulative underwater noise which could disturb marine mammals, and which are screened into the CEA are:

- piling at other OWFs
- other construction activities at OWFs (such as vessels, cable installation works, dredging, sea bed preparation and rock placement)

- other construction activities at other marine renewable projects (e.g. wave and tidal) (such as vessels, cable installation works, dredging, sea bed preparation and rock placement)
- aggregate extraction and dredging
- oil and gas installation projects
- oil and gas seismic surveys
- subsea cables and pipelines
- other marine industries, such as gas storage, offshore mines, and carbon capture
- high resolution geophysical surveys (such as for OWFs)
- UXO clearance.

848. The approach to the assessment for cumulative disturbance from underwater noise has been based on the approach for the assessment of disturbance for those same activities as presented in **Section 12.7**, including the current advice from the SNCBs (JNCC *et al.,* 2020) on the assessment of impacts on the harbour porpoise designated SACs.

849. Where a quantitative assessment has been possible, the potential magnitude of disturbance has been based on the number of harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, and minke whale in the potential effect areas using the latest SCANS-III density estimates (Hammond *et al.,* 2021). For both striped and common dolphin, this also includes the estimates for individuals that could not be identified to species level (i.e. the density estimates for common and/or striped dolphin). For striped dolphin, this is therefore likely an overestimation, as it more likely that individuals identified as being either common or striped dolphin were common dolphin. For those industries where the exact location is not known, a wider area density estimate is used, based on the SCANS-III density estimates (Hammond *et al*., 2022).

850. The number of grey seal in the potential effect areas has been estimated based on the seal at sea usage maps (Carter *et al.,* 2022) for each relevant project or area.

851. It is intended that this approach to assessing the potential cumulative effects of disturbance from underwater noise will reduce some of the uncertainties and complications in using the different assessments from EIAs, based on different noise models, thresholds and criteria, as well as different approaches to density estimates.

852. It should be noted that a large amount of uncertainty is inherent in the CEA. At the project level, uncertainty in the assessment process has been expressed as a level of the confidence in the data used in the assessment. This relates to confidence in

both the understanding of the consequences of the potential effects on marine mammals, but also the information used to inform the predicted magnitude and significance of project effects on marine mammals. As outlined in the tier approach, there is more information and certainty for lower tiers, compared to higher tiers (JNCC and Natural England, 2013).

853. In the CEA, the potential for impacts over wide spatial and temporal scales means that the uncertainty arising from the consideration of a large number of plans or projects leads to a lower confidence in the information used in the assessment, but also the conclusions of the assessment itself. To take this uncertainty into account, where possible, a precautionary approach has been taken at multiple stages of the assessment process, including with the number of projects included in the assessments, the density estimates used to inform the assessments, and the potential areas of effect.

854. The approach to dealing with uncertainty has led to a highly precautionary assessment of the cumulative effects, especially for pile driving, as the CEA is based on the worst-case scenarios for all projects included. It should therefore be noted that building precaution on precaution can lead to unrealistic worst-case scenarios within the assessment.

855. Therefore, the assessment is based on the most realistic worst-case scenario to reduce any uncertainty and avoid presentation of highly unrealistic worst-case scenarios, while still providing a conservative assessment. Careful consideration has been given to determine the most realistic worst-case scenario for the CEA.

12.10.3.1 Impact 1: Underwater Noise from Other Projects

12.10.3.1.1 Impact 1a: Assessment of Underwater Noise from Piling at Other Offshore Wind Farms

856. Following the initial screening of UK and European OWFs (as presented in **Appendix 12.B**), the next stage of the screening exercise was undertaken on those projects that have been identified as having the potential for cumulative construction effects. This stage of the screening is based on known construction periods of UK and European OWF projects. This includes known piling and /or construction timings. These are included to determine a more realistic, but still worst-case, list of UK and European OWF projects that may affect the potential for overlapping piling with the Offshore Project (**Table 12.101**).

857. Of the UK and European OWFs screened in for having a construction period that could potentially overlap with the construction of the Offshore Project, seven OWFs

could be piling at the same time, which is estimated to take place in either 2026 or 2027;

- Dieppe - Le Treport
- Codling
- Dublin Array
- North Irish Sea Array
- South Irish Sea
- Awel y Môr Offshore Wind Farm
- Morecambe.

858. This more realistic short list of OWF projects that could be piling at the same time as the Offshore Project could change as projects develop. This is the best available information at the time of writing, and more accurately reflects the limitations and constraints to project delivery.

Table 12.101 Screening of OWFs for Potential Cumulative Piling and Other Construction Activities at the Same Time as Construction of the Offshore Project. All Details Presented are Based on the Most Up To Date Information at the time of Writing. [HP = Harbour porpoise; BND = Bottlenose Dolphin; CD = Common Dolphin; SD = Striped Dolphin; MW = Minke Whale; GS = Grey Seal]

Name of Project	Country	Project Tier	Marine Mammal Screening Area				OWF Construction Programme		Result of Screening	
			HP – CIS MU	BND – IS & OCSW MUs	CD, SD & MW – CGNS MU	GS - MU 11, MU 12, & RoI East, South-East, and South	Foundation Piling window	Construction window	Potential for overlap of OWF piling with Project piling? [Project construction window of 2026 – 2027]	Potential for overlap of OWF construction with Project construction? [Project construction window of 2026 – 2027]
Dieppe - Le Treport	France	3	N	Y	Y	N	2025-2026	2025-2026	**Yes**	Yes, but assessed for cumulative piling as worst-case
Arklow Bank Phase 2	Ireland	5	Y	Y	Y	Y	Unknown	2027-??	No	**Yes**
Codling	Ireland	5	Y	Y	Y	Y	2026 - 2028	2026 - 2028	**Yes**	Yes, but assessed for cumulative piling as worst-case
Dublin Array	Ireland	5	Y	Y	Y	Y	2025-2027	2025-2027	**Yes**	Yes, but assessed for cumulative piling as worst-case

Name of Project	Country	Project Tier	Marine Mammal Screening Area				OWF Construction Programme		Result of Screening	
			HP – CIS MU	BND – IS & OCSW MUs	CD, SD & MW – CGNS MU	GS - MU 11, MU 12, & RoI East, South-East, and South	Foundation Piling window	Construction window	Potential for overlap of OWF piling with Project piling? [Project construction window of 2026 – 2027]	Potential for overlap of OWF construction with Project construction? [Project construction window of 2026 – 2027]
North Irish Sea Array	Ireland	5	Y	Y	Y	Y	2026-??	2026-??	**Yes**	Yes, but assessed for cumulative piling as worst-case
South Irish Sea	Ireland	5	Y	Y	Y	Y	2026-2029	2026-2029	**Yes**	Yes, but assessed for cumulative piling as worst-case
Awel y Môr Offshore Wind Farm	UK	4	Y	Y	Y	Y	2027-2029	2027-2029	**Yes**	Yes, but assessed for cumulative piling as worst-case
Erebus	UK	4	Y	Y	Y	Y	Floating	2026-2027	No	**Yes**
Morecambe	UK	5	Y	Y	Y	N	2026-2028	2026-2028	**Yes**	Yes, but assessed for cumulative piling as worst-case

Name of Project	Country	Project Tier	Marine Mammal Screening Area				OWF Construction Programme		Result of Screening	
			HP – CIS MU	BND – IS & OCSW MUs	CD, SD & MW – CGNS MU	GS - MU 11, MU 12, & RoI East, South-East, and South	Foundation Piling window	Construction window	Potential for overlap of OWF piling with Project piling? [Project construction window of 2026 – 2027]	Potential for overlap of OWF construction with Project construction? [Project construction window of 2026 – 2027]
North Channel Wind 1	UK	5	Y	Y	Y	N	Floating	2027-2030	No	**Yes**
North Channel Wind 2	UK	5	Y	Y	Y	N	Floating	2027-2029	No	**Yes**

12.10.3.1.1.1 Sensitivity to Potential Disturbance from Piling at other Offshore Wind Farms

859. As outlined in **Table 12.43**, all marine mammal species are assessed as having medium sensitivity to disturbance from underwater noise sources, and marine turtles have a medium sensitivity to underwater noise effects.

12.10.3.1.1.2 Magnitude of Potential Disturbance from Piling at other Offshore Wind Farms

860. The potential disturbance from underwater noise during piling for marine mammal species has been assessed under the same assumptions of disturbance effects as for the Offshore Project, as provided in **Section 12.7.1.1.3.** For harbour porpoise and grey seal, this is based on their known disturbance ranges due to piling, and for dolphin species and minke whale, due to a lack of further information, this is based on the worst-case maximum area modelled for the Offshore Project for each species, using TTS / fleeing response as a proxy for disturbance. See below for further detail for each species.

861. The magnitude of the potential disturbance from piling activities has been estimated for each individual OWF screened in for assessment, based on the following disturbance ranges for each marine mammal species:

- Harbour porpoise
  - The potential impact area during single pile installation, based on the EDR of 26km (JNCC *et al.,* 2020) from each piling location (2,123.7km^2 per project)
- Bottlenose dolphin, common dolphin, and striped dolphin
  - The potential effect area during piling, based on maximum effect range and area for the worst-case modelled for the Offshore Project of 0.1km^2 for TTS / fleeing response as a proxy for disturbance (**Table 12.50**)
- Minke whale
  - The potential effect area during piling, based on maximum effect range and area for the worst-case modelled for the Offshore Project of 5,400km^2 for TTS / fleeing response as a proxy for disturbance (**Table 12.50**)
  - This is likely an overestimation for other OWF sites. The water depth at the Offshore Project site is likely higher than for the other OWFs included within this assessment, and therefore the underwater noise is likely to propagate less at other OWFs. Some of the OWFs included are also within 54km of the coastline, and the following assessment does not take that into account
- Grey seal
  - As noted in **Section 12.7.1.1.3.4**, a study has shown that harbour seal are present in significantly reduced number up to a distance of 25km during

piling (or a disturbance area of 1,963.5km^2) (Russell *et al.,* 2016). This range has been used to determine the number of grey seal that may be disturbed during piling at other OWFs.

862. It should be noted that these potential areas of disturbance assume that there is no overlap in the areas of disturbance between different projects and are therefore highly conservative.

863. Piling at the Offshore Project, based on the assessments as presented in **Section 12.7.1.1.3.5** has also been included in the CEA as a worst-case scenario.

864. The approach to the CEA for piling at OWFs is based on the potential for single piling at each wind farm at the same time as single piling at the Offshore Project. This approach allows for some of the offshore wind farms not to be piling at the same time, while others could be simultaneously piling. This is considered to be the most realistic worst case scenario, as it is highly unlikely that all other wind farms would be simultaneously piling at exactly the same time as piling at the Offshore Project.

865. It is important to note the actual duration for active piling time which could disturb marine mammals is only a very small proportion of the potential construction period, of up to approximately 6.5 days for the Offshore Project, based on the estimated maximum duration to install individual piles (**Table 12.42**).

866. For harbour porpoise, the potential worst case scenario is assessed in **Table 12.102**. The potential magnitude of the temporary effect is assessed as **medium**, however, this is very precautionary, as it is unlikely that all projects could be simultaneously piling at exactly the same time as piling at the Offshore Project and all other offshore wind farm projects.

867. In practice, the potential temporary effects would be less than those predicted in this assessment as there is likely to be a great deal of variation in timing, duration, and hammer energies used throughout the various offshore wind farm project construction periods. In addition, not all individuals would be displaced over the entire potential disturbance range (26km) used within the assessments. For example, the study of harbour porpoise at Horns Rev (Brandt *et al.,* 2011), indicated that at closer distances (2.5 to 4.8km) there was 100% avoidance, however, this proportion decreased significantly moving away from the pile driving activity and at distances of 10km to 18km avoidance was 32% to 49% and at 21km the abundance was reduced by just 2%.

Table 12.102 Quantified CEA for the Potential Disturbance of Harbour Porpoise During Single Piling at other OWFs that Could be Piling at the Same Time as the Offshore Project

Project	Harbour Porpoise Density (/km^2)	Area of Effect (Based on EDRs)	Maximum number of individuals potentially disturbed during single piling
White Cross (the Offshore Project)	0.918	706.9	648.9
Dieppe - Le Treport	0.213	2,123.7	452.3
Codling	0.239	2,123.7	507.6
Dublin Array	0.239	2,123.7	507.6
North Irish Sea Array	0.239	2,123.7	507.6
South Irish Sea	0.239	2,123.7	507.6
Awel y Môr Offshore Wind Farm	0.086	2,123.7	182.6
Morecambe	0.086	2,123.7	182.6
Total number of harbour porpoise (*without* the Offshore Project)			**3,496.8** *2,847.9*
Percentage of CIS MU (*without* the Offshore Project)			**5.59%** *4.56%*
Magnitude of cumulative effect (*without* the Offshore Project)			**Medium** *Low*

868. The assessment for other projects piling at the same time as the Offshore Project is provided in **Table 12.103** for bottlenose dolphin, common dolphin, and striped dolphin. The potential magnitude for the cumulative effect is assessed as **negligible** for all dolphin species, with less than 1% of the reference population that could be temporarily disturbed.

Table 12.103 Quantified CEA for the Potential Disturbance for Dolphin Species During Single Piling at Other OWFs that Could be Piling at the Same Time as the Offshore Project

Project	Area of Effect for Dolphin Species (km^2)	Bottlenose Dolphin Cumulative Assessment		Common Dolphin Cumulative Assessment		Striped Dolphin Cumulative Assessment	
		Bottlenose Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During Single Piling	Common Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During Single Piling	Striped Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During Single Piling
White Cross (the Offshore Project)	0.1	0.0605	0.006	5.2300	0.07	0.6545	0.07
Dieppe - Le Treport	0.1	0.0585	0.006	0.7841	0.002	0.0217	0.002
Codling	0.1	0.0082	0.001	0.6545	0.07	0.6545	0.07
Dublin Array	0.1	0.0082	0.001	0.6545	0.07	0.6545	0.07
North Irish Sea Array	0.1	0.0082	0.001	0.6545	0.07	0.6545	0.07
South Irish Sea	0.1	0.0082	0.001	0.6545	0.07	0.6545	0.07
Awel y Môr Offshore Wind Farm	0.1	0.0082	0.0008	0.6545	0.07	0.6545	0.07
Morecambe	0.1	0.0082	0.0008	0.6545	0.07	0.6545	0.07
Total Number of Individuals		**0.017**		**0.99**		**0.46**	
(Without the Offshore Project*)*		*0.011*		*0.47*		*0.39*	

Percentage of Reference Population *(Without* the Offshore Project*)*	**0.0002%** *0.0001%*	**0.001%** *0.0005%*	**0.002%** *0.002%*
Magnitude of Cumulative Effect *(Without* the Offshore Project*)*	**Negligible** *Negligible*	**Negligible** *Negligible*	**Negligible** *Negligible*

869. For minke whales, the potential magnitude of the temporary effect is assessed as **low**, with between 1% and 5% of the reference population likely to be exposed to the effect (**Table 12.104**).

Table 12.104 Quantified CEA for the Potential Disturbance of Minke Whale During Single Piling at the Other OWFs that Could be Piling at the Same Time as the Offshore Project

Project	Minke whale density (/km2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Single Piling
White Cross (the Offshore Project)	0.0112	5,400.0	60.5
Dieppe - Le Treport	0.0023	5,400.0	12.4
Codling	0.0173	5,400.0	93.4
Dublin Array	0.0173	5,400.0	93.4
North Irish Sea Array	0.0173	5,400.0	93.4
South Irish Sea	0.0173	5,400.0	93.4
Awel y Môr Offshore Wind Farm	0.0173	5,400.0	93.4
Morecambe	0.0173	5,400.0	93.4
Total number of minke whale *(without* the Offshore Project*)*			**633.4** *572.9*
Percentage of CGNS MU *(without* the Offshore Project*)*			**3.15%** *2.85%*
Magnitude of cumulative effect *(without* the Offshore Project*)*			**Low** *Low*

870. For grey seal, based on a single pile installation at each of the offshore wind farms including the Offshore Project, the potential magnitude for the cumulative effect is assessed as **low,** with less than 1% of the reference population with the potential to be impacted (**Table 12.105**).

Table 12.105 Quantified CEA for the Potential Disturbance of Grey Seal During Single Piling at the Other OWFs that Could be Piling at the Same Time as the Offshore Project

Project	Grey seal density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Single Piling
White Cross (the Offshore Project)	0.005	1,963.5	9.82

Project	Grey seal density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Single Piling
Codling	0.015	1,963.5	29.45
Dublin Array	0.014	1,963.5	27.49
North Irish Sea Array	0.012	1,963.5	23.56
South Irish Sea	0.007	1,963.5	13.74
Awel y Môr Offshore Wind Farm	0.182	1,963.5	357.36
Total number of grey seal in wider reference population range *(without the Offshore Project)*			**461.42** *451.61*
Percentage of wider reference population *(without the Offshore Project)*			**3.67%** *3.59%*
Magnitude of cumulative effect *(without the Offshore Project)*			**Low** *Low*

871. For marine turtles, a similar level of effect would be expected at each other OWF as for the Offshore Project, although it should be noted that marine turtles would not be present in the area surrounding all cumulative projects.

872. Under the Popper *et al.*, (2014) criteria for piling, there is a high risk of masking / behavioural response in the near field (<100m), a moderate risk in the intermediate field (>100m and <1,000m), and a low risk in the far field (>1,000m) (**Table 12.48**). As assessed for the Offshore Project (**Section 12.7.1.1.3.5**), it is highly unlikely that any individuals would be present within the high or moderate risk of disturbance areas, given the general rarity of marine turtles within the CEA Study Area, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. Within the area where there is a low risk of masking/behavioural response in marine turtles (of more than 1,000m), it is still considered unlikely that any individual would be present due to the low number within the CEA Study Area, and therefore unlikely that any individual would be exposed to a potential masking/behavioural response effect. Therefore, as for the Offshore Project alone assessment, the magnitude of effect, without any mitigation, is assessed as **negligible** for cumulative piling projects within the CEA Study Area.

12.10.3.1.1.3 Significance of Effect for the Potential Disturbance during Piling at Other OWFs

873. If all included other OWFs were single piling at the same time as the Offshore Project, there is the potential for a **negligible** to **medium** magnitude of effect (dependent on species). However, as outlined above, it is highly unlikely that all the included projects could be simultaneously piling at exactly the same time.

874. Taking into account the medium receptor sensitivity for all marine mammal species, the overall cumulative effect for the disturbance to marine mammals from piling at other OWFs at the same time as the Offshore Project is **moderate adverse** for harbour porpoise, **minor adverse** for minke whale and grey seal, and **negligible** for bottlenose dolphin, common dolphin, striped dolphin, and leatherback turtle (**Table 12.106**). This is deemed to be a conservative assessment based on the worst-case scenario for offshore wind farms single piling at the same time as the Offshore Project.

875. The Offshore Project specific SIP (**Appendix 12.D: In Principle SIP for the BCA SAC**) would manage and reduce the potential for significant disturbance of harbour porpoise from cumulative underwater noise during offshore wind farm piling. Therefore, the residual effect for harbour porpoise, following implementation of the SIP, is assessed as **minor adverse** (not significant).

Table 12.106 Cumulative Effect Significance for Disturbance to Marine Mammals from Piling at OWFs including the Offshore Project

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Cumulative disturbance due to piling at other OWFs at the same time as at the Offshore Project	Harbour porpoise	Medium	Medium	Moderate adverse	Management of disturbance through the SIP (**Table 12.16**).	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, leatherback turtle		Negligible	Negligible		**Negligible**
	Minke whale, grey seal		Low	Minor adverse		**Minor adverse**

12.10.3.1.2 Impact 1b: Assessment of Underwater Noise from Construction Activities (Other than Piling) at Other OWFs

876. All OWFs with construction dates that have the potential to overlap with the Offshore Project dates have the potential for other construction activities to overlap as well. Other construction activities include sea bed preparation, dredging, trenching, cable installation, rock placement, drilling and vessels.

877. OWFs screened in for other construction activities that could have cumulative effects with other construction activities at the Offshore Project are (**Table 12.101**):

- Arklow Bank Phase 2
- Erebus
- North Channel Wind 1
- North Channel Wind 2.

12.10.3.1.2.1 Sensitivity to Potential Disturbance from Other Construction Activities

2. As outlined in **Table 12.43**, all marine mammal species are assessed as having medium sensitivity to disturbance from underwater noise sources, and marine turtles have a medium sensitivity to underwater noise effects.

12.10.3.1.2.2 Magnitude of Potential Disturbance from Other Construction Activities

878. During the construction of the Offshore Project, there is the potential for overlap with impact from the non-piling construction activities at other offshore wind farms. Noise sources which could cause potential disturbance effects during offshore wind farm construction activities, other than pile driving, can include vessels, seabed preparation, cable installation works and rock placement.

879. The CEA includes all projects that could have non-piling construction activities taking place at the same time as the construction of the Offshore Project. Those other OWFs that have been assessed as part of the piling assessment have not been included in the following assessment, as the effects from piling are considered the worst-case. For the Offshore Project, the worst-case is for the potential for piling to take place at the same time as other construction activities at other OWFs, and therefore the potential for piling at the Offshore Project is included alongside the other OWFs to provide a precautionary and worst-case assessment.

880. The potential disturbance from OWFs during non-piling construction activities, such as vessel noise, sea bed preparation, rock placement and cable installation, has been based on the disturbance area for multiple construction activities taking place at the Offshore Project, as assessed in **Section 12.7.3.1.2**:

- Harbour porpoise, minke whale, and grey seal
  - The potential effect area, based on the worst case disturbance range of 4km, for up to seven activities taking place at the same time, with an area of 351.86km^2
- Bottlenose dolphin, common dolphin, and striped dolphin
  - The potential effect area during all seven OWF construction activities other than piling, based on the maximum effect range and area for the worst-case modelled for the Offshore Project of 0.002km^2 for TTS / fleeing response as a proxy for disturbance (**Table 12.70**).

881. For harbour porpoise, based on the worst case scenario, for all offshore wind farms that could be constructing at the same time as the Offshore Project, the potential magnitude of the temporary effect is assessed as **low**, with between 1% and 5% of the reference population potentially disturbed (**Table 12.107**).

Table 12.107 Quantified CEA for the Potential Disturbance of Harbour Porpoise During the Construction at Other OWFs at the Same Time as Construction at the Offshore Project

Project	Harbour porpoise density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction
White Cross (the Offshore Project)	0.918	706.9	648.9
Arklow Bank Phase II	0.2390	351.86	84.1
Erebus	0.1180	351.86	41.5
North Channel Wind 1	0.2390	351.86	84.1
North Channel Wind 2	0.2390	351.86	84.1
Total number of harbour porpoise *(without the Offshore Project)*			**942.7** *293.8*
Percentage of CIS MU *(without the Offshore Project)*			**1.51%** *0.47%*
Magnitude of cumulative effect *(without the Offshore Project)*			**Low** *Negligible*

882. For all dolphin species, based on all offshore wind farms with the potential for overlapping construction periods with the Offshore Project, the magnitude of effect for is assessed as negligible, with less than 1% of the reference population potentially disturbed (**Table 12.108**).

Table 12.108 Quantified CEA for the Potential Disturbance of Dolphin Species During the Construction at Other OWFs at the Same Time as Construction at the Offshore Project

Project	Area of Effect for Dolphin Species (km²)	Bottlenose Dolphin Cumulative Assessment		Common Dolphin Cumulative Assessment		Striped Dolphin Cumulative Assessment	
		Bottlenose Dolphin Density (/km²)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction	Common Dolphin Density (/km²)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction	Striped Dolphin Density (/km²)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction
White Cross (the Offshore Project)	0.10	0.0605	0.00605	5.230	0.523	0.6545	0.06545
Arklow Bank Phase II	0.002	0.0082	0.00002	0.6545	0.001	0.6545	0.0013
Erebus	0.002	0.0605	0.0001	0.6545	0.001	0.6545	0.0013
North Channel Wind 1	0.002	0.0082	0.00002	0.6545	0.001	0.6545	0.0013
North Channel Wind 2	0.002	0.0082	0.00002	0.6545	0.001	0.6545	0.0013
Total Number of Individuals (*Without* the Offshore Project)		**0.006** *0.0002*		**0.53** *0.005*		**0.07** *0.005*	
Percentage of Reference Population (*Without* the Offshore Project)		**0.00006%** *0.000002%*		**0.0005%** *0.000005%*		**0.0004%** *0.00003%*	
Magnitude of Cumulative Effect		**Negligible** *Negligible*		**Negligible** *Negligible*		**Negligible** *Negligible*	

(*Without* the Offshore Project)			

883. Based on the offshore wind farms that could be undergoing construction at the same time as the Offshore Project, the magnitude of the temporary effect is assessed as **negligible** for minke whale, with less than 1% of the reference population at risk of disturbance (**Table 12.109**).

Table 12.109 Quantified CEA for the Potential Disturbance of Minke Whale During the Construction at Other OWFs at the Same Time as Construction at the Offshore Project

Project	Minke Whale Density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction
White Cross (the Offshore Project)	0.0112	5400.0	60.5
Arklow Bank Phase II	0.0173	351.86	6.1
Erebus	0.0112	351.86	3.9
North Channel Wind 1	0.0173	351.86	6.1
North Channel Wind 2	0.0173	351.86	6.1
Total number of minke whale *(without the Offshore Project)*			**82.7** *22.2*
Percentage of CGNS MU *(without the Offshore Project)*			**0.41%** *0.11%*
Magnitude of cumulative effect *(without the Offshore Project)*			**Negligible** *Negligible*

884. For grey seal, based on the Offshore Projects that could have construction overlapping with the Offshore Project, the potential magnitude for the cumulative disturbance effect is assessed as **negligible**, with less than 1% of the reference population that could be temporarily disturbed (**Table 12.110**).

Table 12.110 Quantified CEA for the Potential Disturbance of Grey Seal During the Construction at Other OWFs at the Same Time as Construction at the Offshore Project

Project	Grey Seal Density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction
White Cross (the Offshore Project)	0.005	1963.5	9.82
Arklow Bank Phase II	0.011	351.86	3.87
Erebus	0.005	351.86	1.79

Project	Grey Seal Density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During Other OWF Construction
Total number of grey seal in wider reference population range *(without* the Offshore Project*)*			**15.48** *5.66*
Percentage of wider reference population *(without* the Offshore Project*)*			**0.12%** *0.05%*
Magnitude of cumulative effect *(without* the Offshore Project*)*			**Negligible** *Negligible*

885. For marine turtles, a similar level of effect would be expected at each other OWF undergoing construction activities as for the Offshore Project, although it should be noted that marine turtles would not be present in the area surrounding all cumulative projects.

886. Under the Popper *et al.*, (2014) criteria for continuous noise, there is a high risk of masking / behavioural response in the near field (<100m), within the intermediate field (>100m and <1,000m), there is a high risk of masking and a moderate risk of behavioural response, and in the far field (>1,000m), there is a low risk of masking and behavioural response. Within the moderate and high risk areas for masking and behavioural response (of less than 1,000m), given the low presence of leatherback turtles in the CEA Study Area, it is highly unlikely that any individuals would be present within the localised area of any other OWF construction activities, and therefore highly unlikely that any individual would be exposed to a potential masking/behavioural response effect. Within the low risk of masking/behavioural response effect area (of more than 1,000m), it is still considered unlikely that any individual would be present given the low number in the wider area, and therefore unlikely that any individual would be exposed to a potential masking/behavioural response effect. Therefore, given the very low potential for presence in the high and moderate risk of masking and behavioural response area, as well as low potential for presence in the low-risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

12.10.3.1.2.3 Significance of Effect for the Potential Disturbance during Offshore Wind Farm Construction

887. If all included offshore wind farms were constructing at the same time as the Offshore Project, there is the potential for a **negligible to low** magnitude of effect (dependent on species).

888. The significance of effect takes into account the **medium** receptor sensitivity for all marine mammal species. The overall assessment for the potential for disturbance due to construction activities at other OWFs overlapping with the Offshore Project is **negligible to minor adverse** for all species. This is deemed to be a conservative assessment based on the worst-case scenario for offshore wind farms constructing at the same time as the Offshore Project (**Table 12.111**).

889. Note, the projects included within the cumulative assessment for disturbance from other offshore wind farms constructing at the same time were based on the current knowledge of activity windows. Therefore, it is very unlikely that all activities would be taking place on the same day or in the same season. This likely represents an over-precautionary and worst-case estimate of the marine mammals that could be at risk of disturbance during the three year construction of the Offshore Project. Therefore, the likely number of marine mammals at risk of disturbance would be less than has been assessed here.

Table 12.111 Cumulative Effect Significance for Disturbance to Marine Mammals from Other OWFs Constructing at the same time as the Offshore Project is Piling

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Cumulative disturbance due to other OWFs undergoing other construction activities at the same time as at the Offshore Project is piling	Harbour porpoise	Medium	Low	Minor adverse	None required.	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, leatherback turtle		Negligible	Negligible		**Negligible**

12.10.3.1.3 Impact 1c: Assessment of Disturbance from Other Industries and Activities

890. During the construction period for the Offshore Project, the other potential noise sources that could also disturb marine mammals are:

- Geophysical surveys for offshore wind farms
- Aggregate extraction and dredging
- Subsea cables and pipelines
- Coastal works
- Oil and gas seismic surveys
- UXO clearance.

891. Further information on the CEA screening is provided in **Appendix 12.B**.

12.10.3.1.3.1 Sensitivity to Potential Disturbance from Other Offshore Projects and Industries

892. As outlined in **Table 12.43**, all marine mammal species are assessed as having **medium** sensitivity to disturbance from underwater noise sources, and marine turtles have a **medium** sensitivity to underwater noise effects.

12.10.3.1.3.2 Magnitude of Potential Disturbance from Other Offshore Projects and Industries

893. The following sections outline the potential for other offshore projects and industries to have a cumulative disturbance effect with the Offshore Project and provide detail as to the method of assessment. A full assessment of all other offshore projects and industries is provided in **Section 12.10.3.1.3.2** below.

12.10.3.1.3.2.1 Potential for Disturbance from Geophysical Surveys

894. As outlined in **Appendix 12.B**, offshore wind farm geophysical surveys using SBP and USBL systems have the potential to disturb marine mammals and have therefore been screened into the CEA, as a precautionary approach.

895. For geophysical surveys with sub-bottom profilers, it is realistic and appropriate to base the assessments on the potential effect area around the vessel itself, as the potential for disturbance would be around the vessel at any one time. Marine mammals would not be at risk throughout the entire area surveyed in a day, as animals would return once the vessel had passed, and the disturbance had ceased.

896. Assessments undertaken for the Review of Consents (RoC) HRA for the Southern North Sea SAC (BEIS, 2020) modelled the potential for disturbance due to the use of a SBP. Results indicated that there is the potential for a possible behavioural response in harbour porpoise at up to 3.77km (44.65km^2) from the source. The current guidance for assessing the significance of noise disturbance for harbour

porpoise SACs (JNCC *et al.,* 2020) recommends the use of an EDR of 5km (78.5km^2) for geophysical surveys.

897. As a worst case, it has been assumed that harbour porpoise, grey seal, and minke whale within 5km of the survey source, a total area of 78.5km^2 could be disturbed form each included geophysical survey.

898. As dolphins are less sensitive to underwater noise than other species, it would be an overestimation to assume that dolphins could be disturbed to the same distance as harbour porpoise. A review of the available information on the potential for disturbance to marine mammals includes the assessments for previous geophysical surveys. These disturbance ranges include reported ranges of effect of 1.5km and 3.12km for cetacean species (Neart na Gaiothe Offshore Wind, 2019; Scottish and Southern Energy, 2020). As a worst-case and precautionary approach, a disturbance range of 3.12km (area of 30.6km^2) has been used to inform the assessment for each included geophysical survey.

899. It is currently not possible to estimate the location or number of potential high-resolution geophysical surveys that could be undertaken at the same time as construction and potential piling activity for the Offshore Project. It is therefore assumed, as a worst-case scenario, that there could potentially be up to two geophysical surveys in the CEA Study Area at any one time, during construction of the Offshore Project.

900. Without knowing the actual location for offshore wind farm geophysical surveys, the following density estimates have been used to estimate the potential number of individuals that could potentially be disturbed:

- For harbour porpoise, the SCANS-III density estimate for the CIS MU of 0.11/km^2
- For bottlenose dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0185/km^2
- For common dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.264/km^2
- For striped dolphin, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.246/km^2
- For minke whale, the SCANS-III density estimate for the whole of the SCANS-III survey area of 0.0082/km^2
- For grey seal, densities were calculated for the entirety of the CEA Study Area, based on the grid cells that overlap with the area, and using the most recent

grey seal population estimate to convert the Carter *et al.* (2022) relative densities to absolute densities. This is 0.0253 grey seal per km^2.

901. It is not currently known what the potential disturbance could be for leatherback turtle as a result of geophysical surveys. As a worst-case, if it is assumed that the geophysical surveys (as an impulsive source) would cause the same level of behavioural response in leatherback turtles as would be expected from impact piling, then there would be a high risk of masking / behavioural response in the near field (<100m), a moderate risk in the intermediate field (>100m and <1,000m), and a low risk in the far field (>1,000m) (**Table 12.48**). The potential for a disturbance effect due to cumulative geophysical surveys at the same time as the construction of the Offshore Project would therefore be less than as assessed for cumulative piling in **Section 12.10.3.1.1.2**, with a magnitude of **negligible**.

12.10.3.1.3.2.2 Potential for Disturbance from Aggregate Extraction and Dredging

902. As stated with **Appendix 12.B**, taking into account the small potential effect ranges and thedistances of the aggregate extraction and dredging projects from the Offshore Project, the potential for contribution to cumulative effects is very small. Therefore, risk of PTS or TTS for all marine mammal species from aggregate extraction and dredging has been screened out from further consideration in the CEA. However, as a precautionary approach, a total of four aggregate extraction and dredging projects are included in the CEA for the potential for cumulative disturbance with the construction of the Offshore Project.

903. As outlined in the BEIS (2020) RoC HRA for the Southern North Sea SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600m of the activities (Diederichs *et al.,* 2010). As a worst-case assessment, a buffer of 600m has been applied to all aggregate and dredging projects screened to the relevant Study Area, for harbour porpoise, minke whale, and grey seal. For dolphin species, they are less sensitive to disturbance than harbour porpoise, the modelled TTS / fleeing response ranges (as provided in **Table 12.70**), for dredging have been used to determine the potential for disturbance at each aggregate site (with a disturbance area of $0.0003km^2$ at each aggregate and dredging project; or $0.0012km^2$ in total).

904. The densities for each marine mammal species are as outlined for the geophysical surveys assessment (see **Section 12.10.3.1.3.2.1**).

905. Given the similarity in activities expected to be undertaken, the potential for a disturbance effect on leatherback turtle due to cumulative aggregate and dredging projects being undertaken at the same time as the construction of the Offshore

Project would be the same as assessed for cumulative OWF construction in **Section 12.10.3.1.2.2**, with a magnitude of **negligible**.

12.10.3.1.3.2.3 Potential for Disturbance from Subsea Cables and Pipelines

906. Two subsea cables have been screened into the cumulative assessment; the X-Links Interconnector 1 & 2 projects. These projects are currently in the early stages of development (Tier 5) and therefore there is limited information available on potential effects and disturbance ranges for which to inform a cumulative assessment with the Offshore Project. However, similar activities are expected for the construction of the X-Links Interconnector Projects as for the other construction activities for the Offshore Project (i.e. dredging, cable laying, rock placement).

907. As described in **Section 12.7.3.1.2**, the disturbance ranges that could be generated during the cabling works would be up to 4km (with a disturbance area of 50.3km^2), for harbour porpoise, minke whale, and grey seal. For dolphin species, as they are less sensitive to disturbance than harbour porpoise, the modelled TTS / fleeing response ranges, for the Offshore Project (as provided in **Table 12.70**) for all activities taking place at the same time have been used to determine the potential for disturbance at each aggregate site (with a disturbance area of 0.002km^2 at each project, for all activities taking place at one; or 0.004km^2 in total). These potential disturbance areas have been used to inform the assessments for the two subsea cabling projects, as activities would be similar, in the absence of any additional information for the project screened in for assessment.

908. The densities for each marine mammal species are based on the highest SCANS-III density estimate, for the survey blocks that the X-Links Projects are within, for all cetacean species, and based on the CEA Study Area density for grey seal (see **Section 12.10.3.1.3.2.1** for how this was calculated).

909. Given the similarity in activities expected to be undertaken, the potential for a disturbance effect on leatherback turtle due to the X-Links projects being constructed at the same time as the construction of the Offshore Project would be the same as assessed for cumulative OWF construction in **Section 12.10.3.1.2.2**, with a magnitude of **negligible**.

12.10.3.1.3.2.4 Potential for Disturbance from Coastal Works

910. One coastal project has the potential to be undergoing construction at the same time as the Offshore Project; Hinkley Point C. As for the subsea cables projects as described above, similar activities are expected for the construction of Hinkley Point C as for the other construction activities at the Offshore Project (i.e. dredging, rock placement). Therefore, the same potential disturbance ranges have been applied

for Hinkley Point C, as for the X-Links Interconnector project assessed above (**Section 12.10.3.1.3.2.3**).

911. The densities for each marine mammal species are based on the SCANS-III density estimate for the survey blocks of Hinkley Point C for all cetacean species and based on the site-specific density estimate for grey seal calculated from the Carter *et al*., 2022 data.

912. Given the similarity in activities expected to be undertaken for Hinkley Point C as for other construction activities, the potential for a disturbance effect on leatherback turtle would be the same as assessed for cumulative OWF construction in **Section 12.10.3.1.2.2**, with a magnitude of **negligible**.

12.10.3.1.3.2.5 Potential for Disturbance from Oil and Gas Seismic Surveys

913. It is currently not possible to estimate the number of potential oil and gas seismic surveys that could be undertaken at the same time as construction and potential piling activity at the Offshore Project. Therefore, it has been assumed that at any one time, one seismic survey could be taking place at the same time as the construction of the Offshore Project, within the CEA Study Area.

914. This assessment for the potential disturbance due to oil and gas seismic surveys is based on the following for each marine mammal species:

- Harbour porpoise
  - The potential impact area during seismic surveys, based on a radius of 12km (452.4km^2), following the current SNCB guidance for the assessment of disturbance on harbour porpoise in the Southern North Sea SAC.
- Bottlenose dolphin, common dolphin, and striped dolphin
  - Strong avoidance of bottlenose dolphin from a 2D seismic survey (with 470 cubic inch airguns, and a peak sound source level of 243 dB re 1 µPa @1m) was modelled at between 1.8km and 11km (based on site specific underwater noise modelling using the dBht method) (DECC, 2011). This equates to an area of 380.13km^2, assuming the largest potential disturbance range of 11km. A potential disturbance range of 11km (disturbance area of 380.13km^2) has therefore been used in the assessment for a potential seismic survey
- Minke whale
  - As for dolphin species, there is little available information on the potential for disturbance from seismic surveys, however, observations of behavioural changes in other baleen whale species have shown avoidance reactions in up to 30km for a seismic survey (Richardson *et al.,* 1999). A potential

disturbance range of 30km (2,827.4km^2) will therefore be applied to minke whale due to a lack of species-specific information.

- Grey seal
  - As for both dolphin species and minke whale, there is little available information on the potential for disturbance from seismic surveys for grey seal, however, observations of behavioural changes in other seal species have shown avoidance reactions up to 3.6km from the source for a seismic survey (Harris *et al.,* 2001). A more recent assessment of potential for disturbance to seal species, as a result of seismic surveys, shows potential disturbance ranges from 13.3km to 17.0km from source (BEIS, 2020). These ranges are based on modelled impact ranges, using the NMFS Level B harassment threshold of 160dB, for a noise source of 3,070 cubic inches, 4,240 cubic inches, or 8,000 cubic inches. A potential disturbance range of 17km (disturbance area of 907.9km^2) has therefore been used in the assessment for a potential seismic survey.

915. The densities for each marine mammal species are as outlined for the geophysical surveys assessment (see **Section 12.10.3.1.3.2.1**).

916. As for geophysical surveys as assessed above, it is not currently known what the potential disturbance could be for leatherback turtle as a result of oil and gas seismic surveys. As a worst-case, if it is assumed that the seismic surveys (as an impulsive source) would cause the same level of behavioural response in leatherback turtles as would be expected from impact piling, then there would be a high risk of masking / behavioural response in the near field (<100m), a moderate risk in the intermediate field (>100m and <1,000m), and a low risk in the far field (>1,000m) (**Table 12.48**). The potential for a disturbance effect due to cumulative oil and gas surveys at the same time as the construction of the Offshore Project would therefore be less than as assessed for cumulative piling in **Section 12.10.3.1.1.2**, with a magnitude of negligible.

12.10.3.1.3.2.6 Potential for Disturbance from UXO Clearance

917. This assessment has been based on the potential for disturbance due to UXO clearance activities for other projects, taking place at the same as the construction of the Offshore Project.

918. It is currently not possible to estimate the number of potential UXO clearance events that could be undertaken at the same time as construction and potential piling activity at the Offshore Project, and therefore, on a worst-case basis, the potential for one high-order clearance and one low-order clearance has been assessed.

919. The magnitude of the potential disturbance from UXO clearance has been estimated based on the following:

- Harbour porpoise
  - The potential impact area of 2,123.7km^2 per high-order UXO clearance, based on 26km EDR for UXO high order detonation, and 78.5km^2 per low-order detonation, following the current SNCB guidance for the assessment of impact to harbour porpoise in the Southern North SAC
- Bottlenose dolphin, common dolphin, and striped dolphin
  - The potential effect area during a single UXO clearance event, based on the modelled worst-case range at the Offshore Project for TTS / fleeing response of 1.1km (3.8km^2) for high-order clearance, and 0.21km (0.14km^2) for low-order clearance, as per the assessment for the Offshore Project alone in **Section 12.7.2.2.3.1**
- Minke whale
  - The potential effect area during a single UXO clearance event, based on the modelled worst-case range at the Offshore Project for TTS / fleeing response of 85.0km (22,698.01km^2) for high-order clearance, and 8.8km (243.29km^2) for low-order clearance, as per the assessment for the Offshore Project alone in **Section 12.7.2.2.3.1**
- Grey seal
  - The potential effect area during a single UXO clearance event, based on the modelled worst-case range at the Offshore Project for TTS / fleeing response of 16.0km (804.25km^2) for high-order clearance and 1.5km (7.07km^2) for low-order clearance, as per the assessment for the Offshore Project alone in **Section 12.7.2.2.3.1**.

920. However, as outlined in the BEIS (2020) RoC HRA, due to the nature of the sound arising from the detonation of UXO, i.e. each blast lasting for a very short duration, marine mammals, including harbour porpoise, are not predicted to be significantly displaced from an area, any changes in behaviour, if they occur, would be an instantaneous response and short-term. Existing guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010a).

921. Mitigation measures required for UXO clearance include the use of low-order clearance techniques, which could include a small donor charge, rather than full high-order detonation which is only used as a last resort. It is therefore highly unlikely that more than one UXO high-order detonation would occur at exactly the same time or on the same day as another UXO high-order detonation, even if they

had overlapping UXO clearance operation durations. The CEA is therefore based on potential for disturbance from one UXO high-order detonation without mitigation (worst-case), as well as one low-order clearance event.

922. The densities for each marine mammal species are as outlined for the geophysical surveys assessment (see **Section 12.10.3.1.3.2.1**).

923. For marine turtles, a similar level of effect would be expected at other UXO clearance events as for the Offshore Project, although it should be noted that marine turtles would not be present in the area surrounding all cumulative projects. Based on the noise criteria for explosions (Popper *et al.*, 2014), there is a high risk of a behavioural response in the near (<100m) and intermediate fields (>100m and <1,000m), and a low risk of behavioural response in the far field (>1,000m). Within the high-risk area, given the low number of leatherback turtles in the CEA Study Area, it is unlikely that any individuals would be present in order to be at risk of disturbance. Within the low risk of effect area (of more than 1,000m), it is unlikely that there would be significant presence of the species due to the low number of leatherback turtles in the CEA Study Area. Therefore, given the low risk of presence in the high-risk area, as well as within the low risk area, the magnitude of effect, without any mitigation, is assessed as **negligible**.

12.10.3.1.3.2.7 Quantitative Assessment of Disturbance from Noisy Activities of Offshore Industries (Other than Offshore Wind)

924. Each of the above described sound sources are quantitively assessed in **Table 12.112** for harbour porpoise, **Table 12.113** for bottlenose dolphin, common dolphin, and striped dolphin, **Table 12.114** for minke whale, **Table 12.115** for grey seal.

925. For harbour porpoise, for all activities (other than offshore wind) with the potential for cumulative disturbance effects, the magnitude of effect is **low**, with up to 1,365 harbour porpoise, and between 1% and 5% of the MU at risk of disturbance (**Table 12.112**).

Table 12.112 Quantitative Assessment for Harbour Porpoise for all Noisy Activities (other than OWF) Occurring at the same time as the Construction of the Offshore Project

Project / Industry	Harbour porpoise density (/km²)	Area of Effect (km²)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities

White Cross (the Offshore Project)	0.918	706.9	648.9
Geophysical surveys	0.11	157.0	17.3
Aggregates and dredging	0.11	4.52	0.50
Cable and pipelines [X-Links 1 & 2]	0.118	703.72	83.0
Coastal works [Hinkley Point C]	0.118	351.86	41.5
Seismic surveys	0.11	452.4	49.8
UXO clearance [high-order]	0.11	2,123.7	233.6
UXO clearance [low-order]	0.11	78.5	8.6
Total number of harbour porpoise *(without* the Offshore Project*)*			**1,364.8** *715.8*
Percentage of CIS MU *(without* the Offshore Project*)*			**2.18%** *1.14%*
Magnitude of cumulative effect *(without* the Offshore Project*)*			**Low** *Low*

926. For bottlenose dolphin, common dolphin, and striped dolphin, for all activities (other than offshore wind) with the potential for cumulative disturbance effects, the magnitude of effect is **negligible**, with less 1% of reference population at risk of disturbance (**Table 12.113**).

Table 12.113 Quantitative Assessment for Bottlenose Dolphin, Common Dolphin, and Striped Dolphin for all Noisy Activities (other than OWF) Occurring at the same time as the Construction of the Offshore Project

Project	Area of Effect for Dolphin Species (km^2)	Bottlenose Dolphin Cumulative Assessment		Common Dolphin Cumulative Assessment		Striped Dolphin Cumulative Assessment	
		Bottlenose Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities	Common Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities	Striped Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities
White Cross (the Offshore Project)	0.10	0.0605	0.006	5.230	0.523	0.6545	0.065
Geophysical surveys	61.2	0.0185	1.13	0.264	16.2	0.246	15.1
Aggregates and dredging	0.0012	0.0185	0.00002	0.264	0.0003	0.246	0.0003
Cable and pipelines [X-Links 1 & 2]	0.004	0.0605	0.0002	1.870	0.007	1.870	0.007
Coastal works [Hinkley Point C]	0.002	0.0605	0.0001	0.6545	0.001	0.6545	0.001
Seismic surveys	380.13	0.0185	7.0	0.264	100.4	0.246	93.5
UXO clearance [high-order]	3.8	0.0185	0.07	0.264	1.0	0.246	0.93

Project	Area of Effect for Dolphin Species (km^2)	Bottlenose Dolphin Cumulative Assessment		Common Dolphin Cumulative Assessment		Striped Dolphin Cumulative Assessment	
		Bottlenose Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities	Common Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities	Striped Dolphin Density ($/km^2$)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities
UXO clearance [low-order]	0.14	0.0185	0.003	0.264	0.04	0.246	0.03
Total Number of Individuals *(Without* the Offshore Project*)*		**8.2** *8.2*		**118.1** *117.6*		**109.6** *109.5*	
Percentage of Reference Population *(Without* the Offshore Project*)*		**0.08%** *0.08%*		**0.12%** *0.11%*		**0.57%** *0.57%*	
Magnitude of Cumulative Effect *(Without* the Offshore Project*)*		**Negligible** *Negligible*		**Negligible** *Negligible*		**Negligible** *Negligible*	

927. For minke whale, for all activities (other than offshore wind) with the potential for cumulative disturbance effects, the magnitude of effect is **low**, with 286 individuals, and between 1% and 5% of the reference population at risk of cumulative disturbance (**Table 12.114**).

Table 12.114 Quantitative Assessment for Minke Whale for all Noisy Activities (other than OWF) Occurring at the same time as the Construction of the Offshore Project

Project	Minke Whale Density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities
White Cross (the Offshore Project)	0.0112	5400.0	60.5
Geophysical surveys	0.0082	157.0	1.3
Aggregates and dredging	0.0082	4.52	0.04
Cable and pipelines [X-Links 1 & 2]	0.0122	703.7	8.6
Coastal works [Hinkley Point C]	0.0112	351.86	3.9
Seismic surveys	0.0082	2,827.4	23.2
UXO clearance [high-order]	0.0082	22,698.0	186.1
UXO clearance [low-order]	0.0082	243.3	2.0
Total number of minke whale *(without the Offshore Project)*			**286.0** *225.5*
Percentage of CGNS MU *(without the Offshore Project)*			**1.42%** *1.12%*
Magnitude of cumulative effect *(without the Offshore Project)*			**Low** *Low*

928. For grey seal, for all activities (other than offshore wind) with the potential for cumulative disturbance effects, the magnitude of effect is **negligible**, with up 85 individuals, and less than 1% of the reference population at risk of disturbance (**Table 12.115**).

Table 12.115 Quantitative Assessment for Grey Seal for all Noisy Activities (other than OWF) Occurring at the same time as the Construction of the Offshore Project

Project	Grey Seal Density (/km^2)	Area of Effect (km^2)	Maximum Number of Individuals Potentially Disturbed During All Other Offshore Industries and Activities
White Cross (the Offshore Project)	0.005	1963.5	9.8
Geophysical surveys	0.0253	157.0	4.0
Aggregates and dredging	0.0253	4.52	0.11
Cable and pipelines [X-Links 1 & 2]	0.0253	703.7	17.8
Coastal works [Hinkley Point C]	0.0253	351.86	8.9
Seismic surveys	0.0253	907.9	23.0
UXO clearance [high-order]	0.0253	804.3	20.3
UXO clearance [low-order]	0.0253	7.1	0.2
Total number of grey seal in wider reference population range (*without* the Offshore Project)			**84.1** *74.3*
Percentage of wider reference population (*without* the Offshore Project)			**0.67%** *0.59%*
Magnitude of cumulative effect (*without* the Offshore Project)			**Negligible** *Negligible*

12.10.3.1.3.3 Significance of Effect for Potential Disturbance during Other Offshore Projects and Industries

929. If all included other offshore projects and industries were undertaking noisy activities at the same time as the Offshore Project, there is the potential for a **negligible to low** magnitude of effect (dependent on species).

930. Therefore, taking into account the medium receptor sensitivity for all marine mammal species, the overall cumulative effect assessment for disturbance to marine mammals and marine turtles from other noisy industries including is **negligible to minor adverse** for all species (**Table 12.116**). This is deemed to be a conservative assessment based on the worst-case scenario for offshore wind farms constructing at the same time as the Offshore Project.

Table 12.116 Cumulative Effect Significance for Disturbance to Marine Mammals from Other Offshore Projects and Industries Taking Place at the same time as the Offshore Project

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Cumulative disturbance due to other offshore projects and industries at the same time the Offshore Project is piling	Harbour porpoise, minke whale	Medium	Low	Minor adverse	None required.	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle		Negligible	Negligible		**Negligible**

12.10.3.1.4 Impact 1: Overall Cumulative Underwater Noise Effects for all Offshore Industries and Activities (Total for Impacts 1a, 1b, and 1c)

931. **Table 12.117** provides a summary of the number of each marine mammal species that could be disturbed from all cumulative noise sources, including construction at the Offshore Project, together as a worst-case scenario.

932. For harbour porpoise, up to 4,225 individuals (6.8% of the CIS MU) could be disturbed as a result of cumulative underwater noise. The potential magnitude of the temporary effect is assessed as **medium**, with between 5% and 10% of the reference population potentially disturbed.

933. For bottlenose dolphin, less than nine (8.3) individuals (or 0.08% of the OCSW MU) could be disturbed as a result of cumulative underwater noise. For common dolphin, 119 individuals (or 0.12% of the CGNS MU) could be disturbed, and up to 110 striped dolphin (or 0.57% of the reference population) could be disturbed as a result of cumulative underwater noise. The potential magnitude of the temporary effect is assessed as **negligible**, with less than 1% of the reference population potentially disturbed, for all dolphin species.

934. For minke whale, up to 881 individuals (4.4% of CGNS MU) could be disturbed as a result of cumulative underwater noise. The potential magnitude of the temporary effect is assessed as **low**, with between 1% and 5% of the reference population potentially impacted.

935. For grey seal, up to 542 (4.3% of the wider reference population) could be disturbed as a result of cumulative underwater noise. The potential magnitude of the temporary effect is assessed as **low** for grey seal, with between 1% and 5% of the reference population potentially affected.

936. Leatherback turtle have been assessed as having a **negligible** magnitude of effect, for all potential cumulative disturbance effects as a result of noisy activities.

Table 12.117 Quantified CEA for the Potential Disturbance of Marine Mammals from Cumulative Underwater Noise Sources During Construction of the Offshore Project (Worst Case)

Offshore Project and Industry	Number of Marine Mammals Potentially Disturbed					
	Harbour porpoise	Bottlenose dolphin	Common dolphin	Striped dolphin	Minke whale	Grey seal
Worst-case disturbance from the Offshore Project	648.9	0.006	0.523	0.065	60.5	9.8
Piling at other offshore wind farms	2,847.9	0.011	0.47	0.39	572.9	451.6
Construction activities at other offshore wind farms	293.8	0.0002	0.005	0.005	22.2	5.7
Geophysical surveys	17.3	1.13	16.2	15.1	1.3	4.0
Aggregates and dredging	0.50	0.00002	0.0003	0.0003	0.04	0.11
Cable and pipelines	83.0	0.0002	0.007	0.007	8.6	17.8
Coastal works	41.5	0.0001	0.001	0.001	3.9	8.9
Seismic surveys	49.8	7.0	100.4	93.5	23.2	23.0
UXO clearance	242.2	0.07	1.04	0.97	188.1	20.5
Total number of individuals (*without* the Offshore Project)	**4,225.0** *3,576.0*	**8.3** *8.2*	**118.6** *118.0*	**110.0** *109.9*	**880.8** *820.3*	**541.4** *531.6*
Percentage of MU (*without* the Offshore Project)	**6.76%** *5.72%*	**0.08%** *0.08%*	**0.12%** *0.11%*	**0.57%** *0.57%*	**4.38%** *4.08%*	**4.30%** *4.22%*
Magnitude of cumulative effect (*without* the Offshore Project)	**Low** *Low*	**Negligible** *Negligible*	**Negligible** *Negligible*	**Negligible** *Negligible*	**Low** *Low*	**Negligible** *Negligible*

12.10.3.1.4.1 Significance of Effect for Potential Disturbance for all Offshore Industries and Activities

937. If all included offshore wind farms, and other industries and activities were undertaking noisy activities at the same time as the construction of the Offshore Project, there is the potential for **a negligible to medium** magnitude of effect (dependent on species).

938. Therefore, taking into account the **medium** receptor sensitivity for all marine mammal species, the overall cumulative assessment for disturbance to marine mammals **moderate adverse** for harbour porpoise, and **minor adverse** for all other species (**Table 12.118**). This is deemed to be a conservative assessment based on the worst-case scenario for offshore wind farms constructing at the same time as the Offshore Project.

939. the Offshore Project specific SIP (**Appendix 12.D: In Principle SIP for the BCA SAC**) would manage and reduce the potential for significant disturbance of harbour porpoise from cumulative underwater noise during offshore wind farm piling. Therefore, the residual effect for harbour porpoise, following implementation of the SIP, is assessed as **minor adverse** (not significant).

Table 12.118 Cumulative Effect Significance for Disturbance to Marine Mammals from All Offshore Industries and Projects

Potential Effect	Species	Sensitivity	Magnitude	Effect Significance	Mitigation	Residual Effect
Cumulative disturbance due to all offshore industries and projects	Harbour porpoise	Medium	Medium	Moderate adverse	Management of disturbance through the SIP (**Table 12.16**).	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, leatherback turtle		Negligible	Negligible		**Negligible**
	Minke whale, grey seal		Low	Minor adverse		**Minor adverse**

940. While there is a medium magnitude of effect for harbour porpoise, it should be noted that the Offshore Project is contributing a small amount to the overall disturbance of each species (a total of 649 individuals would be disturbed from the

Offshore Project; or 15.4% of the total harbour porpoise at risk of cumulative disturbance). For harbour porpoise, the effect significance would be **moderate adverse** whether the Offshore Project is included in the assessments or not.

941. While the projects included within the cumulative assessment for disturbance from other offshore wind farms under construction, and other noisy activities taking place at the same time were done so based on the current knowledge of their possible construction or activity windows, and it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst-case estimate of the marine mammals that could be at risk of disturbance during the three year construction of the Offshore Project.

12.10.3.2 Impact 2: Increased Collision Risk

12.10.3.2.1 Increased Collision Risk Due to Vessels

942. As outlined in **Sections 12.7.6** and **12.8.5**, the increased collision risk due to the Offshore Project vessels, has an effect significance of minor adverse. Less than one individual (0.3 harbour porpoise being the highest number at risk) of all marine mammal species at risk (**Table 12.77** for construction phase related vessel collision risk; **Table 12.89** for operation and maintenance phase related vessel collision risk).

943. As outlined in the **Draft MMMP** and the **CEMP**, vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where marine species are accustomed to vessels. This is in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and within a vessel speed of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals and marine turtles. It is expected that other offshore projects and industries would follow similar measures in order to reduce the potential for collision risk of marine mammals (or marine turtles) with vessels.

944. As vessel movements to and from any port will be incorporated within existing vessel routes, there would be no increased collision risk as the increase in the number offshore wind farm vessels would be relatively small compared to the baseline levels of vessel movements in these areas. Once on-site, offshore wind farm vessels and other construction related vessels would be stationary or slow moving, as they undertake the activity they are associated with. Therefore, the risk of any increased collision risk for cumulative projects for marine mammals and marine turtles would be negligible, at worst.

945. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low or negligible.

946. Therefore, with the sensitivity of **high** for all marine mammal and marine turtle species, and the expected magnitude level of **negligible** (at worst), the effect significance for all marine mammal and marine turtle species would be **minor adverse**.

12.10.3.2.2 Increase in Collision Risk from Wave and Tidal Projects

947. **Appendix 12.B** screens for the potential for wave and tidal projects to be operational at the same time as the Offshore Project is undergoing construction or through its operational phase. Three wave or tidal projects have the potential to be operational prior to the construction of the Offshore Project, and therefore have the potential for a cumulate effect during both the construction and operation and maintenance phases of the Offshore Project.

For those projects where sufficient information is known, an assessment for the potential for collision risk is provided below (**Table 12.119**). This is based on the assessments undertaken for each of those projects.

948. The magnitude for potential increased collision risk with other projects has been assessed as high for harbour porpoise and grey seal, taking into account the collision risk weighting as described in **Section 12.7.5.1**, low for bottlenose dolphin and common dolphin, negligible for striped dolphin, and medium for minke whale (**Table 12.118**). However, this is before mitigation and management measures are taken into account on the wave and tidal projects, which reduces the overall effect significance to minor to all species, and all wave and tidal projects. Therefore, the overall magnitude would be **negligible** for all species, as a result of cumulative collision risk with wave and tidal projects.

949. Therefore, with the sensitivity of **high** for all marine mammal species, and the expected magnitude level of **negligible**, the effect significance for all marine mammal and marine turtle species would be **minor adverse**.

Table 12.119 Potential for Cumulative Collision Risk from Vessels at the Offshore Project and Wave and Tidal Projects

Project with the Potential for Collision Risk	Project Phase	Summary of Assessments for Collision Risk from the Offshore Project and Wave and Tidal Energy Projects					
		Harbour porpoise	Bottlenose dolphin	Common dolphin	Striped dolphin	Minke whale	Grey seal
White Cross (the Offshore Project)	Construction	0.3 at risk of collision	0.009 at risk of collision	0.07 at risk of collision	0.02 at risk of collision	0.02 at risk of collision	0.18 at risk of collision
	Operation and Maintenance	0.12 at risk of collision	0.004 at risk of collision	0.03 at risk of collision	0.009 at risk of collision	0.008 at risk of collision	0.07 at risk of collision
Morlais[27]	Operation	24.89 at risk of collision	0.7 at risk of collision	7.36 at risk of collision	-	2.33 at risk of collision	3.94 at risk of collision
Marine Energy Test Area (META)[28]	Operation	Minor adverse	Negligible adverse	Negligible adverse	-	-	Minor adverse
Perpetuus Tidal Energy Centre (PTEC)[29]	Operation	Minor adverse	Minor adverse	Minor adverse	-	-	Negligible adverse
Total number of marine mammals at risk during construction of the Offshore Project (% of reference population)		**25.2 (0.04%)**	**0.71 (0.006%)**	**7.4 (0.007%)**	**0.02 (0.0001%)**	**2.4 (0.012%)**	**4.1 (0.03%)**

[27] ORML1938 MDZ_A31.15 MMC366 MOR-RHDHV-APP-0022 (02) Vol III_Chapter 12.2 Marine Mammals [https://publicregister.naturalresources.wales/Search/Download?RecordId=43392]

[28] ORML1957v2 ES Addendum [https://publicregister.naturalresources.wales/Search/Download?RecordId=90526] & Environmental Statement, Chapter 9 META Marine Mammals , Basking Shark and Otter [https://publicregister.naturalresources.wales/Search/Download?RecordId=22891]

[29] PTEC Environmental Statement, Chapter 13 Marine Mammals [https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/77kt1hpovnuijca2o9nud7dvr36968vtn8vagjn73b9sph5pncp6k40tjkdt5opt2m1l5rr12j0pabhj3fcke8q2n0ng833k403s/df1c3fedc48e332d16470aa88ca31626/Volume+II+ES+Chapters+1+to+16.zip?]

Project with the Potential for Collision Risk	Project Phase	Summary of Assessments for Collision Risk from the Offshore Project and Wave and Tidal Energy Projects					
		Harbour porpoise	Bottlenose dolphin	Common dolphin	Striped dolphin	Minke whale	Grey seal
Total number of marine mammals at risk during operation and maintenance of the Offshore Project (% of reference population)		**25.0 (0.04%)**	**0.70 (0.006%)**	**7.4 (0.007%)**	**0.01 (0.00005%)**	**2.3 (0.012%)**	**4.0 (0.03%)**

12.10.3.3 Impact 3: Entanglement

950. For the potential for entanglement, as discussed in **Section 12.8.7**, marine mammals and marine turtles are not expected to be at risk of entanglement with the dynamic cables and mooring lines associated with the Offshore Project due to either direct or secondary entanglement. **Section 12.8.7.1** discusses the baseline levels of entanglement of marine mammal and turtle species in the UK due to entanglements in fishing gear. The operation and maintenance of the Offshore Project is not expected to increase the rates of entanglement of marine mammals and marine turtles in fishing gear, as it is likely that the presence of the wind farm infrastructure would provide marine mammals greater opportunity to detect (and avoid) any fishing gear that may be present in the area and caught on the cables associated with the Offshore Project.

951. While there is the potential for a number of other floating offshore wind farms to be developed in the Celtic Sea through the construction and operation and maintenance periods of the Offshore Project (see **Appendix 12.B**). It is expected that these projects would also not pose a risk of entanglement to marine mammal species, in line with the reasons outlined above for the Offshore Project. In addition, it is expected that all floating wind farms and other marine renewable projects (such as wave and tidal projects) will be required to undertake monitoring. This is to ensure that no fishing gear is caught on the ECC, and, all Projects would need to undertake such monitoring for infrastructure integrity purposes as well as for management of entanglements, and therefore the risk for any marine mammal or marine turtle entanglement to occur is very low.

952. Therefore, it is not expected that would be any potential for a cumulative entanglement risk, and therefore has an magnitude level of **negligible** for all species.

953. With the sensitivity of **negligible** (for direct entanglement) **to medium** (for secondary entanglement) for all species except minke whale. With a sensitivity of **high** for secondary entanglement, and the expected magnitude level of **negligible** for all species except minke whale, with a magnitude level of **low**. The significance for harbour porpoise, and all dolphin and seal species would be **negligible**, and for minke whale, would be **negligible to moderate adverse**.

12.10.3.4 Impact 4: Changes to Prey Availability

954. It has been assumed that any potential impacts on marine mammal and marine turtles prey species from underwater noise, including piling, would be the same or less than those for marine mammals and marine turtles. Therefore, there would be

no additional cumulative effects other than those assessed for marine mammals and marine turtles above. For example, if prey are disturbed from an area as a result of underwater noise, marine mammals and marine turtles will be disturbed from the same or greater area. Therefore any changes to prey availability would not affect marine mammals and marine turtles as they would already be disturbed from the same area.

955. Any effects to prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area.

956. There is no potential for cumulative effect to have any significant effects on marine mammal and marine turtle populations as a result of changes to prey availability. Taking into account the range of prey species taken by marine mammals and the extent of their foraging ranges.

12.11 Potential Transboundary Impacts

957. The highly mobile nature of marine mammals and marine turtles included within this assessment means that there is the potential for transboundary effects to the species assessed. This has been taken into account throughout the assessment, as the Study Area for each species is based on their relevant MU (or area within which the same individuals are considered to part of one larger overall population).

958. The MUs (and therefore reference populations) for each species covers an area wider than the UK (**Table 12.120**). This approach has been taken through all of the assessments, and therefore any potential effects on marine mammals in other countries are already considered within the assessments.

959. There is a substantial level of marine development being undertaken, and being planned, by other countries (including France and the Republic of Ireland) in the wider area. Each of these countries have their own independent environmental assessment requirements and controls. As noted above, marine mammals are highly mobile and there is therefore the potential for transboundary effects to marine mammal populations, especially with regard to noise. If there is potential for the Offshore Project to effect marine mammals from other designated sites, this is assessed in the **RIAA**.

960. The potential for transboundary effects has been assessed with the other cumulative effects, as these are based on the wide MU areas; and European wind farms, where relevant, are included in the CEA.

961. Leatherback turtle have not been quantitively assessed under the reference population approach, as there is no population estimate available, however, the potential for effect to leatherback turtle across the wider CEA Study Area has been assessed, and therefore the potential for transboundary effects to this population has been considered where appropriate.

Table 12.120 Other Countries Considered in the Marine Mammal Assessments Through the Relevant MU Reference Populations

Marine Mammal Species	Country Assessed as Part of the Reference Population Approach	Inclusion Within Assessments
Harbour porpoise	Republic of Ireland and France	Part of the CIS MU for harbour porpoise.
Bottlenose dolphin	Republic of Ireland and France	Part of the OCSW MU for bottlenose dolphin.
Common dolphin	Republic of Ireland, Netherlands, Germany, France, Belgium, Denmark, Sweden, and Norway	Part of the CGNS MU for common dolphin.
Striped dolphin	Republic of Ireland, Netherlands, Germany, France, Belgium, Denmark, Sweden, and Norway	Part of the reference population assessed for striped dolphin.
Minke whale	Republic of Ireland, Netherlands, Germany, France, Belgium, Denmark, Sweden, and Norway	Part of the CGNS MU for minke whale.
Grey seal	Republic of Ireland	Part of the wider reference population for grey seal.

12.12 Inter-Relationships

962. Inter-relationship effects are covered as part of the assessment and consider impacts from the construction, operation and maintenance or decommissioning of the Offshore Project on the same receptor (or group). A description of the process to identify and assess these effects is presented in **Chapter 6: EIA Methodology**. The potential inter-relationship effects that could arise in relation to marine mammals and marine turtle ecosystems include both:

- **Project lifetime effects:** Effects arising throughout more than one phase of the Offshore Project (construction, operation, and decommissioning) to interact to potentially create a more significant effect on a receptor than if just one phase were assessed in isolation

- **Receptor led effects:** Assessment of the scope for all relevant effects to interact, spatially and temporally, to create inter-related effects on a receptor (or group). Receptor-led effects might be short term, temporary or transient effects, or incorporate longer term effects.

963. **Table 12.121** serves as a sign-posting for inter-relationships.

Table 12.121 Chapter 12: Marine Mammal and Marine Turtle Ecology Inter-relationships

Topic and description	Related chapter	Where addressed in this Chapter	Rationale
Underwater noise from vessels	**Chapter 15: Shipping and Navigation**	**Section 12.7.4** for construction, **Section 12.8.3** for operation and maintenance, and **Section 12.9** for decommissioning	Increased vessel traffic associated with the Offshore Project could affect the level of disturbance for marine mammals
Increased risk of collision with vessels	**Chapter 15: Shipping and Navigation**	**Section 12.7.6** for construction, **Section 12.8.5** for operation and maintenance, and **Section 12.9** for decommissioning	Increased vessel traffic associated with the Offshore Projects could affect the level of collision risk for marine mammals
Changes to prey availability	**Chapter 11: Fish and Shellfish Ecology** and **Chapter 10: Benthic and Intertidal Ecology**	**Section 12.7.11** for construction and **Section 12.8.10** for operation and maintenance	Potential impacts on fish species could affect the prey resource for marine mammals
Changes to water quality	**Chapter 9: Marine Water and Sediment Quality**	**Section 12.7.12** for construction and **Section 12.8.11** for operation and maintenance	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species

12.13 Interactions

964. The impacts identified and assessed in this chapter have the potential to interact with each other, which could give rise to synergistic effects as a result of that interaction. The areas of interaction between the assessed impacts are presented in **Table 12.122**, along with an indication as to whether the interaction may give

rise to synergistic effects. This provides a screening tool for which impacts have the potential to interact.

965. **Table 12.125** then provides an assessment for each receptor (or receptor group) related to these impacts in two ways. Firstly, the impacts are considered within a development phase (i.e. construction, operation, maintenance or decommissioning) to see if, for example, multiple construction impacts could combine. Secondly, a lifetime assessment is undertaken which considers the potential for impacts to affect receptors across development phases. The significance of each individual effect is determined by the sensitivity of the receptor and the magnitude of effect; the sensitivity is constant whereas the magnitude may differ. Therefore, when considering the potential for effects to be additive it is the magnitude of effect which is important – the magnitudes of the different effects are combined upon the same sensitivity receptor. If minor effect and minor effect were added this would effectively double count the sensitivity.

Table 12.122 Interaction Between Effects During Construction

Project Inter-Relationships - Construction	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9	Impact 10	Impact 11	Impact 12
Impact 1: Underwater noise during foundation installation (piling)		Yes	Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 2: Underwater noise during UXO clearance	Yes		Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 3: Underwater noise effects from other activities such as seabed preparations, cable laying and rock placement	Yes	Yes		Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 4: Underwater noise and disturbance from vessels	Yes	Yes	Yes		Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 5: Barrier effects caused by underwater noise	Yes	Yes	Yes	Yes		No	Yes	No	Yes	Yes	Yes	Yes
Impact 6: Interactions and collision risk with vessels	No	No	No	No	No		No	No	No	No	No	No
Impact 7: Disturbance at seal haul out sites	Yes	Yes	Yes	Yes	Yes	No		No	No	No	No	No
Impact 8: Entanglement	No	No	No	No	No	No	No		No	No	No	No
Impact 9: Electromagnetic fields direct and indirect effects	Yes	Yes	Yes	Yes	Yes	No	No	No		Yes	Yes	Yes

Project Inter-Relationships - Construction	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9	Impact 10	Impact 11	Impact 12
Impact 10: Barrier effects from the physical presence of the wind farm	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes		Yes	Yes
Impact 11: Changes to prey availability	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes		Yes
Impact 12: Changes to water quality	Yes	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	

Table 12.123 Interaction Between Effects During Operation and Maintenance

Project Inter-Relationships - Operation and Maintenance	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9	Impact 10	Impact 11
Impact 1: Underwater noise from operational wind turbines		Yes	Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 2: Underwater noise from maintenance activities such as cable repairs and rock placement	Yes		Yes	Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 3: Underwater noise and disturbance from vessels	Yes	Yes		Yes	No	Yes	No	Yes	Yes	Yes	Yes
Impact 4: Barrier effects from underwater noise from operational wind turbines	Yes	Yes	Yes		No	Yes	No	Yes	Yes	Yes	Yes

Project Inter-Relationships - Operation and Maintenance	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9	Impact 10	Impact 11
Impact 5: Interaction and collision risk with vessels	No	No	No	No		No	No	No	No	No	No
Impact 6: Disturbance at seal haul out sites	Yes	Yes	Yes	Yes	No		No	No	No	No	No
Impact 7: Entanglement	No	No	No	No	No	No		No	No	No	No
Impact 8: Barrier effects due to physical presence	Yes	Yes	Yes	Yes	No	No	No		Yes	Yes	Yes
Impact 9: Electromagnetic fields direct and indirect effects	Yes	Yes	Yes	Yes	No	No	No	Yes		Yes	Yes
Impact 10: Changes to prey availability	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes		Yes
Impact 11: Changes to water quality	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	

Table 12.124 Interaction Between Effects During Decommissioning

Project Inter-Relationships - Decommissioning	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9
Impact 1: Underwater noise from foundation and cable removal		Yes	Yes	No	Yes	No	Yes	Yes	Yes
Impact 2: Underwater noise and disturbance from vessels	Yes		Yes	No	Yes	No	Yes	Yes	Yes
Impact 3: Barrier effects caused by underwater noise	Yes	Yes		No	Yes	No	Yes	Yes	Yes
Impact 4: Interaction and collision risk with vessels	No	No	No		No	No	No	No	No
Impact 5: Disturbance at seal haul out sites	Yes	Yes	Yes	No		No	No	No	No
Impact 6: Entanglement	No	No	No	No	No		No	No	No
Impact 7: Electromagnetic fields direct and indirect effects	Yes	Yes	Yes	No	No	No		Yes	Yes
Impact 8: Changes to prey availability	Yes	Yes	Yes	No	No	No	Yes		Yes
Impact 9: Changes to water quality	Yes	Yes	Yes	No	No	No	Yes	Yes	

Table 12.125 Potential Interactions Between Effects on Marine Mammals and Marine Turtles

Highest Level Significance (Residual Effect)					
Receptor	Construction	Operation and Maintenance	Decommissioning	Phase Assessment	Lifetime Assessment
Harbour porpoise	Minor adverse	Minor adverse	Minor adverse	**No greater than the individually assessed effects.** **Construction** The MMMP (for both UXO and piling) will reduce the risk of injury for mammals and marine turtles and therefore during UXO clearance or piling there will be no pathway for interaction of potential injury with disturbance effects (i.e. all individuals are assumed to be disturbed if within range and excluded from the disturbance footprint). Likewise, there is no pathway for vessel interaction or effects on prey resource to interact with noise effects as it is assumed that individuals will be excluded from the disturbance footprint (i.e. there cannot be a vessel interaction if the	**No greater than the individually assessed effects.** The greatest magnitude of effect will be the spatial footprint of construction noise (i.e. UXO clearance and piling). Once this disturbance impact has ceased all further impact during construction and Operation and maintenance will be small scale, highly localised and episodic. There is no evidence of long term displacement of marine mammals
Bottlenose dolphin	Minor adverse	Minor adverse	Minor adverse		
Common dolphin	Minor adverse	Minor adverse	Minor adverse		

Highest Level Significance (Residual Effect)					
Striped dolphin	Minor adverse	Minor adverse	Minor adverse	individual is excluded from the vicinity of the construction works). Once noisy activities have ceased the footprint of disturbance and changes to prey resource will be highly localised. It is therefore considered that the interaction of these impacts would not represent an increase in the significance level. **Operation** Operational noise impacts from wind turbines will be highly localised to within 0.1km of each wind turbine, whilst the majority of change to habitat for prey species will also be confined to the immediate footprint of wind turbine. The magnitude of effect is negligible and relates to largely the same spatial footprint. Therefore, there is no greater impact from any interaction between these effects. There is potential for interaction with maintenance noise disturbance and vessel interaction but given the negligible magnitude of effects and episodic nature of these impacts it is not considered that the interaction of these impacts would	from operational wind farms. It is therefore considered that over the Offshore Project lifetime these impacts would not combine and represent an increase in the significance level.
Minke whale	Minor adverse	Minor adverse	Minor adverse		
Grey seal	Minor adverse	Minor adverse	Minor adverse		
Leatherback turtle	Minor adverse	Minor adverse	Minor adverse		

Highest Level Significance (Residual Effect)					
				represent an increase in the significance level. The potential for entanglement could interact with the potential for collision risk, however, both are unlikely to cause any significant (or determinable) effect on the marine mammal and marine turtle populations assessed. Any potential entanglement or collision (in the unlikely event that it occurs) would not alter the overall population level. Management and best-practice measures would be put in place to reduce the potential for either event to occur, and there would not be any increase in risk due to both impacts interacting. **Decommissioning** As the decommissioning plan is not in effect at this stage and will be subject to future advancements, the worst-case impacts are considered only for the construction and operation and maintenance stages.	

12.14 Potential Monitoring Requirements

966. Mitigation will be required for the following activities, and will use the relevant guidance and advice at the time (the current guidelines are noted below):

- UXO clearance (see **Section 12.7.1.5**):
  - Following the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010a).
- Piling (see **Section 12.7.1**):
  - Following the Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b).

967. The relevant guidelines will be used as a standard. However, if required, they may be adapted to ensure that any predicted impact ranges are effectively mitigated for all marine mammal and marine turtle species. It is expected that ADDs will be used as part of the mitigation for both UXO clearance and piling.

968. Mitigation protocols (**MMMPs**) will be developed for UXO clearance and piling. These will be secured in the licence conditions prior to construction.

969. In addition to the mitigation above, the following measures will also be put in place to reduce vessel collision risk and entanglement:

- Best practice to reduce vessel collision risk measures to be detailed within the **draft MMMP** (see **Section 12.7.5.4**).
- Monitoring of entanglement risk (see **Sections 12.7.7.4** and **12.8.6**). The entanglement monitoring requirements will be detailed in the PEMP.

970. For vessel collision risk, Cornwall Marine and Coastal Code for Vessels[30] will be followed, to reduce the potential for a vessel collision, by reducing vessel transit speeds and by maintaining speed and course when in the presence of marine mammal species. This code will be followed for all vessels transiting to and from the Windfarm Site. In the unlikely event that a collision event occurs, this will be reported on, and full information of the incident, including the marine mammal species, will be recorded.

971. For entanglement, the management measures include monitoring of the inter-array and mooring lines, to ensure that any fighting gear that may become entangled within the cables, would be removed. This will significantly reduce the potential for

[30] https://www.cornwallwildlifetrust.org.uk/sites/default/files/2019-03/Cornwall%20Marine%20and%20Coastal%20Code%20Guidelines.pdf

an entanglement event to occur. Any entanglement event that does occur through the lifetime of the Offshore Project will be reported and full information of the incident will be recorded. In addition, further monitoring measures may be put in place to ensure a second event does not occur.

972. The mitigation and monitoring of marine mammals and marine turtles for the Offshore Project will be agreed with the MMO and Natural England prior to construction.

12.15 European Protected Species Requirements

973. A Marine Wildlife Licence application will be made for all activities that have the potential for injury or disturbance on EPS (cetaceans). The activities that may require an EPS licence are:

- UXO clearance
- Piling and offshore construction activities.

974. Prior to any of these activities taking place, an EPS risk assessment will be undertaken, following the staged approach as outlined in JNCC *et al.* (2010).

975. Mitigation will be put in place for UXO clearance and piling (see **Section 12.4.4**), following current guidelines and advice. Where ADD activation is required, these will also be considered within the EPS Risk Assessments.

976. The potential for geophysical surveys (high-resolution seismic surveys, such as Sub-Bottom Profilers or Multi-Beam Echo Sounders) has not been included within this assessment. However, were any to be required at the Offshore Project prior or following construction, they would be consented for separately, including an assessment of potential risk to EPS. This will include following the *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines)*[31].

12.16 Summary

977. This chapter has investigated the potential effects on marine mammal and marine turtle receptors arising from the Offshore Project. The range of potential impacts and associated effects considered has been informed by the Scoping Opinion, consultation, and agreed through ETG Meetings, as well as reference to existing

[31] https://hub.jncc.gov.uk/assets/e2a46de5-43d4-43f0-b296-c62134397ce4

policy and guidance. The impacts considered include those brought about directly as well as indirectly.

978. **Table 12.126** presents a summary of the impacts assessed within this ES chapter, any commitments made, and mitigation required and the residual effects.

Table 12.126 Summary of Potential Effects for Marine Mammals and Marine Turtles During Construction, Operation and Maintenance, and Decommissioning of the Offshore Project

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
Construction						
Impact 1: PTS from single strike of the maximum hammer energy	Harbour porpoise	High	Low to negligible for OSP jacket pile; Negligible for mooring pin pile	Minor to moderate adverse for OSP jacket pile; Minor adverse for mooring pin pile	MMMP for piling (**Section 12.7.1.5**)	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle		Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**
Impact 1: PTS during piling from cumulative exposure for piling	Harbour porpoise	High	Medium for both OSP jacket pile and mooring pin pile	Major adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, and leatherback turtle		Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
	Minke whale		Medium for OSP jacket pile; Low for mooring pin pile	Major adverse for OSP jacket pile; Moderate adverse for mooring pin pile		**Minor adverse**
Impact 1: TTS from single strike of maximum energy	All marine mammal and marine turtle species	Medium	Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile	None required.	**Minor adverse**
Impact 1: TTS during piling from cumulative exposure for piling	Harbour porpoise	Medium	Low for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile	None required.	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle		Negligible for both OSP jacket pile and mooring pin pile	Minor adverse for both OSP jacket pile and mooring pin pile		**Minor adverse**
Impact 1: Disturbance / Displacement	Harbour porpoise	Medium	Low to negligible	Negligible to minor adverse	None required.	**Negligible to minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, and leatherback turtle		Negligible	Negligible		**Negligible**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
Impact 2: PTS from high-order detonation	Harbour porpoise	High	Medium	Major adverse	MMMP for UXO clearance (**Section 12.7.2.6**)	Minor adverse
	Bottlenose dolphin, leatherback turtle		Negligible	Minor adverse		**Minor adverse**
	Common dolphin, striped dolphin, minke whale		Low	Moderate adverse		**Minor adverse**
	Grey seal		Medium for the ECC; Negligible to low for the Windfarm Site	Major adverse for the ECC; Minor to moderate adverse for the Windfarm Site		**Minor adverse**
Impact 2: PTS from low-order detonation	Harbour porpoise	High	Medium	Major adverse	MMMP for UXO clearance (**Section 12.7.2.6**)	**Minor adverse**
	Bottlenose dolphin, striped dolphin, minke whale, leatherback turtle		Negligible	Minor adverse		**Minor adverse**
	Common dolphin		Low	Moderate adverse		**Minor adverse**
	Grey seal		Negligible to low for the ECC; Negligible for the	Minor to moderate adverse for the ECC;		**Minor adverse**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
			Windfarm Site	Minor adverse for the Windfarm Site		
Impact 2: TTS / disturbance from high-order detonation	Harbour porpoise, minke whale	Medium	Low	Minor adverse	None required.	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, leatherback turtle		Negligible	Negligible		**Negligible**
	Grey seal		Negligible to low for the ECC; Negligible for the Windfarm Site	Negligible to minor adverse for the ECC; Negligible for the Windfarm Site		**Negligible to minor adverse**
Impact 2: TTS / disturbance from low-order detonation	Harbour porpoise	Medium	Low	Minor adverse	None required.	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, minke whale, grey seal, leatherback turtle		Negligible	Negligible		**Negligible**
Impact 2: Disturbance from ADD activation prior	Harbour porpoise, bottlenose dolphin, minke whale, leatherback turtle	Medium	Negligible	Negligible	None required.	**Negligible**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
to high-order UXO clearance	Common dolphin, striped dolphin		Low	Minor adverse		**Minor adverse**
	Grey seal		Negligible to low	Negligible to minor adverse		**Negligible to minor adverse**
Impact 2: Disturbance from ADD activation prior to low-order UXO clearance	All marine mammal and marine turtle species	Medium	Negligible	Negligible	None required.	**Negligible**
Impact 3: TTS / disturbance during other construction activities	All marine mammals and marine turtles	Medium	Negligible	Minor adverse	None required.	**Minor adverse**
Impact 4: TTS due to construction vessels (up to five vessels at any one time)	All marine mammals and marine turtles	Medium	Negligible	Negligible	None required, however best practice measures will be applied (**Section 12.1.1.1**).	**Negligible**
Impact 4: Disturbance from construction vessels	Harbour porpoise, minke whale	Medium	Low	Minor adverse	None required, however best practice measures will be applied (**Section 12.1.1.1**).	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin	Low to medium	Low	Minor adverse		**Minor adverse**
	Grey seal	Low	Low	Minor adverse		**Minor adverse**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
	Leatherback turtle	Medium	Negligible	Negligible		**Negligible**
Impact 5: Barrier effects caused by underwater noise	All marine mammals and marine turtles	Medium	Negligible	Minor adverse	None required.	**Minor adverse**
Impact 6: Increased collision risk with vessels	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, leatherback turtle	High	Negligible	Minor adverse	Recommended best practice as outlined in the Draft MMMP.	**Minor adverse**
	Grey seal		Low	Moderate adverse		**Minor adverse**
Impact 7: Disturbance at seal haul out sites	Grey seal	Low to Medium	Negligible	Negligible to minor adverse	Recommended best practice as outlined in the Draft MMMP.	**Negligible to Minor adverse**
Impact 8: Entanglement	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, grey seal, and leatherback turtle	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to minor adverse	Monitoring measures in PEMP, and as set out in **Section 12.8.7.4**.	**Negligible**
	Minke whale	Negligible (direct entanglement)	Low	Negligible to moderate adverse		**Negligible to minor adverse**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
		High (secondary entanglement)				
Impact 9: EMF direct and indirect effects	Harbour porpoise, bottlenose dolphin, common dolphin Striped dolphin, minke whale, grey seal	Low	Low	Negligible	None required.	**Negligible**
	Leatherback turtle	Medium	Low	Minor adverse		**Minor adverse**
Impact 10: Barrier effects due to physical presence	All marine mammals and marine turtles	Negligible	Negligible	Negligible	None required	**Negligible**
Impact 11: Change in prey availability	Harbour porpoise, minke whale	Low to medium	Negligible to low	Negligible to minor adverse	No mitigation required. However, measures in MMMP and SIP will also reduce potential effects of underwater noise on prey species.	**Negligible to minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle	Low	Negligible to low	Negligible to minor adverse		**Negligible to minor adverse**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
Impact 12: Change in water quality	All marine mammals and marine turtles	Negligible	Negligible	Negligible	None required	**Negligible**
Operation and Maintenance						
Impact 1: Disturbance due to operational wind turbines	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin	Low	Negligible	Negligible	None required.	**Negligible**
	Minke whale, leatherback turtle	Medium	Negligible	Minor adverse		**Minor adverse**
	Grey seal	Low	Negligible	Negligible		**Negligible**
Impact 2: TTS / disturbance during maintenance activities	All marine mammals and marine turtles	Medium	Negligible	Negligible	None required.	**Negligible**
Impact 3: TTS due to underwater noise from maintenance vessels	All marine mammals and marine turtles	Medium	Negligible	Negligible	None required.	**Negligible**
Impact 3: Disturbance due to underwater noise from maintenance vessels	All marine mammal species	Medium	Low	Minor adverse	None required.	**Minor adverse**
	Leatherback turtle	Medium	Negligible	Negligible		**Negligible**
Impact 4: Barrier effects as a result of underwater noise	All marine mammals and marine turtles	Medium	No effect	No effect	None required.	**No effect**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
Impact 5: Increased collision risk with vessels	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, minke whale, leatherback turtle	High	Negligible	Minor adverse	Recommended best practice as outlined in the Draft MMMP.	**Minor adverse**
	Grey seal		Negligible to low[32]	Minor to moderate adverse		**Minor adverse**
Impact 6: Disturbance at seal haul out sites	Grey seal	Low to Medium	Negligible	Negligible to minor adverse	Recommended best practice as outlined in the Draft MMMP.	**Negligible to Minor adverse**
Impact 7: Entanglement	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, grey seal, and leatherback turtle	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to minor adverse	Monitoring measures in PEMP, and as set out in **Section 12.8.7.4**.	**Negligible**
	Minke whale	Negligible (direct entanglement)	Low	Negligible to moderate adverse		**Negligible to minor adverse**

Based on the weighted magnitude levels as set out in **Paragraph 561**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
		High (secondary entanglement)				
Impact 8: Potential for a barrier effect (due to the physical presence of the windfarm)	All marine mammals and marine turtles	Negligible	Negligible	Negligible	None required.	**Negligible**
Impact 9: EMF direct and indirect effects	Harbour porpoise, bottlenose dolphin, common dolphin Striped dolphin, minke whale, grey seal	Low	Low	Negligible	None required.	**Negligible**
	Leatherback turtle	Medium	Low	Minor adverse		**Minor adverse**
Impact 10: Changes to prey availability	Harbour porpoise, minke whale	Low to medium	Negligible	Negligible	None required.	**Negligible**
- Permanent habitat loss - Temporary increased **SSC** and sediment deposition - Underwater noise and vibration - EMF	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle	Low	Negligible	Negligible		**Negligible**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
- Barrier effects - Ghost fishing						
Impact 10: Changes to prey availability - Fish aggregation effects	Harbour porpoise, minke whale	Low to medium	Negligible	Negligible beneficial	None required.	**Negligible beneficial**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle	Low	Negligible	Negligible beneficial		**Negligible beneficial**
Impact 11: Changes to water quality	All marine mammals and marine turtles	Negligible	Negligible	Negligible	None required.	**Negligible**
Decommissioning						
Impact 1: Underwater noise from foundation and cable removal	As assessed for construction related effects.					
Impact 2: Interaction and collision risk with vessels						
Impact 3: Underwater noise and disturbance from vessels						

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
Impact 4: Barrier effects caused by underwater noise						
Impact 5: Changes to prey availability						
Impact 6: Disturbance at seal haul out sites						
Impact 7: Entanglement						
Impact 8: EMF direct and indirect effects						
Cumulative Effects						
Impact 1: Cumulative disturbance due to all offshore industries and projects	Harbour porpoise	Medium	Medium	Moderate adverse	Management of disturbance through the SIP (**Table 12.16**).	**Minor adverse**
	Bottlenose dolphin, common dolphin, striped dolphin, leatherback turtle		Negligible	Negligible		**Negligible**
	Minke whale, grey seal		Low	Minor adverse		**Minor adverse**
Impact 2: Increased Collision Risk Due to Vessels	All marine mammals and marine turtles	High	Negligible	Minor adverse	Recommended best practice as outlined in the Draft MMMP.	**Minor adverse**

Potential Effect	Receptor	Sensitivity	Magnitude	Significance	Potential Mitigation Measure	Residual Effect
Impact 2: Increase in Collision Risk from Wave and Tidal Projects	All marine mammals and marine turtles	High	Negligible	Minor adverse	None required.	**Minor adverse**
Impact 3: Entanglement	Harbour porpoise, bottlenose dolphin, common dolphin, striped dolphin, grey seal, and leatherback turtle	Negligible (direct entanglement) Medium (secondary entanglement)	Negligible	Negligible to minor adverse	Monitoring measures in PEMP, and as set out in **Section 12.8.7.4**.	**Negligible**
	Minke whale	Negligible (direct entanglement) High (secondary entanglement)	Low	Negligible to moderate adverse		**Negligible to minor adverse**
Impact 4: Changes to prey availability	Harbour porpoise, minke whale	Low to medium	No effect	No effect	None required.	**No effect**
	Bottlenose dolphin, common dolphin, striped dolphin, grey seal, leatherback turtle	Low	No effect	No effect	None required.	**No effect**

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WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Modelling Report

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White Cross Offshore Windfarm: Underwater noise assessment

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06 December 2022

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This report is a controlled document. The report documentation page lists the version number, record of changes, referencing information, abstract and other documentation details.

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Glossary

Term	Definition
Decibel (dB)	A customary scale commonly used (in various ways) for reporting levels of sound. A difference of 10 dB corresponds to a factor of 10 in sound power. The actual sound measurement is compared to a fixed reference level and the “decibel” value is defined to be $10\log_{10}(actual/reference)$ where $(actual/reference)$ is a power ratio. Because sound power is usually proportional to sound pressure squared, the decibel value for sound pressure is $20\log_{10}(actual\ pressure/reference\ pressure)$. The standard reference for underwater sound is 1 micropascal (μPa). The dB value is followed by a second value identifying the specific reference pressure (e.g., re 1 μPa).
High-order UXO detonation	Full destruction by detonation of an unexploded ordnance device by means of an initial donor charge to trigger the detonation.
Low-order UXO detonation/clearance	Any destruction of an unexploded ordnance device that does not lead to full (high-order) detonation, through destruction or burning of the explosive material.
Low-yield UXO clearance	Alternative low noise UXO clearance technique, similar to low-order, using a proprietary system to destroy explosive material with a lower noise output
Peak pressure	The greatest pressure above or below zero that is associated with a sound wave.
Peak-to-peak pressure	The sum of the greatest positive and negative pressures that are associated with a sound wave.
Permanent Threshold Shift (PTS)	A permanent total or partial loss of hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the air, and thus a permanent reduction of hearing acuity
Sound Exposure Level (SEL)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Sound Pressure Level (SPL)	The sound pressure level is an expression of sound pressure using the decibel (dB) scale; the standard frequency pressures of which are 1 μPa for water and 20 μPa for air.
Temporary Threshold Shift (TTS)	Temporary reduction of hearing acuity because of exposure to sound over time. Exposure to high levels of sound over relatively short time periods could cause the same amount of TTS as exposure to lower levels of sound over longer time periods. The duration of TTS varies depending on the nature of the stimulus.
Unweighted sound level	Sound levels which are “raw” or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a “weighting envelope” in the frequency domain, typically to make an unweighted level

Term	Definition
	relevant to a particular species. Examples of this are the dB(A), where the overall sound level has been adjusted to account for the hearing ability of humans in air, or the filters used by Southall *et al*. (2019) for marine mammals.

Acronyms

Acronym	Definition
EIA	Environmental Impact Assessment
FPSO	Floating Production Storage and Offloading vessel
HF	High-Frequency Cetaceans (Marine mammal hearing group from Southall *et al*., 2019)
INSPIRE	Impulse Noise Sound Propagation and Range Estimator (Subacoustech's noise model for estimating impact piling noise)
ISO	International Organization for Standardization
LF	Low-Frequency Cetaceans (Marine mammal hearing group from Southall *et al*., 2019)
MTD	Marine Technical Directorate Ltd.
NEQ	Net Explosive Quantity (usually given in kg as a TNT equivalent)
NMFS	National Marine Fisheries Service
NPL	National Physical Laboratory
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PCW	Phocid Carnivores in Water (Marine mammal hearing group from Southall *et al*., 2019)
PPV	Peak Particle Velocity
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SE	Sound Exposure
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Single Strike Sound Exposure Level
SL	Source Level
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
$SPL_{peak\text{-}to\text{-}peak}$	Peak-to-peak Sound Pressure Level
SPL_{RMS}	Root Mean Square Sound Pressure Level
TNT	Trinitrotoluene (explosive)
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance
VHF	Very High-Frequency Cetaceans (Marine mammal hearing group from Southall *et al*., 2019)

Units

Unit	Definition
dB	Decibel (sound pressure)
Hz	Hertz (frequency)
kHz	Kilohertz (frequency)
kg	Kilogram (mass)
km	Kilometre (distance)
km^2	Square kilometres (area)
knot	Knot (speed, at sea)

Unit	Definition
m	Metre (distance)
ms^{-1}	Metres per second (speed)
MW	Megawatt (power)
Pa^2s	Pascal squared seconds (acoustic energy)
µPa	Micropascal (pressure)

1 Introduction

White Cross Windfarm Project (hereafter referred to as the 'Offshore Project') is a proposed wind farm development off the west coast of England in the Bristol Channel. As part of the Environmental Impact Assessment (EIA) process, Subacoustech Environmental has undertaken underwater noise modelling and analysis in relation to marine fauna for the Windfarm Site.

The primary activities considered for this study are associated with ground preparation and installation of the floating turbines and their associated infrastructure. The expected or potential noise sources at the Offshore Project considered in this assessment are:

- Clearance of Unexploded Ordnance (UXO);
- Impact piling to install foundations for the Offshore Substation Platform (OSP) and as a potential securing method for substructure mooring anchors;
- Installation of drag embedment anchors and suction anchors;
- Cable laying and trenching;
- Cutting and removal of service cables;
- Seabed protection using dredging;
- Cable protection including rock placement; and
- Vessel movements.

In addition, noise from the operational Wind Turbine Generators (WTGs) and potential cable "snapping" have also been considered.

This report presents a detailed assessment of the potential underwater noise and its effects during construction of the Offshore Project, and covers the following:

- A review of background information on the units for measuring and assessing underwater noise and a review of the underwater noise metrics and criteria used to assess the possible environmental effects in marine receptors (Section 2);
- Baseline noise characterisation, covering the expected levels of baseline noise at the site (Section 3);
- Discussion of the approach, input parameters and assumptions for the noise modelling undertaken (Section 4);
- Noise modelling results for the potential noise sources present during construction of the project (Section 5); and
- Summary and conclusions (Section 6).

2 Underwater noise metrics

2.1 Underwater noise

2.1.1 Background

Sound travels much faster in water (approximately 1,500 ms^{-1}) than in air (340 ms^{-1}). Since water is a relatively incompressible, dense medium, the pressure associated with underwater sound tends to be much higher than in air. As an example, background noise levels in the sea of 130 dB re 1 µPa for UK coastal waters are not uncommon (Nedwell *et al*. 2003 and 2007).

It should be noted that stated underwater noise levels should not be confused with noise levels in air, which use a different scale.

2.1.2 Units of measurement

Sound measurements underwater are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. A logarithmic scale is used because, rather than equal increments of sound having an equal increase in effect, typically each doubling of sound level will cause a roughly equal increase of "loudness."

Any quantity expressed in this scale is termed a "level." If the unit is sound pressure, expressed on the dB scale, it will be termed a "sound pressure level."

The fundamental definition of the dB scale is given by:

$$Level = 10 \times \log_{10}\left(\frac{Q}{Q_{ref}}\right)$$

where Q is the quantity being expressed on the scale, and Q_{ref} is the reference quantity.

The dB scale represents a ratio. It is therefore used with a reference unit, which expresses the base from which the ratio is expressed. The reference quantity is conventionally smaller than the smallest value to be expressed on the scale so that any level quoted is positive. For example, a reference quantity of 20 µPa is used for sound in air since that is the lower threshold of human hearing.

When used with sound pressure, the pressure value is squared. So that variations in the units agree, the sound pressure must be specified as units of Root Mean Square (RMS) pressure squared. This is equivalent to expressing the sound as:

$$Sound\ pressure\ level = 20 \times \log_{10}\left(\frac{P_{RMS}}{P_{ref}}\right)$$

For underwater sound, a unit of 1 µPa is typically used as the reference unit (P_{ref}); a Pascal is equal to the pressure exerted by one Newton over one square metre, one micropascal equals one millionth of this.

2.1.2.1 Sound pressure level (SPL)

The sound pressure level (SPL) is normally used to characterise noise and vibration of a continuous nature, such as drilling, boring, continuous wave sonar, or background sea and river noise levels. To calculate the SPL, the variation in sound pressure is measured over a specific period to determine the RMS level of the time-varying sound. The SPL can therefore be considered a measure of the average unweighted level of sound over the measurement period.

Where SPL is used to characterise transient pressure waves, such as that from impact piling, seismic airgun or underwater blasting, it is critical that the period over which the RMS level is calculated is quoted. For instance, in the case of a pile strike lasting a tenth of a second, the mean taken over a tenth of a second will be ten times higher than the mean averaged over one second. Often, transient sounds such as these are quantified using "peak" SPLs or sound exposure levels (SELs).

Unless otherwise defined, all SPL noise levels in this report are referenced to 1 µPa. It is recognised that ISO 18405 (2017) defines SPL in reference to the unit 1 µPa^2. As the key publications used in this assessment use the unit 1 µPa, this terminology will also be used in this report. This does not affect any results or values.

2.1.2.2 Peak sound pressure level (SPL_{peak})

Peak SPLs are often used to characterise transient sound from impulsive sources, such as percussive impact piling. SPL_{peak} is calculated using the maximum variation of the pressure from positive to zero within the wave. This represents the maximum change in positive pressure (differential pressure from positive to zero) as the transient pressure wave propagates.

A further variation of this is the peak-to-peak SPL ($SPL_{peak\text{-}to\text{-}peak}$) where the maximum variation of the pressure from positive to negative is considered. Where the wave is symmetrically distributed in positive and negative pressure, the peak-to-peak pressure will be twice the peak level, or 6 dB higher (see section 2.1.2).

2.1.2.3 Sound exposure level (SEL)

When considering the noise from transient sources, the issue of the duration of the pressure wave is often addressed by measuring the total acoustic energy (energy flux density) of the wave. This form of analysis was initially used to explain the apparent discrepancies in the biological effect of short and long-range blast waves on human divers. Currently, the SEL metric has been used to develop criteria for assessing injury ranges for fish and marine mammals from various noise sources (Popper *et al*., 2014 and Southall *et al*., 2019).

The SEL sums the acoustic energy over a measurement period, and effectively takes account of both the SPL of the sound and the duration it is present in the acoustic environment. Sound Exposure (SE) is defined by the equation:

$$SE = \int_0^T p^2(t)dt$$

where p is the acoustic pressure in Pascals, T is the total duration of the sound in seconds, and t is the time in seconds. The SE is a measurement of acoustic energy and has units of Pascal squared seconds (Pa^2s).

To express the SE on a logarithmic scale by means of a dB, it has to be compared with a reference acoustic energy level (${p^2}_{ref}$) and a reference time (T_{ref}). The SEL is then defined by:

$$SEL = 10 \times \log_{10}\left(\frac{\int_0^T p^2(t)dt}{{p^2}_{ref}T_{ref}}\right)$$

By selecting a common reference pressure (p_{ref}) of 1 µPa for assessments of underwater noise, the SEL and SPL can be compared using the expression:

$$SEL = SPL + 10 \times \log_{10} T$$

where the SPL is a measure of the average level of broadband noise and the SEL sums the cumulative broadband noise energy.

This means that, for continuous sounds of less than one second, the SEL will be lower than the SPL. For periods greater than one second, the SEL will be numerically greater than the SPL (i.e., for a continuous sound of 10 seconds duration, the SEL will be 10 dB higher than the SPL; for a sound of 100 seconds duration the SEL will be 20 dB higher than the SPL, and so on).

2.2 Analysis of environmental effects

2.2.1 Background

Over the last 20 years it has become increasingly evident that noise from human activities in and around underwater environments can have an impact on the marine species in the area. The extent to which intense underwater sound might cause adverse impacts in species is dependent upon the incident sound level, source frequency, duration of exposure, and/or repetition rate of an impulsive sound (see, for example, Hastings and Popper, 2005). As a result, scientific interest in the hearing abilities of aquatic species has increased. Studies are primarily based on evidence from high level sources of underwater noise such as blasting or impact piling, as these sources are likely to have the greatest immediate environmental impact and therefore the clearest observable effects, although interest in chronic noise exposure is increasing.

The impacts of underwater sound on marine species can be broadly summarised as follows:

- Physical traumatic injury and fatality;
- Auditory injury (either permanent or temporary); and
- Disturbance.

The following sections discuss the underwater noise criteria used in this study.

2.2.2 Criteria to be used

The main metrics and criteria that have been used in this study to aid assessment of environmental effects come from two key papers covering underwater noise and its effects:

- Southall *et al*. (2019) marine mammal noise exposure criteria; and
- Popper *et al*. (2014) sound exposure guidelines for fishes and sea turtles.

At the time of writing these are used as the most up-to-date and authoritative criteria for assessing environmental effects for use in impact assessments.

In addition, criteria from Lucke *et al*. (2009), for harbour porpoise TTS and behavioural reaction, and noise levels from Hawkins *et al*. (2014), for observed responses in fish, have also been included as part of this study.

2.2.2.1 Marine mammals

Southall *et al*. (2019)

The Southall *et al*. (2019) paper is effectively an update of the previous Southall *et al*. (2007) paper and provides identical thresholds to those from the National Marine Fisheries Service (NMFS) (2018) guidance for marine mammals.

The Southall *et al*. (2019) guidance groups marine mammals into categories of similar species and applies filters to the unweighted noise to approximate the hearing sensitivities of the receptor. The hearing groups given in Southall *et al*. (2019) are given in Table 2-1 and Figure 2-1. Further groups for sirenians and other marine carnivores in water are also given, but these have not been used for this study as those species are not commonly found in the Bristol Channel or Irish Sea.

Table 2-1 Marine mammal hearing groups from Southall et al. (2019)

Hearing group	Generalised hearing group	Example species
Low-frequency cetaceans (LF)	7 Hz to 35 kHz	Baleen whales
High-frequency cetaceans (HF)	150 Hz to 160 kHz	Dolphins, toothed whales, beaked whales, bottlenose whales (including bottlenose dolphin)
Very high-frequency cetaceans (VHF)	275 Hz to 160 kHz	True porpoises (including harbour porpoise)
Phocid carnivores in water (PCW)	50 Hz to 86 kHz	True seals (including harbour seal

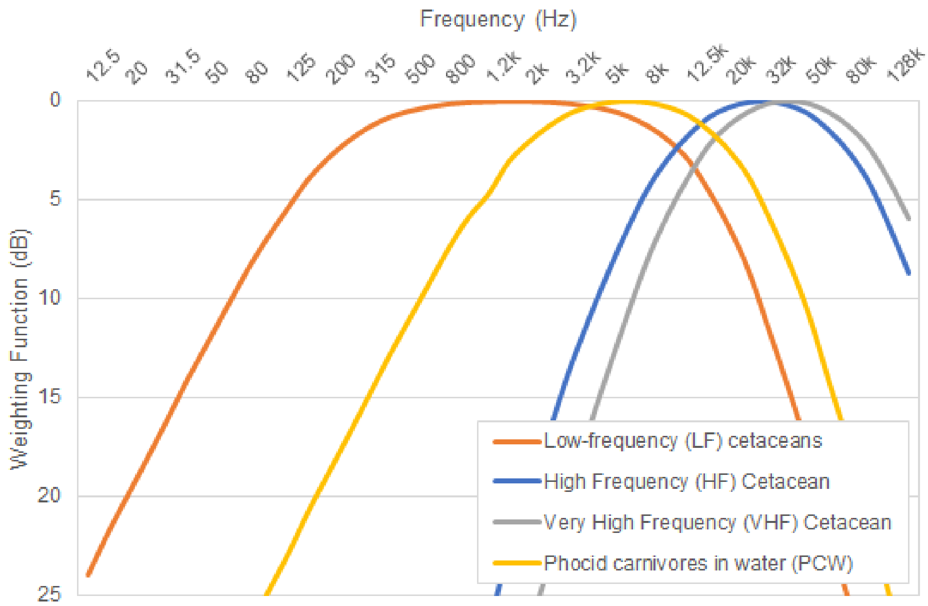

Figure 2-1 Auditory weighing functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PCW) from Southall et al. (2019)

Southall *et al*. (2019) also gives individual criteria based on whether the noise source is considered impulsive or non-impulsive. Southall *et al*. (2019) categorises impulsive noises as having high peak sound pressure, short duration, fast rise-time and broad frequency content at source, and non-impulsive sources as steady-state noise. For the noise sources considered in this study, UXO detonations and impact piling are considered impulsive noise sources and all other sources are considered non-impulsive. A non-impulsive noise does not necessarily have to have a long duration.

Southall *et al*. (2019) presents single pulse, unweighted peak criteria (SPL_{peak}) and cumulative (i.e., more than a single sound impulse) weighted sound exposure criteria (SEL_{cum}) for both permanent threshold shift (PTS), where unrecoverable hearing damage may occur, and temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors. In principle the SEL_{cum} metric is effectively still valid for a single instance of noise, although this is more commonly defined as SEL_{ss} (single pulse/strike). These dual criteria are only used for impulsive noise, with the criteria set giving the greatest calculated range used as the PTS impact range.

Table 2-2 and Table 2-3 present the Southall *et al*. (2019) criteria for the onset of PTS and TTS for each of the key marine mammal hearing groups considering impulsive and non-impulsive sources.

Table 2-2 Single strike, impulsive, unweighted SPL_{peak} criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Hearing group	Unweighted SPL_{peak} (dB re 1 µPa)	
	Impulsive	
	PTS	TTS
Low-frequency cetaceans (LF)	219	213
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid carnivores in water (PCW)	218	212

Table 2-3 Cumulative, impulsive and non-impulsive, weighted SEL_{cum} criteria for PTS and TTS in marine mammals (Southall et al., 2019)

Hearing group	Weighted SEL_{cum} (dB re 1 µPa²s)			
	Impulsive		Non-impulsive	
	PTS	TTS	PTS	TTS
Low-frequency cetaceans (LF)	183	168	199	179
High-frequency cetaceans (HF)	185	170	198	178
Very high-frequency cetaceans (VHF)	155	140	173	153
Phocid carnivores in water (PCW)	185	170	201	181

Where SEL_{cum} are required, a fleeing animal model has been used for marine mammals. This assumes that a receptor, when exposed to high noise levels, will swim away from the noise source. For this a constant fleeing speed of 3.25 ms^{-1} has been assumed for the low-frequency cetaceans (LF) group (Blix and Folkow, 1995), based on data for minke whale, and for other receptors, a constant fleeing speed of 1.5 ms^{-1} has been assumed, based on a cruising speed for a harbour porpoise (Otani *et al*. 2000). These are considered worst-case assumptions as marine mammals are expected to be able to swim much faster under stress conditions.

<u>Lucke *et al*. (2009)</u>

Noise levels from Lucke *et al*. (2009) have been included to cover aversive behavioural reactions and TTS impact on harbour porpoises from impulsive noise. The Lucke *et al*. (2009) study exposed harbour porpoises to seismic airgun stimuli and derived noise levels where TTS and an aversive behavioural reaction were documented. These levels have been used for this study in the absence of dedicated behavioural effect data or criteria from impact piling noise. These levels are summarised in Table 2-4.

Table 2-4 Unweighted single strike noise levels used for assessments based on data from Lucke et al. (2009)

Noise metric	TTS	Aversive behavioural reaction
Unweighted SPL_{peak}	199.7 dB re 1 µPa	174 dB re 1 µPa
Unweighted SEL_{ss}	164.3 dB re 1 µPa²s	145 dB re 1 µPa²s

2.2.2.2 <u>Fish</u>

<u>Popper *et al*. (2014)</u>

The large number of, and variation in, fish species leads to a greater challenge in production of a generic noise criterion, or range of criteria, for the assessment of noise impacts. Whereas previous studies applied broad criteria based on limited studies of fish that are not present in UK waters (e.g., McCauley *et al*., 2000), the publication of Popper *et al*. (2014) provides an authoritative summary of the latest research and guidelines for fish exposure to sound and uses categories for fish that are representative of the species present in UK waters.

The Popper *et al*. (2014) study groups species of fish by whether they possess a swim bladder, and whether it is involved in its hearing; groups for sea turtles and fish eggs and larvae are also included. The guidance also gives specific criteria (as both unweighted SPL_{peak} and unweighted SEL_{cum} values) for a variety of noise sources. A further set of criteria also exists for turtles, which have not been included as part of this study as they are not expected to be present at the site.

A specific set of criteria for explosions (covering UXO detonation), pile driving (covering impact piling) and continuous noise sources (covering all other noise sources considered in this study) are available in Popper *et al.* (2014) which have been considered in this study; these are summarised in Table 2-5 to Table 2-7.

Table 2-5 Criteria for mortality and potential mortal injury in species of fish from explosions (Popper et al., 2014)

Type of animal	Mortality and potential mortal injury
Fish: no swim bladder	229 – 234 dB SPL_{peak}
Fish: swim bladder is not involved in hearing	229 – 234 dB SPL_{peak}
Fish: swim bladder involved in hearing	229 – 234 dB SPL_{peak}
Sea turtles	229 – 234 dB SPL_{peak}
Eggs and larvae	> 13 mm s^{-1} peak velocity

Table 2-6 Criteria for mortality and potential mortal injury, recoverable injury and TTS in species of fish from pile driving noise (Popper et al., 2014)

Type of animal	Mortality and potential mortal injury	Impairment	
		Recoverable injury	TTS
Fish: no swim bladder	> 219 dB SEL_{cum} > 213 dB SPL_{peak}	> 216 dB SEL_{cum} > 213 dB SPL_{peak}	>> 186 dB SEL_{cum}
Fish: swim bladder is not involved in hearing	210 dB SEL_{cum} > 207 dB SPL_{peak}	203 dB SEL_{cum} > 207 dB SPL_{peak}	>> 186 dB SEL_{cum}
Fish: swim bladder involved in hearing	207 dB SEL_{cum} > 207 dB SPL_{peak}	203 dB SEL_{cum} > 207 dB SPL_{peak}	>> 186 dB SEL_{cum}
Sea turtles	> 210 dB SEL_{cum} > 207 dB SPL_{peak}	See Table 2-9	
Eggs and larvae	> 210 dB SEL_{cum} > 207 dB SPL_{peak}		

Table 2-7 Criteria for recoverable injury and TTS in species of fish from continuous noise sources (Popper et al., 2014)

Type of animal	Impairment	
	Recoverable injury	TTS
Fish: swim bladder involved in hearing	170 dB SPL_{RMS} for 48 hrs	158 dB SPL_{RMS} for 12 hrs

Where insufficient data are available, Popper *et al*. (2014) also gives qualitative criteria that summarise the effect of the noise as having either a high, moderate, or low effect on an individual in either the near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres). These qualitative effects are reproduced for the three noise groups in Table 2-8 to Table 2-10.

Table 2-8 Summary of the qualitative effects on species of fish and sea turtles from explosions (Popper et al., 2014) (N = Near-field, I = Intermediate-field, F = Far-field)

Type of animal	Impairment			Behaviour
	Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	N/A	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	(N) High (I) High (F) Low	(N) High (I) Moderate (F) Low	N/A	(N) High (I) High (F) Low
Fish: swim bladder involved in hearing	(N) High (I) High (F) Low	(N) High (I) High (F) Low	N/A	(N) High (I) High (F) Low

Type of animal	Impairment			Behaviour
	Recoverable injury	TTS	Masking	
Sea turtles	(N) High (I) High (F) Low	(N) High (I) High (F) Low	N/A	(N) High (I) High (F) Low
Eggs and larvae	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	N/A	(N) High (I) Low (F) Low

Table 2-9 Summary of the qualitative effects on species of fish and sea turtles from pile driving noise (Popper et al., 2014) (N = Near-field, I = Intermediate-field, F = Far-field)

Type of animal	Impairment			Behaviour
	Recoverable injury	TTS	Masking	
Fish: no swim bladder	See Table 2-6		(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing			(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing			(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea turtles	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Table 2-10 Summary of the qualitative effects on fish and sea turtles from continuous noise (Popper et al., 2014) (N = Near-field, I = Intermediate-field, F = Far-field)

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	See Table 2-7		(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Both fleeing and stationary animal models have been considered for the SEL_{cum} criteria for fish. It is recognised that there is limited evidence for fish fleeing from high level noise source in the wild, and it would be reasonably expected that the reaction would differ between species. Most species are likely to move away from a sound that is loud enough to cause harm (Dahl *et al*., 2015; Popper *et al*., 2014), some may seek protection in the sediment and others may dive deeper in the water column. For those species that flee, the speed chosen for this study of 1.5 ms^{-1} is relatively slow in relation to data from Hirata (1999) and thus is considered somewhat conservative.

Although it is feasible that some species will not flee, those that are likely to remain are more likely to be benthic species or species without a swim bladder; these are the least sensitive species with regards to sound. For example, from Popper *et al*. (2014): "There is evidence (e.g., Goertner *et al*., 1994; Stephenson *et al*., 2010; Halvorsen *et al*., 2012) that little or no damage occurs to fishes without a swim bladder except at very short ranges from an in-water explosive event. Goertner (1978) showed that the range from an explosive event over which damage may occur to a non-swim bladder fish is in the order of 100 times less that for swim bladder fish."

Stationary animal modelling has been included in this study based on research from Hawkins *et al*. (2014) and other modelling for similar EIA projects. However, basing the modelling on a stationary (zero flee speed) receptor is likely to greatly overestimate the potential risk to fish species, assuming that an individual would remain in the high noise level region of the water column, especially when considering the precautionary nature of the parameters already built into the cumulative exposure calculations.

Hawkins *et al*. (2014)

In the absence of reliable numeric criteria for disturbance in fish, observed levels from impulsive stimuli given in Hawkins *et al*. (2014) have been used for this study, although the authors of this paper themselves urge caution with the use of these values as criteria. The study was conducted under conditions that are unlikely to be equivalent to those present at this project.

The report gives unweighted SPL_{peak}, $SPL_{peak\text{-}to\text{-}peak}$, and SEL_{ss} levels where a 50% response level was recorded in sprat and mackerel for an impulsive noise source, simulating pile driving. These levels are summarised in Table 2-11.

Table 2-11 Levels where a 50% response was observed in fish from Hawkins et al. (2014)

Noise metric	Observed noise level for 50% response
Unweighted SPL_{peak}	173 dB re 1 μPa
	168 dB re 1 μPa
Unweighted $SPL_{peak\text{-}to\text{-}peak}$	163 dB re 1 μPa
Unweighted SEL_{ss}	142 dB re 1 μPa^2s
	135 dB re 1 μPa^2s

2.2.3 Particle motion

The criteria defined in the above section all define the noise impacts on fishes in terms of sound pressure or sound pressure-associated functions (i.e., SEL). It has been identified by researchers (e.g., Popper and Hawkins, 2019; Nedelec *et al*., 2016; Radford *et al*., 2012) that species of fish, as well as invertebrates, actually detect particle motion rather than pressure. Particle motion describes the back-and-forth movement of a tiny theoretical 'element' of water, substrate or other media as a sound wave passes, rather than the pressure caused by the action of the force created by its movement. Particle motion is usually defined in reference to the velocity of the particle (often a peak particle velocity, PPV), but sometimes the related acceleration or displacement of the particle is used. Note that species in the "Fish: swim bladder involved in hearing" category of Popper *et al*. (2014) are sensitive to sound pressure.

Popper and Hawkins (2018) state that in derivation of the sound pressure-based criteria in Popper *et al*. (2014), it may be the unmeasured particle motion detected by the fish, to which the fish were responding: there is a relationship between particle motion and sound pressure in a medium. This relationship is very difficult to define when the sound field is complex, such as close to the noise source or where there are multiple reflections of the sound wave in shallow water; even the terms “shallow” and “close” do not have simple definitions.

The primary reason for the continuing use of sound pressure as the criteria, despite particle motion appearing to be the physical measure to which the fish react or sense, is a lack of data (Popper and Hawkins, 2018), both in respect of predictions of the particle motion level as a consequence of a noise source such as piling, and in a lack of knowledge of the sensitivity of fish to a particle motion value. There continue to be calls for additional research on the levels of, and effect with respect to, levels particle motion. Until sufficient data are available to enable revised thresholds based on the particle motion metric, Popper *et al*. (2014) continues to be the best source of criteria in respect to fish impacts (Andersson *et al*., 2016; Popper and Hawkins, 2019).

3 Baseline noise

The baseline noise level in open water, in the absence of any anthropogenic noise source, is generally dependent on a mix of the movement of the water and sediment, weather conditions and shipping. There is a component of biological noise from marine mammals and fish vocalisation, as well as an element from invertebrates.

Outside of the naturally occurring ambient noise, man-made noise dominates the background. The Celtic Sea is shipped by fishing, cargo and passenger vessels, which contribute to the ambient noise in the water, and the Offshore Project location will be subject to vessels transiting to and from the Bristol Channel. The larger vessels are not only louder, but the noise tends to have a lower frequency, which travels more readily, especially in the deeper open water. Other vessels such as aggregate dredgers and small fishing boats have a lower overall contribution. There are no known dredging areas, active dredge zones, or dredging application option and prospecting areas within or in close proximity to the Offshore Project.

Typical underwater noise levels show a frequency dependency in relation to different noise sources: the classic curves for this are given in Wenz (1962) and are reproduced in Figure 3-1. These show that any unweighted, overall (i.e., single-figure, non-frequency-dependent) noise level is typically dependent on the very low-frequency (< 100 Hz) element of the noise. The introduction of a nearby anthropogenic noise source (such as piling or sources involving engines) will tend to increase the noise level in the 100 Hz to 1 kHz region, but to a lesser extent, will also extend into higher and lower frequencies.

There is no known and available source of background noise data for the Celtic Sea region of the Offshore Project, nor the Celtic Sea generally. Some baseline noise data is available from monitoring undertaken from a station installed in the middle of the Burbo Bank Extension, which continuously monitored the ambient noise levels between 23rd March 2016 and 25th April 2016. The measurements taken during this survey identified the main contributing sources of noise that make up the ambient noise environment in the Irish Sea. While it is recognised that this is the Irish Sea rather than the Celtic Sea, both locations are subject to shipping traffic, to Liverpool and Avonmouth/Newport, respectively. Although this survey was undertaken in 2016, it is expected to represent a best estimate of the subsea noise levels in this region prior to installation of WTGs in the absence of anything more location-specific.

The overview of the entire monitoring period in Figure 3-2 below shows that the range of underwater noise levels typically lie, with isolated exceptions, between 95 dB and 130 dB re 1 µPa SPL_{RMS} (displayed as 10-minute averages). Although there are clear instances of times when the noise levels reach or approach the upper and lower extremes on most days, a trend can be identified when looking at this timeframe. The logarithmic average noise level over this period was 120.4 dB re 1 µPa SPL SPL_{RMS}.

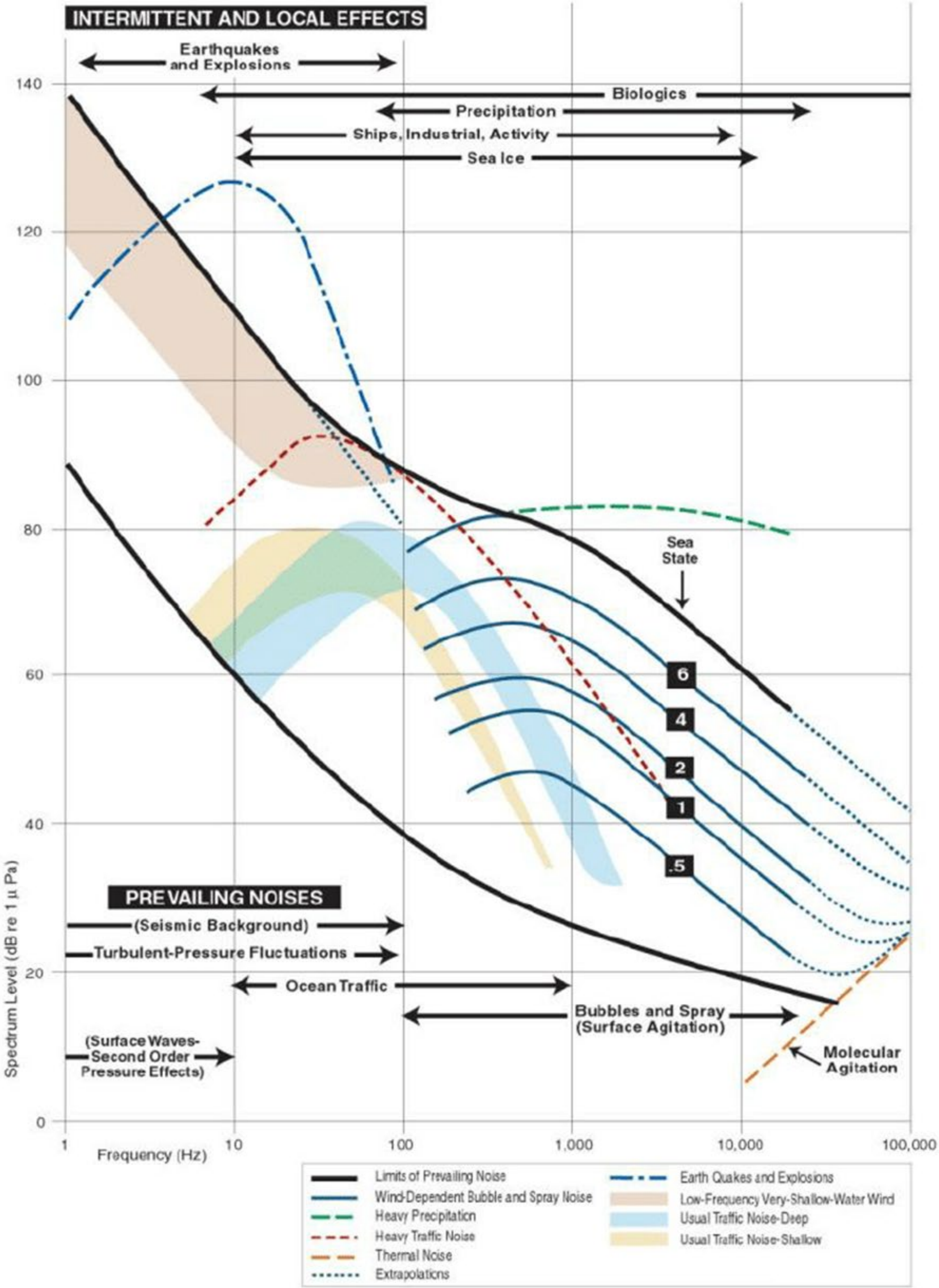

Figure 3-1: Ambient underwater noise, following Wenz (1962), showing frequency dependency from different noise sources

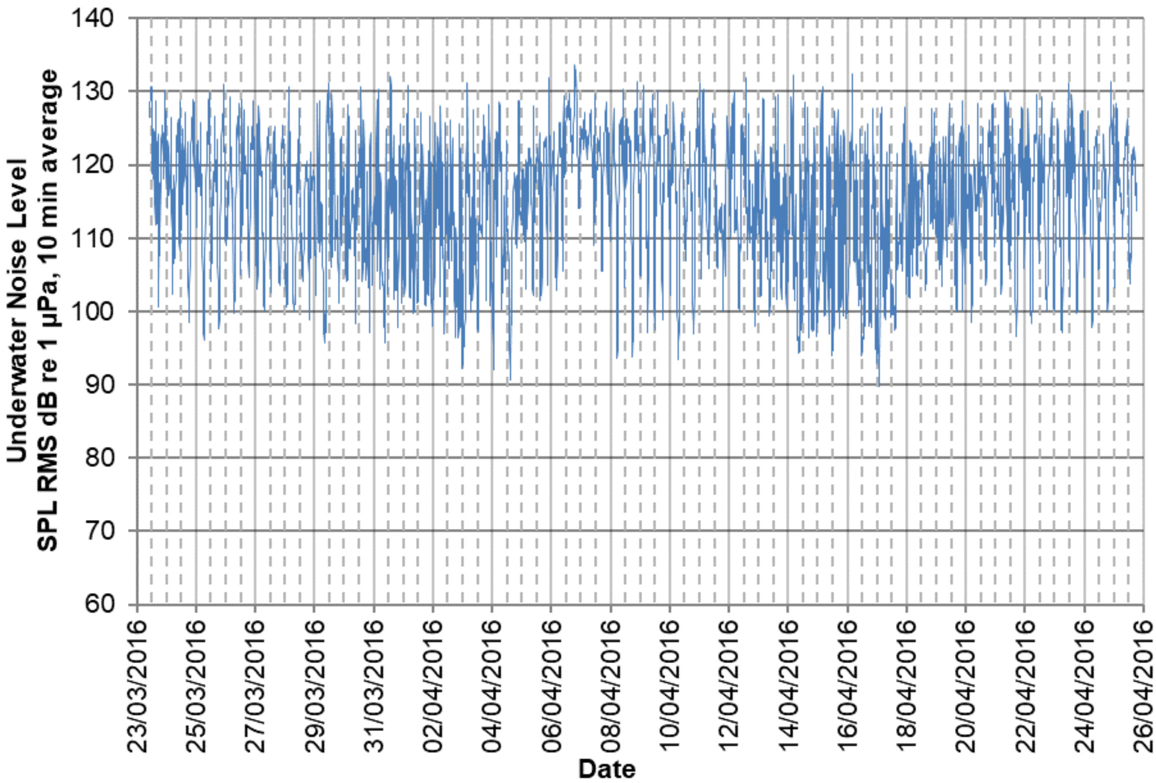

Figure 3-2: Overall sampled underwater noise levels at Burbo Bank Extension site, March-April 2016

Two primary sources influence the noise levels above: flow-related noise associated with tides moving material on the seabed and vessel noise. The highest noise levels above are produced at times of greatest currents and the passing of vessels, whereas the quietest noise levels are at slack water with no significant anthropogenic influence.

The lowest noise levels were sampled in the absence of vessel movements and at slack water.

In principle, when noise introduced by anthropogenic sources propagates far enough it will reduce to the level of natural ambient noise, at which point it can be considered negligible. In practice, as the underwater noise thresholds defined in section 2.2.2 are all considerably above the level of background noise, any noise baseline would not feature in an assessment to these criteria.

4 Modelling methodology

4.1 Introduction

Several approaches have been used to model the noise sources that are likely to be present during construction of the Offshore Project. For all noise making activities (except UXO and impact piling), the modelling approach is based on directly measured data from Subacoustech Environmental's underwater noise measurement database. To model noise from UXO clearance, an approach based on equations from Soloway and Dahl (2014) has been used. For impact piling, Subacoustech's INSPIRE underwater noise model has been used.

The NPL Good Practice Guide 133 for underwater noise measurements (Robinson *et al.*, 2014) indicated that under certain circumstances, a simple modelling approach, such as those considered here for sources other than impact piling, may be considered acceptable. As the sources are either quiet when compared to impact piling (e.g., drilling and cable laying) or where detailed modelling would imply unjustified accuracy (e.g., where data is limited, such as with UXO clearance), the method of modelling that has been presented here is considered sufficient and there would be little benefit in undertaking a more detailed modelling approach. The limitations of this approach are noted, including the lack of frequency or bathymetric dependence, but are acceptable due to the relatively low noise levels produced by the non-impulsive noise sources.

4.2 UXO clearance

It is possible that UXO devices with a range of charge weights (or quantity of contained explosives) may exist within the boundary of the Offshore Project site. These need to be cleared before any construction can begin. There are expected to be a variety of explosive types, many of which have been subject to degradation and burying over time. Two otherwise identical explosive devices are likely to produce different blasts in the case where one has spent an extended period on the seabed. A selection of explosive sizes has been considered and, in each case, it has been assumed that the maximum explosive charge in each device is present and either detonates with the clearance (high-order) or alternatively a clearance method such as deflagration (low-order) or the HYDRA system (low-yield) can be used.

Five UXO clearance scenarios have been considered for this study:

- High-order detonation, unmitigated
- High-order detonation, with bubble curtain
- Low-order clearance (e.g., deflagration)
- Low-yield clearance (e.g., HYDRA system)
- Low-yield clearance (e.g., HYDRA system, with bubble curtain)

4.2.1 *Estimation of underwater noise levels*

4.2.1.1 *High-order clearance*

The noise produced by the detonation of explosives is affected by several different elements, only one of which can easily be factored into a calculation: the charge weight. In this case the charge weight is based in the equivalent weight of TNT. Many other elements relating to its situation (e.g., its design, composition, age, position, orientation, whether it is covered by sediment) and exactly how they will affect the sound produced by detonation are usually unknown and cannot be directly considered in this type of assessment. This leads to a high degree of uncertainty in the estimation of the source noise level. A worst-case estimation has therefore been used for calculations, assuming the UXO to be detonated is not buried, degraded or subject to any other significant attenuation from its “as new” condition. It assumes that a ‘high-order’ clearance technique is used, using an external ‘donor charge’ initiator to detonate the explosive material in the UXO, producing a blast wave equivalent to full detonation of the device.

The consequence of this is that the noise levels produced, particularly by the larger explosives under consideration, are likely to be over-estimated as some degree of degradation would be expected.

A range of TNT equivalent charge weights for the potential UXO devices that could be present within the Offshore Project site boundary have been estimated from the smaller to largest with a selection in between. These have been estimated as follows:

Table 4-1 Selection of potential UXO and respective charge weights, NEQ

	4.7" Artillery	SC-50 HE Bomb	250lb MC Bomb	SC-250 HE Bomb	Mark XV Mine	1,000lb MC Bomb
Predicted charge weight, NEQ	3.1 kg	25 kg	67.8 kg	130 kg	227 kg	309.4 kg

Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014), which follows Arons (1954) and MTD (1996).

4.2.1.2 Low-order clearance

Other techniques are being considered to reduce the impact of noise impacts from high order UXO clearance, caused by detonation of the main charge of the UXO. Deflagration is such an alternative technique, intended to result in a 'low order' burn of the explosive material in a UXO, which destroys, but does not detonate, the internal explosive.

Deflagration is a safer technique for UXO disposal as it is intended to avoid the high pressures associated with an explosion, which would lead to an increased risk of adverse effects to marine life. Where the UXO device cannot be moved, deflagration represents a significant improvement over high-order clearance in respect to environmental effects.

Where the technique proceeds as intended, it is still not without noise impact. The process requires an initial shaped explosive donor charge, typically less than 250 g, to breach the casing and ignite the internal high explosive (HE) material without full detonation. The shaped charge and burn will both produce noise, although it will be significantly less than the high order detonation of the much larger UXO. It may not destroy all of the HE, necessitating further deflagration events or collection of the remnants. The deflagration may produce an unintentional high order event.

For calculation of the scenario of total destruction of the HE material using deflagration, it is anticipated that the initial shaped charge is the greatest source of noise (Cheong *et al.* 2020). The shaped charge is treated as a bulk charge with NEQ determined according to the size of UXO on which it is placed. A prediction of this impact is based on a charge weight of 2 kg, which is larger than that which would reasonably be expected for deflagration or similar techniques (up to 250 grams as noted above) but represents a high-end scenario for deflagration. The worst-case scenario would of course be a high order detonation with maximum pressures from complete detonation of the UXO, and this has also been used in the calculation of impact for comparison.

4.2.1.3 Low-yield clearance

The low-yield clearance is associated with the HYDRA UXO clearance system developed by EORCA UK. As with the low order deflagration technique, this involves the use of a small charge to initiate destruction of the UXO, avoiding a much louder detonation of the main explosive. Unlike deflagration, the HYDRA uses shaped charges to produce high pressure water jets that disintegrate the explosive material.

As with the low order clearance, the low yield clearance still generates sound from the donor charge. Based on recent tests from clearance using the HYDRA system at the Seagreen Alpha and Bravo offshore wind farm development site (Cook and Banda, 2021), the donor charge is predicted to be 750 g, which will be used in the calculations of noise impact on the environment. This study also showed that for the low-yield technique, Soloway and Dahl (2014) underestimated the noise impacts at approximately 500 m and 1500 m. Although Cook and Banda's conclusions note that the reasons for this underprediction cannot be determined on the basis of that study, a correction has been added to account for it to ensure a precautionary assessment.

4.2.1.4 Mitigation using bubble curtains

Both the high-order detonation and low-yield clearance scenarios have also considered noise level reductions using a bubble curtain as mitigation as separate results. This has applied a nominal 10 dB attenuation by the bubble curtain.

4.2.2 Estimation of underwater noise propagation

For this assessment, the attenuation of the noise from UXO detonation has been accounted for in calculations using geometric spreading and a sound absorption coefficient, primarily using the methodologies cited in Soloway and Dahl (2014), which establishes a trend based on measured data in open water. These are, for SPL_{peak}:

$$SPL_{peak} = 52.4 \times 10^{6} \left(\frac{R}{W^{1/3}}\right)^{-1.13}$$

and for SEL_{ss}

$$SEL = 6.14 \times \log_{10}\left(W^{1/3}\left(\frac{R}{W^{1/3}}\right)^{-2.12}\right) + 219$$

where W is the equivalent charge weight for TNT in kilograms and R is the range from the source.

These equations give a relatively simple calculation which can be used to give an indication of the range of effect. The equation does not consider variable bathymetry or seabed type, and thus calculation results will be the same regardless of where it is used. An attenuation correction can be added to the Soloway and Dahl (2014) equations for the absorption over long ranges (i.e., of the order of thousands of metres), based on measurements of high intensity noise propagation taken in the North and Irish Seas in similar depths to those present at the Offshore Project. In order to best accommodate the effect on noise transmission over longer ranges, an additional term was included in Subacoustech's calculations for sound absorption in seawater, α, in decibels per meter, without which a substantial overestimate for the noise level at long range would be expected. This figure is based on typical environmental conditions in the North Sea and the dominant frequency of sound seen by Subacoustech from UXO clearance in direct measurements.

Despite this attenuation correction, the resulting noise levels still need to be considered carefully. For example, SPL_{peak} noise levels over larger distances are difficult to predict accurately (von Benda-Beckmann *et al*., 2015). Soloway and Dahl (2014) only verify results from the equation above for small charges at ranges of less than 1 km, although the results do agree with the measurements presented by von Benda-Beckmann *et al*. (2015). At longer ranges, greater confidence is expected with the SEL calculations.

A further limitation in the Soloway and Dahl (2014) equations that must be considered are that variations in noise levels at different depths are not considered. Where animals are swimming near the surface, the acoustics can cause the noise level, and hence the exposure, to be lower (MTD, 1996). The risk to animals near the surface may therefore be lower than indicated by the impact ranges and therefore the results presented can be considered conservative in respect of the impact on animals swimming near the water surface.

Additionally, an impulsive wave tends to be smoothed (i.e., the pulse becomes longer) over distance (Cudahy and Parvin, 2001, Hastie *et al.* 2019), meaning the injurious potential of a wave at greater range can be even lower than just a reduction in the absolute noise level. Research is ongoing on the use of kurtosis as a metric for assessment of impulsiveness in impact assessments (Müller *et al.* 2020). An assessment in respect of SEL is considered preferential at long range as it considers the overall energy, and the smoothing of the peak is less critical to the consideration of harm to a receptor.

The selection of assessment criteria must also be considered in light of this, the smoothing of the pulse at range means that a pulse may be considered a non-pulse at greater distance. As there is still doubt in the transition point between pulse and non-pulse, and what the degree of benefit may be to a receptor from this characteristic, this study has presented impact ranges for only impulsive criteria. On this basis it should be expected that long-range PTS or TTS impact ranges (i.e., a minimum of 5 km from the pile) are likely to be highly precautionary.

A summary of the unweighted UXO clearance source levels calculated using the equations above are given for high-order, low-order clearances and low-yield clearances in Table 4-2. Where bubble curtains are considered an additional 10 dB attenuation has been included to the noise level at source.

Table 4-2 UXO clearance source levels, following Soloway and Dahl (2014)

	Unweighted noise source levels, UXO clearance						
	LY[1]	**LO**[2]	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309.4 kg**
SPL_{peak} dB re 1 µPa	281.9	276.6	284.9	288.1	290.2	292.1	293.1
SEL_{ss} dB re 1 µPa²s	226.3	220.9	227.9	230.7	232.5	234.0	234.9

To account for the weightings required for modelling using the Southall *et al*. (2019) criteria (section 2.2.2.1), reductions in source level have been applied, based on the frequencies in a typical explosive noise spectrum to acquire a single weighted figure. Table 4-3 presents details of the reductions in source level for each of the weighting used for modelling.

Table 4-3 Reductions in source level for UXO clearance when the Southall et al. (2019) weightings are applied

Noise source	Reduction in source level from the unweighted level			
	LF	**HF**	**VHF**	**PCW**
UXO clearance	1.4 dB	28.9 dB	35.0 dB	9.2 dB

4.3 Impact piling

It is possible that impact piling may be necessary at the Offshore Project for the installation of OSP jacket piles or mooring line anchors. The modelling of impact piling has been undertaken using the INSPIRE noise model. The INSPIRE model (currently version 5.1) is a semi-empirical underwater noise propagation model. It is based around a combination of numerical modelling, using a combined geometric and energy flow/hysteresis loss methodology, and actual measured data, and has been validated in Thompson *et al.* (2013). It is designed to calculate the propagation of noise in shallow, mixed water, typical of the conditions around the UK and well suited to the region surrounding the Offshore Project. The model has been widely used in the consent phase for offshore wind projects around the UK and has been tuned for accuracy using over 80 datasets of underwater noise propagation from monitoring offshore piling activities, including in the Irish Sea.

The INSPIRE model estimates unweighted SPL_{peak}, SEL_{ss} and SEL_{cum} noise levels, as well as various other weighted noise metrics. Calculations are made along 180 equally spaced radial transects (one every two degrees). For each modelling run a criterion can be specified allowing a contour to be drawn, within which a given effect may occur. These results can then be plotted over digital bathymetry data so that impact ranges can be clearly visualised, as necessary. INSPIRE also produces these contours as GIS shapefiles.

INSPIRE considers a wide array of input parameters, including variations in bathymetry and source frequency content to ensure accurate results are produced specific to the location and nature of the piling operation. It should also be noted that the results presented in this study should be considered conservative as maximum design parameters and worst-case assumptions have been selected for:

- Piling hammer blow energies;
- Soft start, ramp-up profile, and strike rate;
- Total duration of piling; and
- Receptor swim speeds.

[1] Low-yield methodology, with correction based on Cook and Banda (2021)
[2] Low-order deflagration, 2 kg

4.3.1 Modelling parameters

Modelling has been undertaken at three representative locations; the south-east (SE) corner giving a worst-case location for the OSP at the closest point to the Bristol Channel Approaches SAC, and mooring anchor locations covering the extents of the Offshore Project site at the north-west (NW) and south-west (SW) corners. These locations are shown in Figure 4-1 and summarised in Table 4-4.

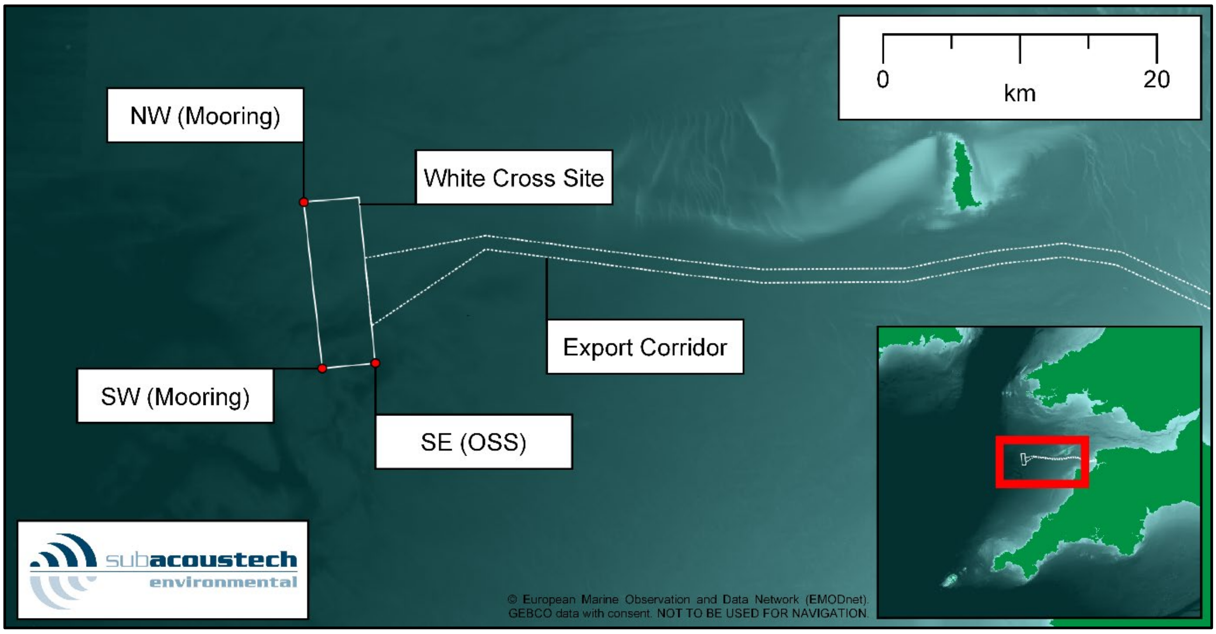

Figure 4-1 Map showing the approximate impact piling locations used for modelling

Table 4-4 Summary of the underwater noise modelling locations at the Offshore Project site

Modelling locations	SE (OSP)	NW (Mooring)	SW (Mooring)
Latitude	51.04441°N	51.14976°N	51.03975°N
Longitude	005.28343°W	005.36415°W	005.33915°W
Water depth (mean tide)	75.3 m	71.6 m	74.9 m

Two piling scenarios have been modelling covering the potential jacket piles for the OSP foundation and the potential pin piles for the substructure mooring anchors:

- OSP jacket piles – 4.0 m diameter piles, installed using a maximum blow energy of 2,500 kJ, with a maximum of four piles installed in a 24-hour period; and
- Mooring anchor pin piles – 2.0 m diameter piles, installed using a maximum blow energy of 800 kJ, with a maximum of eight piles installed in a 24-hour period.

For SEL_{cum} criteria, the soft start and ramp-up of blow energies, along with the total duration and strike rate must also be considered. The parameters used for this project are presented in Table 4-5 and Table 4-6. For the OSP foundation scenario, a maximum of four piles are expected to be installed in any 24-hour period, for the mooring anchors, up to eight piles are expected to be installed in a 24-hour period.

Table 4-5 Summary of the sort start and ramp-up scenario for the OSP foundation jacket piles used for calculating SEL_{cum} for impact piling

OSP Jacket piles	**400 kJ**	**800 kJ**	**1,200 kJ**	**1,600 kJ**	**2,000 kJ**	**2,500 kJ**
Number of strikes	200	150	150	150	150	7,350
Duration	20 mins	10 mins	10 mins	10 mins	10 mins	210 mins
Strikes per minute	10	15	15	15	15	35
8,150 strikes, 4.5 hours per pile / 32,600 strikes, 18 hours for 4 piles						

Table 4-6 Summary of the sort start and ramp-up scenario for the substructure mooring anchor pin piles used for calculating SEL_{cum} for impact piling

Mooring Anchor Pin piles	**128 kJ**	**256 kJ**	**384 kJ**	**512 kJ**	**640 kJ**	**800 kJ**
Number of strikes	98	74	74	74	74	3,607
Duration	9.8 mins	4.9 mins	4.9 mins	4.9 mins	4.9 mins	103.1 mins
Strikes per minute	10	15	15	15	15	35
4001 strikes, 2.21 hours per pile / 32,008 strikes, 17.68 hours for 8 piles						

Also considered is the length of pile in contact with the water at the start and end of the piling scenarios, as this will affect the radiating area of the pile for noise into the water. For the OSP scenario the starting pile height is 65 m above the seabed, reducing to 7 m when completely installed; for the mooring anchors scenario the starting pile height is 50 m above the seabed, reducing to 0 m when completely installed.

For impact piling, the INSPIRE model assumes that the noise source (the hammer striking the pile) acts as a single point, as it will appear at a distance. The source level is estimated based on the pile diameter and the blow energy imparted on the pile by the hammer. This is then adjusted based on the length of the pile in contact with the water, which can affect the amount of noise that is transmitted from the pile into its surroundings.

It is worth noting that the "source level" concept technically does not exist in the context of many shallow water noise sources (Heaney *et al.*, 2020). In underwater noise modelling an "apparent source level" is usually employed, which is a value that can be used to produce the correct noise levels at range (for a specific model), as required in impact assessments. The unweighted, single strike, SPL_{peak} and SEL_{ss} source levels estimated for impact piling are provided in Table 4-7. Due to the deep water considered, and that all piling will occur sub-surface, there is no difference in source level between the two pin pile mooring anchor locations.

The figures are presented in Table 4-7 are in accordance with typical requests by regulatory authorities, although as noted above, they are not necessarily compatible or comparable with any other model or predicted source levels.

Table 4-7 Summary of the maximum unweighted SPL_{peak} and SEL_{ss} source levels used for impact piling modelling

Source levels	OSP jacket piles	Mooring anchor pin piles
Unweighted SPL_{peak}	241.3 dB re 1 µPa @ 1 m	236.4 dB re 1 µPa @ 1 m
Unweighted SEL_{ss}	222.1 dB re 1 µPa^{2}s @ 1 m	216.4 dB re 1 µPa^{2}s @ 1 m

4.4 Other noise making activities

Approximate subsea noise levels have been predicted for the other proposed site activities using a modelling approach based on measured data from Subacoustech Environmental's own underwater noise measurement database or other available data, scaled to relevant parameters for the site, or where a proxy has been used to a lack of available data. The calculation of underwater noise transmission loss for non-impulsive sources is based on an empirical analysis of the noise measurements taken on transect around those sources by Subacoustech Environmental. The predictions use the following principle fitted to the measured data:

$$Recieved\ level = Source\ level\ (SL) - N \log R - \alpha\ R$$

where R is the range from the source, N is the transmission loss, and α is the absorption loss.

As described in Section 4.3.1, noise modelling requires knowledge of the source level, which is the theoretical noise level at one metre from the noise source. Predicted "apparent" source levels and propagation calculations for the construction activities are presented below with a summary of the number of datasets used in each case. These figures are presented in accordance with typical requests by regulatory authorities, although as noted above, they are not necessarily compatible or comparable with any other model or predicted source levels.

It should be noted that this modelling approach does not take bathymetry or other environmental conditions into account, and as such can be applied to any location in or around the Offshore Project site.

- Seabed fixtures – noise from drag embedment anchors for WTG mooring and suction pile installation for the OSP have been considered:
    - Drag embedment anchors
        - Source level: 171 dB re 1 µPa @ 1 m
        - Transmission loss: $19 \log R - 0.0009\ R$
        - Based on two datasets of excavator scraping noise, which is a worst-case equivalence to the noise as the drag embedment anchors should be embedded in deep mud. Vessel noise is likely to be the greatest noise source during this installation.
    - Suction pile installation
        - Source level: 192 dB re 1 µPa @ 1 m
        - Transmission loss: $19 \log R - 0.0009\ R$
        - Based on a review by Koschniski and Lüdemann (2019), which states that the noise of suction pumps used at Borkum Riffgrund 2 (an offshore wind project in the North Sea, Germany) could not be measured above background levels (137 dB) at a range of 750 m. Therefore, the estimated source level given here is highly precautionary.
- Cable installation – noise from a cable laying vessel and trenching machinery have been considered to cover the noise from cable installation:
    - Cable laying
        - Source level: 171 dB re 1 µPa @ 1 m
        - Transmission loss: $13 \log R$ (no absorption)
        - Based on 11 datasets from a pipelaying vessel measuring 300 m in length; this is considered a worst-case noise source for cable laying operations.
    - Trenching
        - Source level: 172 dB re 1 µPa @ 1 m

    - Transmission loss: $13 \log R - 0.0004\,R$
    - Based on three datasets from trenching vessels measuring more than 100 m in length.

- Seabed preparation – two types of dredging, backhoe and suction, have been modelled for seabed preparation:
  - Backhoe dredging
    - Source level: 165 dB re 1 µPa @ 1 m
    - Transmission loss: $19 \log R - 0.0009\,R$
    - Based on seven datasets of backhoe dredgers.
  - Suction dredging
    - Source level: 186 dB re 1 µPa @ 1 m
    - Transmission loss: $19 \log R - 0.0009\,R$
    - Based on five datasets from suction and cutter-suction dredgers.
- Cable protection – the noise from, and associated with, rock placement has been used to model cable protection:
  - Rock placement
    - Source level: 172 dB re 1 µPa @ 1 m
    - Transmission loss: $12 \log R - 0.0005\,R$
    - Based on four datasets from rock placement vessel "Rollingstone."
- Vessel movement – two groups of vessel noise have been considered, large and medium vessels:
  - Large vessels
    - Source level: 168 dB re 1 µPa @ 1 m
    - Transmission loss: $12 \log R - 0.0021\,R$
    - Based on five datasets of large vessels including container ships, floating production storage and offloading vessels (FPSOs) and other vessels more than 100 m in length. Vessel speed assumed as 10 knots.
  - Medium vessels
    - Source level: 161 dB re 1 µPa @ 1 m
    - Transmission loss: $12 \log R - 0.0021\,R$
    - Based on three datasets of moderate-sized vessels less than 100 m in length. Vessel speed assumed as 10 knots.

For SEL_{cum} calculations, the duration the noise is present has also been considered, with all sources assumed to be operating for a worst-case 12 hours in any given 24-hour period, apart from vessel noise which is assumed to be present for 24 hours a day.

To account for the weightings required for modelling using the Southall *et al*. (2019) criteria (section 2.2.2.1), reductions in source level have been applied to the various noises based on their frequency content. Table 4-8 presents details of the reductions in source level for each of the weighting used for modelling.

Table 4-8 Reductions in source level for the different noise sources considered for modelling when the Southall et al. (2019) weightings are applied

Noise source	Reduction in source level from the unweighted level			
	LF	HF	VHF	PCW
Drag embedment anchors	2.5 dB	7.9 dB	9.6 dB	4.2 dB
Suction pile installation	2.5 dB	7.9 dB	9.6 dB	4.2 dB
Cable laying	3.6 dB	22.9 dB	23.9 dB	13.2 dB
Trenching	4.1 dB	23.0 dB	25.0 dB	13.7 dB
Dredging	2.5 dB	7.9 dB	9.6 dB	4.2 dB
Rock placement	1.6 dB	11.9 dB	12.5 dB	8.2 dB
Vessel movement	5.5 dB	34.4 dB	38.6 dB	17.4 dB

The cable cutting and removal activity could also potentially create noise and has been considered in respect of research by Pangerc *et al* (2016). The study noted that cable cutting, specifically diamond wire cutting for the removal and termination of subsea structures, had been little studied in the past, but was noted to be a 'low noise technique' although without any clear published data to back this up. Pangerc *et al.*(2016) reported on data obtained in 2014 from cutting of a 0.76 m diameter conductor using diamond wire cutting, which took approximately 2 hours.

Underwater noise monitors were set up at 100 m, 250 m and 800 m from the activity. In this time the noise increased temporarily in some frequency bands, generally in excess of 5 kHz and up to 40 kHz, although nothing could be directly attributed to the wire cutting, with a number of other activities also occurring in the area including support vessels. No source level could be reasonably derived. In any respect, noise in any of these frequency bands at 100 m from the wire cutting did not exceed approximately 130 dB SPL_{rms} and so is significantly below any impact thresholds for continuous noise. Therefore, cable cutting will not be considered further.

4.4.1 Operational WTG noise

The main source of underwater noise from operational WTGs will be mechanically generated vibration from the rotating machinery in the turbines, which is transmitted into the sea through the structure of the turbine tower and any foundations (Nedwell *et al*., 2003; Tougaard *et al*., 2020). Noise levels generated above the water surface are low enough that no significant airborne source will pass from the air to the water.

Tougaard *et al*. (2020) published a study investigating underwater noise data from 17 operational WTGs in Europe and the United States, from 0.2 MW to 6.15 MW nominal power output. The paper identified the nominal power output and wind speed as the two primary driving factors for underwater noise generation. Although the datasets were acquired under different conditions, the authors devised a formula based on the published data for the operational wind farms, allowing a broadband noise level to be estimated based on the application of wind speed, turbine size (by nominal power output) and distance from the turbine:

$$L_{eq} = C + \alpha \log_{10}\left(\frac{distance}{100m}\right) + \beta \log_{10}\left(\frac{wind\ speed}{10\ m/s}\right) + \gamma \log_{10}\left(\frac{turbine\ size}{1\ MW}\right)$$

with C, a fixed constant, and the coefficients α, β, and γ derived from the empirical data for the 17 WTG datasets.

The turbine sizes proposed at Windfarm Site are much larger than those used for the estimation above with turbines of between 12 MW and 18 MW being considered. The Windfarm Site is also situated in greater water depths than the sites in the Tougaard *et al*. (2020) study, which would suggest that sound would attenuate more slowly for this location. However, the turbine foundations and moorings at the Windfarm Site are of a different type to those in the Tougaard *et al*. (2020) study and this is likely to make a significant difference to the noise transmitted into the water.

The noise source for most operational WTGs is the radiating area of the foundation in the water. For a monopile, this is the surface area of the cylindrical pile in the water column. Other fixed foundations such as jacket or tripod foundations are more complex. The complexities of the acoustics in large structures such as any of these make it difficult to predict their effect on the noise output (Tougaard *et al*., 2020). For modelling it has been assumed that the WTGs will be operational for 24 hours a day.

The radiating source for a floating turbine is limited to the weighted and buoyant section that rests beneath the sea surface, a significantly smaller area than a fixed turbine. With a much smaller radiating area, the noise is expected to be lower, with a reasonable assumption of equivalent sound generation within the turbine and transmission through the turbine tower. The mooring cables have been suggested as a potential additional source noise, but this is speculative[3] and if confirmed is likely to be isolated to the particular environmental conditions (e.g., water depth, currents) in which the noise was identified. However, the potential for similar cable "snaps" cannot be ruled out at the Windfarm Site. See section 4.4.2 for further information.

Little empirical data exists for the operational noise produced by floating WTGs. Tougaard *et al*. (2020) and a similar study by Stöber and Thomsen (2021) did not include any floating designs. Measurements taken by JASCO Applied Science (Martin *et al*., 2011) of the HYWIND demonstrator, West of Stavanger, Norway, showed broadband noise levels of the order of 120 dB (SPL_{RMS}) at a range of 150 m from the 2.3 MW WTG. However, much of this was found to be influenced by the ambient noise from existing shipping sources and none of the components of the noise relating to the WTG operation appeared to exceed 110 dB at the monitoring location. It is worth noting that the operational WTG noise is dominated by low frequency noise (< 100 Hz), and only differs minimally from long term background noise across all measured frequencies up to 16 kHz. It is therefore likely that even if the noise measurement at the position near the turbine was influenced by operational WTG noise, ambient noise levels will typically reach this level naturally.

Using the Tougaard *et al*. (2020) equation, an uplift of approximately 12 dB would be applied to increase the sound output from a 2.3 MW turbine to an 18 MW turbine. This would suggest an upper limit of 132 dB (SPL_{RMS}) at 150 m from the largest proposed floating turbine at the Windfarm Site. At 10 m, this would be 160 dB (SPL_{RMS}), or 136 dB (SPL_{RMS}) at 100 m. Based on the criteria from Popper *et al*. (2014) for continuous noise, the TTS threshold of 158 dB (SPL_{RMS}) would require an individual to be closer than 20 m from the WTG for a period of 12 hours, which for a source near the surface in water depths of the order of 75 m, would be very low risk. As studies have shown that fish populations have increased in the vicinity of offshore wind farms (Stenberg *et al*., 2015), there appears to be a minimal risk to fish from operational turbines.

To compare this to the relevant marine mammal impact thresholds from Southall *et al*. (2019) requires the values to be presented as SELs. For continuous-type noise, a 1-second SPL_{RMS} (as described above) is roughly equivalent to an SEL over 1-second. An SPL_{RMS} for a continuous noise will remain the same over an extended period of time, whereas an exposure metric, like SEL, will increase over the duration of the sound. As an example, at an arbitrary 100 m from an operating WTG for an hour, a receptor would receive an unweighted SEL of 172 dB re 1 µPa^2s, using the same calculation as above. With species weightings considered this is still well below any potentially injurious or TTS thresholds given by Southall *et al*. (2019), meaning that, for noise from operational WTGs, TTS risk is small.

Multiple turbines operating simultaneously will each contribute to the underwater noise within the wind farm boundary. However, as it has been shown that a receptor would need to remain very close (much less than 100 m) to a turbine over an extended period to have any risk of impact, any additive noise effect will be minimal. To give a numerical example, if the noise was 136 dB (SPL_{RMS}) at 100 m from an

[3] The marine noise report (Statoil, 2015) for the HYWIND turbine states: "These [snapping noise] transients are thought to be related to tension releases in the mooring system." It has not been confirmed that the turbine or cables are in fact the source of this noise.

operational WTG, and the nearest turbine was separated by 1 km (approximate minimum separation, actual separations vary between designs), then the predicted noise level contribution from the adjacent turbine would be 24 dB lower, which combined, would contribute less than 0.1 dB to the overall noise from the closest turbine.

4.4.2 Cable "snapping"

As well as the relatively low noise levels from the operational machinery measured from operational floating WTGs at the HYWIND site (JASCO, 2011) (section 4.4.1), the measurements also identified what appeared to be a "snapping" noise that were thought to be related to tension release in the mooring system, although this has not been verified. It is understood that the mooring cables are designed to be permanently in tension such that no line should ever go slack, even in extreme conditions; partly to avoid the risk of entanglement to marine mammals (Statoil, 2015). If the cables are the source of the noise, this will likely be caused by the specific circumstances at the HYWIND site; that is, the depth of water, length of cables in use, current and current fluctuations. The JASCO (2011) findings were isolated, and it does not necessarily follow that this will occur at the Offshore Project, but this does not rule out the potential for it either. Unless there was further evidence that other floating turbines moorings, or some other noise associated with the turbines, is shown to creating this "snap" then it may be anomaly or potentially even an artifact of the monitoring system.

According to JASCO (2011), up to 23 of these "snaps" were identified per day. Over the two months of monitoring undertaken by JASCO, less than 10 staps exceeding 160 dB (SPL_{peak}) were identified on most days.

As the source of the noise is unclear, its distance from the monitor cannot be ascertained and thus a prediction of the noise closer to the source is not possible for estimation of PTS in terms of SPL_{peak}. Subsequent analysis of the HYWIND data by Xodus (2015) predicted potential cumulative SELs of up to 157 dB re 1 μPa^{2}s over 24 hours caused by snapping chains from six turbines; the equivalent for the maximum eight turbines planned the Windfarm Site would be approximately 159 dB re 1 μPa^{2}s (SEL). This prediction makes a series of worst-case assumptions (e.g., all turbines producing the maximum number of snaps in a day, equivalent noise levels from multiple locations affecting a receptor to the same degree) and this level is below any SPL_{peak} PTS or injury criteria for marine mammals or fish.

There are no reliable noise thresholds that would be recommended to identify disturbance for rare, or intermittent, impulses of this type. As any snapping occurs at an average rate of less than one snap per hour, disturbance leading to avoidance behaviour should be considered minimal.

5 Modelling results

The following sections present the modelling outputs for the various noise sources being considered including UXO detonation (section 5.1), impact piling (section 5.2), and other noise sources, including drag embedment anchors, suction pile installation, cable laying, trenching and removal, dredging, rock placement and vessel movements (section 5.3).

5.1 UXO clearance

Table 5-1 to Table 5-4 present the impact ranges for the various UXO detonation or clearance scenarios, considering various charge weights and impact criteria. It should be noted that Popper *et al*. (2014) gives specific impact criteria for explosions (Table 2-5). A UXO detonation source is defined as a single pulse, and as such the SEL_{cum} criteria from Southall *et al*. (2019) have been given as SEL_{ss} in the tables below, and fleeing animal assumptions do not apply.

Results for the mitigated equivalent clearances are given in section 5.1.2.

5.1.1 Unmitigated clearances

Table 5-1 Summary of the PTS and TTS impact ranges for UXO detonation using the impulsive, unweighted SPL_{peak} noise criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) Unweighted SPL_{peak}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
PTS	219 dB (LF)	600 m	350 m	810 m	1.1 km	1.4 km	1.7 km	1.8 km
	230 dB (HF)	190 m	110 m	260 m	370 m	460 m	550 m	610 m
	202 dB (VHF)	3.4 km	1.9 km	4.6 km	6.4 km	8.0 km	9.6 km	11 km
	218 dB (PCW)	660 m	390 m	900 m	1.2 km	1.5 km	1.8 km	2.0 km
TTS	213 dB (LF)	1.1 km	650 m	1.5 km	2.1 km	2.6 km	3.1 km	3.4 km
	230 dB (HF)	360 m	210 m	490 m	680 m	850 m	1.0 km	1.1 km
	196 dB (VHF)	6.2 km	3.6 km	8.5 km	12 km	15 km	18 km	20 km
	212 dB (PCW)	1.2 km	720 m	1.6 km	2.3 km	2.8 km	3.4 km	3.8 km

Table 5-2 Summary of the PTS and TTS impact ranges for UXO detonation using the impulsive, weighted SEL_{ss} noise criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) Weighted SEL_{ss}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
PTS	183 dB (LF)	1.6 km	630 m	2.1 km	3.5 km	4.8 km	6.3 km	7.4 km
	185 dB (HF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
	155 dB (VHF)	450 m	200 m	560 m	800 m	980 m	1.1 km	1.2 km
	185 dB (PCW)	290 m	110 m	380 m	630 m	860 m	1.1 km	1.3 km
TTS	168 dB (LF)	23 km	8.8 km	29 km	45 km	60 km	75 km	85 km
	170 dB (HF)	110 m	<50	150 m	230 m	310 m	380 m	430 m
	140 dB (VHF)	2.1 km	1.3 km	2.4 km	2.9 km	3.2 km	3.5 km	3.7 km
	170 dB (PCW)	3.9 km	1.5 km	5.2 km	8.2 km	11 km	14 km	16 km

Table 5-3 Summary of the PTS and TTS impact ranges for UXO detonation using the non-impulsive, weighted SEL_{ss} noise criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) Weighted SEL_{ss}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
PTS	199 dB (LF)	100 m	< 50 m	120 m	210 m	290 m	380 m	440 m
	198 dB (HF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
	173 dB (VHF)	< 50 m	< 50 m	< 50 m	60 m	80 m	100 m	100 m
	201 dB (PCW)	< 50 m	< 50 m	< 50 m	< 50 m	50 m	70 m	80 m
TTS	179 dB (LF)	3.3 km	1.2 km	4.4 km	7.1 km	9.7 km	13 km	15 km
	178 dB (HF)	< 50 m	< 50 m	< 50 m	70 m	90 m	110 m	130 m
	153 dB (VHF)	590 m	280 m	730 m	1.0 km	1.2 km	1.4 km	1.5 km
	181 dB (PCW)	590 m	220 m	780 m	1.2 km	1.7 km	2.2 km	2.6 km

Table 5-4 Summary of the impact ranges for UXO detonation using the unweighted SPL_{peak} explosion noise criteria from Popper et al. (2014) for species of fish

Popper *et al.* (2014) Unweighted SPL_{peak}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
Mortality & potential mortal injury	234 dB	130 m	80 m	170 m	240 m	300 m	370 m	410 m
	229 dB	210 m	120 m	290 m	410 m	510 m	610 m	680 m

5.1.2 UXO clearance (with bubble curtain mitigation)

Table 5-5 Summary of the PTS and TTS impact ranges for mitigated UXO detonation using the impulsive, unweighted SPL_{peak} noise criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) Unweighted SPL_{peak}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
PTS	219 dB (LF)	210 m	120 m	290 m	410 m	510 m	610 m	680 m
	230 dB (HF)	80 m	< 50 m	100 m	130 m	160 m	200 m	220 m
	202 dB (VHF)	1.2 km	720 m	1.6 km	2.3 km	2.8 km	3.4 km	3.8 km
	218 dB (PCW)	240 m	140 m	320 m	450 m	560 m	680 m	750 m
TTS	213 dB (LF)	400 m	230 m	540 m	760 m	940 m	1.1 km	1.2 km
	230 dB (HF)	130 m	80 m	170 m	240 m	300 m	370 m	410 m
	196 dB (VHF)	2.2 km	1.3 km	3.0 km	4.2 km	5.3 km	6.4 km	7.1 km
	212 dB (PCW)	440 m	260 m	600 m	840 m	1.0 km	1.2 km	1.3 km

Table 5-6 Summary of the PTS and TTS impact ranges for mitigated UXO detonation using the impulsive, weighted SEL_{ss} noise criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) Weighted SEL_{ss}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
PTS	183 dB (LF)	280 m	100 m	370 m	610 m	840 m	1.1 km	1.2 km
	185 dB (HF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
	155 dB (VHF)	100 m	< 50 m	120 m	200 m	260 m	330 m	370 m
	185 dB (PCW)	< 50 m	< 50 m	70 m	100 m	140 m	190 m	220 m
TTS	168 dB (LF)	3.9 km	1.5 km	5.2 km	8.4 km	12 km	15 km	18 km
	170 dB (HF)	< 50 m	< 50 m	< 50 m	< 50 m	70 m	80 m	100 m
	140 dB (VHF)	860 m	430 m	1.0 km	1.3 km	1.6 km	1.8 km	1.9 km
	170 dB (PCW)	700 m	270 m	930 m	1.5 km	2.0 km	2.6 km	3.1 km

Table 5-7 Summary of the PTS and TTS impact ranges for mitigated UXO detonation using the non-impulsive, weighted SEL_{ss} noise criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) Weighted SEL_{ss}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
PTS	199 dB (LF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	70 m	80 m
	198 dB (HF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
	173 dB (VHF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
	201 dB (PCW)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
TTS	179 dB (LF)	570 m	220 m	760 m	1.2 km	1.7 km	2.2 km	2.5 km
	178 dB (HF)	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m	< 50 m
	153 dB (VHF)	130 m	60 m	170 m	270 m	350 m	440 m	490 m
	181 dB (PCW)	100 m	< 50 m	130 m	210 m	300 m	390 m	450 m

Table 5-8 Summary of the impact ranges for mitigated UXO detonation using the unweighted SPL_{peak} explosion noise criteria from Popper et al. (2014) for species of fish

Popper *et al.* (2014) Unweighted SPL_{peak}		**Low yield**	**Low order**	**25 kg**	**67.8 kg**	**130 kg**	**227 kg**	**309 kg**
Mortality & potential mortal injury	234 dB	< 50 m	< 50 m	70 m	90 m	110 m	130 m	140 m
	229 dB	80 m	< 50 m	100 m	140 m	180 m	220 m	240 m

5.2 Impact piling

The results in this section present the modelling impact ranges for the impact piling scenarios detailed in section 4.3.1 and calculated using the INSPIRE model. For the results in this section, predicted ranges smaller than 50 m and areas less than 0.01 km^2 for single strike criteria, and ranges smaller than 100 m and areas less than 0.1 km^2 for cumulative criteria have not been presented. This close to the noise source, the modelling processes are unable to calculate a sufficient level of accuracy due to the complexity of the acoustic effects near the pile.

Table 5-9 to Table 5-26 present the results of the impact piling modelling split into the three modelling locations. The results cover the Southall *et al*. (2019) and Lucke *et al*. (2009) criteria for marine mammals, and the Popper *et al*. (2014) criteria and Hawkins *et al*. (2014) observed levels for fish, as covered in section 2.2.2. The impact ranges contours for the results shown below have been provided as GIS shapefiles.

For marine mammals, considering the Southall *et al*. (2019) criteria, the largest ranges are predicted for LF cetaceans at the SE, OSP location with maximum predicted PTS ranges of up to 12 km; maximum PTS ranges of up to 6.0 km are predicted for mooring piles at the SW location for LF cetaceans. Smaller ranges are predicted for VHF cetaceans and phocid carnivores in water (PCW); minimal ranges are predicted for HF cetaceans.

With regards to fish and the Popper *et al*. (2014) criteria, the largest impact ranges are predicted for the OSP foundation scenario at the SE location, with maximum recoverable injury (203 dB SEL_{cum}) ranges of up to 14 km for stationary receptors, these ranges reduce to less than 100 m for a fleeing receptor. TTS ranges (186 dB SEL_{cum}) are expected to be up to 51 km for stationary receptors and 24 km for fleeing receptors. Smaller ranges are predicted for the mooring pile scenarios

5.2.1 SE (OSP)

Table 5-9 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the unweighted SPL_{peak} impulsive criteria from Southall et al. (2019) for marine mammals

Southall *et al*. (2019) *Unweighted SPL_{peak}*		Area	Maximum range	Minimum range	Mean range
PTS	LF (219 dB)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	HF (230 dB)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	VHF (202 dB)	1.0 km^2	570 m	570 m	570 m
	PCW (218 dB)	0.01 km^2	< 50 m	< 50 m	< 50 m
TTS	LF (213 dB)	0.03 km^2	100 m	100 m	100 m
	HF (224 dB)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	VHF (196 dB)	6.5 km^2	1.4 km	1.4 km	1.4 km
	PCW (212 dB)	0.04 km^2	120 m	120 m	120 m

Table 5-10 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the weighted SEL_{cum} impulsive criteria from Southall et al. (2019) for marine mammals assuming a fleeing animal

Southall *et al*. (2019) *Weighted SEL_{cum}*		Area	Maximum range	Minimum range	Mean range
PTS (Fleeing)	LF (183 dB)	310 km^2	12 km	8.4 km	9.8 km
	HF (185 dB)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	VHF (155 dB)	55 km^2	4.6 km	3.9 km	4.2 km
	PCW (185 dB)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
TTS (Fleeing)	LF (168 dB)	5400 km^2	54 km	27 km	41 km
	HF (170 dB)	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	VHF (140 dB)	3000 km^2	37 km	25 km	31 km
	PCW (170 dB)	600 km^2	16 km	12 km	14 km

Table 5-11 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the unweighted criteria from Lucke et al. (2019) for harbour porpoise

Lucke *et al.* (2009)		Area	Maximum range	Minimum range	Mean range
Unweighted $SPL_{peak-to-peak}$	199.7 dB	13 km^2	2.0 km	2.0 km	2.0 km
	173 dB	3000 km^2	34 km	29 km	31 km
Unweighted SEL_{ss}	164.3 dB	250 km^2	9.0 km	8.9 km	9.0 km
	145 dB	5700 km^2	47 km	38 km	43 km

Table 5-12 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the unweighted SPL_{peak} pile driving criteria from Popper et al. (2014) for species of fish

Popper *et al.* (2014) *Unweighted SPL_{peak}*	Area	Maximum range	Minimum range	Mean range
213 dB	0.03 km^2	100 m	100 m	100 m
207 dB	0.21 km^2	260 m	260 m	260 m

Table 5-13 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the unweighted SEL_{cum} pile driving criteria from Popper et al. (2014) for species of fish assuming both fleeing and stationary animals

Popper *et al.* (2014) *Unweighted SEL_{cum}*		Area	Maximum range	Minimum range	Mean range
Fleeing	219 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	216 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	210 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	207 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	203 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	186 dB	1400 km^2	24 km	18 km	21 km
Stationary	219 dB	8.4 km^2	1.7 km	1.6 km	1.6 km
	216 dB	21 km^2	2.6 km	2.6 km	2.6 km
	210 dB	110 km^2	6.0 km	5.9 km	5.9 km
	207 dB	230 km^2	8.6 km	8.5 km	8.5 km
	203 dB	550 km^2	14 km	13 km	13 km
	186 dB	6500 km^2	51 km	39 km	46 km

Table 5-14 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the observed levels from Hawkins et al. (2014)

Hawkins *et al.* (2014)		Area	Maximum range	Minimum range	Mean range
Unweighted SPL_{peak}	173 dB	1400 km^2	22 km	20 km	21 km
	168 dB	2700 km^2	32 km	28 km	29 km
Unweighted $SPL_{peak-to-peak}$	163 dB	8000 km^2	58 km	41 km	50 km
Unweighted SEL_{ss}	142 dB	7700 km^2	56 km	41 km	50 km
	135 dB	14000 km^2	81 km	44 km	66 km

5.2.2 NW (Mooring)

Table 5-15 Summary of the impact ranges for impact piling modelling at the NW (mooring) location using the unweighted SPL_{peak} impulsive criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) *Unweighted SPL_{peak}*		Area	Maximum range	Minimum range	Mean range
PTS	LF (219 dB)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	HF (230 dB)	< 0.01 km^2	< 50 m	< 50 m	< 50 m
	VHF (202 dB)	0.21 km^2	260 m	260 m	260 m

Southall *et al.* (2019) *Unweighted SPLpeak*		Area	Maximum range	Minimum range	Mean range
	PCW (218 dB)	< 0.01 km²	< 50 m	< 50 m	< 50 m
TTS	LF (213 dB)	0.01 km²	< 50 m	< 50 m	< 50 m
	HF (224 dB)	< 0.01 km²	< 50 m	< 50 m	< 50 m
	VHF (196 dB)	1.4 km²	670 m	670 m	670 m
	PCW (212 dB)	0.01 km²	50 m	50 m	50 m

Table 5-16 Summary of the impact ranges for impact piling modelling at the NW (mooring) location using the weighted SEL_{cum} impulsive criteria from Southall et al. (2019) for marine mammals assuming a fleeing animal

Southall *et al.* (2019) *Weighted SELcum*		Area	Maximum range	Minimum range	Mean range
PTS (Fleeing)	LF (183 dB)	86 km²	5.9 km	4.8 km	5.2 km
	HF (185 dB)	< 0.1 km²	< 100 m	< 100 m	< 100 m
	VHF (155 dB)	11 km²	2.1 km	1.8 km	1.9 km
	PCW (185 dB)	< 0.1 km²	< 100 m	< 100 m	< 100 m
TTS (Fleeing)	LF (168 dB)	3700 km²	40 km	28 km	34 km
	HF (170 dB)	< 0.1 km²	< 100 m	< 100 m	< 100 m
	VHF (140 dB)	1800 km²	27 km	21 km	24 km
	PCW (170 dB)	280 km²	10 km	8.8 km	9.5 km

Table 5-17 Summary of the impact ranges for impact piling modelling at the NW (mooring) location using the unweighted criteria from Lucke et al. (2009) for harbour porpoise

Lucke *et al.* (2009)		Area	Maximum range	Minimum range	Mean range
Unweighted SPLpeak-to-peak	199.7 dB	3.0 km²	980 m	970 m	980 m
	173 dB	1600 km²	24 km	22 km	23 km
Unweighted SELss	164.3 dB	59 km²	4.4 km	4.3 km	4.3 km
	145 dB	3000 km²	33 km	29 km	31 km

Table 5-18 Summary of the impact ranges for impact piling modelling at the NW (mooring) location using the unweighted SPL_{peak} pile driving criteria from Popper et al. (2014) for species of fish

Popper *et al.* (2014) *Unweighted SPLpeak*	Area	Maximum range	Minimum range	Mean range
213 dB	0.01 km²	50 m	50 m	50 m
207 dB	0.04 km²	120 m	120 m	120 m

Table 5-19 Summary of the impact ranges for impact piling modelling at the NW (mooring) location using the unweighted SEL_{cum} pile driving criteria from Popper et al. (2014) for species of fish assuming both fleeing and stationary animals

Popper *et al.* (2014) *Unweighted SELcum*		Area	Maximum range	Minimum range	Mean range
Fleeing	219 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	216 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	210 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	207 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	203 dB	< 0.1 km²	< 100 m	< 100 m	< 100 m
	186 dB	380 km²	12 km	10 km	11 km
Stationary	219 dB	1.2 km²	630 m	600 m	610 m
	216 dB	2.9 km²	980 m	950 m	960 m
	210 dB	17 km²	2.4 km	2.4 km	2.4 km
	207 dB	41 km²	3.7 km	3.6 km	3.6 km
	203 dB	120 km²	6.3 km	6.2 km	6.2 km

Popper *et al.* (2014) *Unweighted SEL_{cum}*		Area	Maximum range	Minimum range	Mean range
	186 dB	3200 km²	34 km	30 km	32 km

Table 5-20 Summary of the impact ranges for impact piling modelling at the NW (mooring) location using the observed levels from Hawkins et al. (2014)

Hawkins *et al.* (2014)		Area	Maximum range	Minimum range	Mean range
Unweighted SPL_{peak}	173 dB	600 km²	14 km	14 km	14 km
	168 dB	1400 km²	22 km	20 km	21 km
Unweighted $SPL_{peak\text{-}to\text{-}peak}$	163 dB	54 km²	45 km	37 km	41 km
Unweighted SEL_{ss}	142 dB	4400 km²	40 km	34 km	37 km
	135 dB	9100 km²	61 km	45 km	54 km

5.2.3 SW (Mooring)

Table 5-21 Summary of the impact ranges for impact piling modelling at the SW (mooring) location using the unweighted SPL_{peak} impulsive criteria from Southall et al. (2019) for marine mammals

Southall *et al.* (2019) *Unweighted SPL_{peak}*		Area	Maximum range	Minimum range	Mean range
PTS	LF (219 dB)	< 0.01 km²	< 50 m	< 50 m	< 50 m
	HF (230 dB)	< 0.01 km²	< 50 m	< 50 m	< 50 m
	VHF (202 dB)	0.21 km²	260 m	260 m	260 m
	PCW (218 dB)	< 0.01 km²	< 50 m	< 50 m	< 50 m
TTS	LF (213 dB)	0.01 km²	< 50 m	< 50 m	< 50 m
	HF (224 dB)	< 0.01 km²	< 50 m	< 50 m	< 50 m
	VHF (196 dB)	1.4 km²	680 m	670 m	680 m
	PCW (212 dB)	0.01 km²	50 m	50 m	50 m

Table 5-22 Summary of the impact ranges for impact piling modelling at the SW (mooring) location using the weighted SEL_{cum} impulsive criteria from Southall et al. (2019) for marine mammals assuming a fleeing animal

Southall *et al.* (2019) *Weighted SEL_{cum}*		Area	Maximum range	Minimum range	Mean range
PTS (Fleeing)	LF (183 dB)	90 km²	6.0 km	5.0 km	5.3 km
	HF (185 dB)	< 0.1 km²	< 100 m	< 100 m	< 100 m
	VHF (155 dB)	12 km²	2.1 km	1.9 km	2.0 km
	PCW (185 dB)	< 0.1 km²	< 100 m	< 100 m	< 100 m
TTS (Fleeing)	LF (168 dB)	3700 km²	41 km	28 km	34 km
	HF (170 dB)	< 0.1 km²	< 100 m	< 100 m	< 100 m
	VHF (140 dB)	1800 km²	27 km	22 km	24 km
	PCW (170 dB)	290 km²	10 km	9.1 km	9.6 km

Table 5-23 Summary of the impact ranges for impact piling modelling at the SW (mooring) location using the unweighted criteria from Lucke et al. (2009) for harbour porpoise

Lucke *et al.* (2009)		Area	Maximum range	Minimum range	Mean range
Unweighted $SPL_{peak\text{-}to\text{-}peak}$	199.7 dB	3.0 km²	980 m	970 m	980 m
	173 dB	1600 km²	24 km	22 km	23 km
Unweighted SEL_{ss}	164.3 dB	59 km²	4.4 km	4.4 km	4.4 km
	145 dB	3000 km²	33 km	30 km	31 km

Table 5-24 Summary of the impact ranges for impact piling modelling at the SW (mooring) location using the unweighted SPL_{peak} pile driving criteria from Popper et al. (2014) for species of fish

Popper *et al*. (2014) *Unweighted SPL_{peak}*	**Area**	**Maximum range**	**Minimum range**	**Mean range**
213 dB	0.01 km^2	< 50 m	< 50 m	< 50 m
207 dB	0.04 km^2	120 m	120 m	120 m

Table 5-25 Summary of the impact ranges for impact piling modelling at the SW (mooring) location using the unweighted SEL_{cum} pile driving criteria from Popper et al. (2014) for species of fish assuming both fleeing and stationary animals

Popper *et al*. (2014) *Unweighted SEL_{cum}*		**Area**	**Maximum range**	**Minimum range**	**Mean range**
Fleeing	219 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	216 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	210 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	207 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	203 dB	< 0.1 km^2	< 100 m	< 100 m	< 100 m
	186 dB	390 km^2	12 km	11 km	11 km
Stationary	219 dB	1.2 km^2	630 m	600 m	610 m
	216 dB	2.9 km^2	980 m	950 m	960 m
	210 dB	18 km^2	2.4 km	2.4 km	2.4 km
	207 dB	42 km^2	3.7 km	3.7 km	3.7 km
	203 dB	120 km^2	6.3 km	6.3 km	6.3 km
	186 dB	3200 km^2	34 km	30 km	32 km

Table 5-26 Summary of the impact ranges for impact piling modelling at the SE (OSP) location using the observed levels from Hawkins et al. (2014)

Hawkins *et al*. (2014)		**Area**	**Maximum range**	**Minimum range**	**Mean range**
Unweighted SPL_{peak}	173 dB	610 km^2	14 km	14 km	14 km
	168 dB	1400 km^2	22 km	21 km	21 km
Unweighted $SPL_{peak\text{-}to\text{-}peak}$	163 dB	5300 km^2	45 km	38 km	41 km
Unweighted SEL_{ss}	142 dB	4400 km^2	41 km	35 km	37 km
	135 dB	9000 km^2	62 km	45 km	54 km

5.3 Other noise making activities

Table 5-27 to Table 5-31 summarise the predicted impact ranges for the noise sources covered in section 4.4. It is worth noting that Southall *et al*. (2019) and Popper *et al*. (2014) give different criteria for non-impulsive or continuous noise sources compared to impulsive noise (as used for UXO clearance and impact piling); all sources in this section are considered non-pulse or continuous. The Lucke *et al*. (2009) criteria and the Hawkins *et al*. (2014) observed levels have not been included as they only consider impulsive sources.

The modelling is presented as an unweighted SPL_{RMS} level against range plot in Figure 5-1.

Given the modelled impact ranges, any marine mammal would have to be closer than 10 m from the continuous noise source at the start of the activity in order to acquire the necessary exposure to induce PTS as per Southall *et al*. (2019) considering a fleeing animal. For a stationary animal the largest predicted PTS range is 820 m for VHF cetaceans and suction pile installation noise. For these criteria, this would only mean that the receptor reaches the 'onset' stage at these ranges, which is the minimum exposure that could potentially lead to the start of an effect and may only be marginal. In most hearing groups, the noise levels are low enough that there is a minimal risk.

For fish, there is a low risk of any injury or TTS with reference to the SPL_{RMS} guidance for continuous noise sources in Popper *et al*. (2014).

For operational WTGs, injury risk is minimal. Increase in wind speed would not lead to significant increases in the impact ranges.

Table 5-27 Summary of the impact ranges for the different noise sources using the non-impulsive PTS criteria from Southall et al. (2019) for marine mammals assuming a fleeing receptor

Southall *et al.* (2019)	**PTS (Fleeing)**			
Weighted SEL_{cum}	**LF** (199 dB)	**HF** (198 dB)	**VHF** (173 dB)	**PCW** (201 dB)
Drag embedment anchors	< 10 m	< 10 m	< 10 m	< 10 m
Suction pile installation	< 10 m	< 10 m	< 10 m	< 10 m
Cable laying	< 10 m	< 10 m	< 10 m	< 10 m
Trenching	< 10 m	< 10 m	< 10 m	< 10 m
Backhoe dredging	< 10 m	< 10 m	< 10 m	< 10 m
Suction dredging	< 10 m	< 10 m	< 10 m	< 10 m
Rock placement	< 10 m	< 10 m	< 10 m	< 10 m
Vessel movement (large)	< 10 m	< 10 m	< 10 m	< 10 m
Vessel movement (medium)	< 10 m	< 10 m	< 10 m	< 10 m
Operational WTG (12 MW)	< 10 m	< 10 m	< 10 m	< 10 m
Operational WTG (18 MW)	< 10 m	< 10 m	< 10 m	< 10 m

Table 5-28 Summary of the impact ranges for the different noise sources using the non-impulsive TTS criteria from Southall et al. (2019) for marine mammals assuming a fleeing receptor

Southall *et al.* (2019)	**TTS (Fleeing)**			
Weighted SEL_{cum}	**LF** (179 dB)	**HF** (178 dB)	**VHF** (153 dB)	**PCW** (181 dB)
Drag embedment anchors	< 10 m	< 10 m	< 10 m	< 10 m
Suction pile installation	< 10 m	< 10 m	780 m	< 10 m
Cable laying	< 10 m	< 10 m	< 10 m	< 10 m
Trenching	< 10 m	< 10 m	< 10 m	< 10 m
Backhoe dredging	< 10 m	< 10 m	< 10 m	< 10 m
Suction dredging	< 10 m	< 10 m	230 m	< 10 m
Rock placement	< 10 m	< 10 m	990 m	< 10 m
Vessel movement (large)	< 10 m	< 10 m	< 10 m	< 10 m
Vessel movement (medium)	< 10 m	< 10 m	< 10 m	< 10 m
Operational WTG (12 MW)	< 10 m	< 10 m	< 10 m	< 10 m
Operational WTG (18 MW)	< 10 m	< 10 m	< 10 m	< 10 m

Table 5-29 Summary of the impact ranges for the different noise sources using the non-impulsive PTS criteria from Southall et al. (2019) for marine mammals assuming a stationary receptor

Southall *et al.* (2019)	**PTS (Stationary)**			
Weighted SEL_{cum}	**LF** (199 dB)	**HF** (198 dB)	**VHF** (173 dB)	**PCW** (201 dB)
Drag embedment anchors	< 10 m	< 10 m	70 m	< 10 m
Suction pile installation	90 m	50 m	820 m	60 m
Cable laying	10 m	< 10 m	40 m	< 10 m
Trenching	20 m	< 10 m	40 m	< 10 m
Backhoe dredging	< 10 m	< 10 m	< 10 m	< 10 m
Suction dredging	40 m	30 m	400 m	30 m
Rock placement	30 m	< 10 m	530 m	< 10 m
Vessel movement (large)	10 m	< 10 m	< 10 m	< 10 m
Vessel movement (medium)	< 10 m	< 10 m	< 10 m	< 10 m
Operational WTG (12 MW)	< 10 m	< 10 m	< 10 m	< 10 m
Operational WTG (18 MW)	< 10 m	< 10 m	< 10 m	< 10 m

Table 5-30 Summary of the impact ranges for the different noise sources using the non-impulsive TTS criteria from Southall et al. (2019) for marine mammals assuming a stationary receptor

Southall *et al.* (2019) Weighted SELcum	**TTS (Stationary)**			
	LF (179 dB)	**HF** (178 dB)	**VHF** (153 dB)	**PCW** (181 dB)
Drag embedment anchors	60 m	70 m	690 m	20 m
Suction pile installation	930 m	570 m	5.6 km	610 m
Cable laying	480 m	20 m	1.3 km	60 m
Trenching	500 m	20 m	1.2 km	< 10 m
Backhoe dredging	20 m	20 m	30 m	< 10 m
Suction dredging	460 m	280 m	3.3 km	300 m
Rock placement	1.3 km	230 m	9.9 km	270 m
Vessel movement (large)	480 m	< 10 m	140 m	40 m
Vessel movement (medium)	130 m	< 10 m	30 m	< 10 m
Operational WTG (12 MW)	10 m	< 10 m	20 m	< 10 m
Operational WTG (18 MW)	20 m	< 10 m	30 m	< 10 m

Table 5-31 Summary of the impact ranges for the different noise sources using the shipping and continuous noise criteria from Popper et al. (2014) for species of fish (swim bladder involved in hearing)

Popper *et al.* (2014) Unweighted SELRMS	**Recoverable injury** 170 dB (48 hours)	**TTS** 158 dB (12 hours)
Drag embedment anchors	< 10 m	< 10 m
Suction pile installation	20 m	60 m
Cable laying	< 10 m	10 m
Trenching	< 10 m	10 m
Backhoe dredging	< 10 m	< 10 m
Suction dredging	< 10 m	30 m
Rock placement	< 10 m	20 m
Vessel movement (large)	< 10 m	< 10 m
Vessel movement (medium)	< 10 m	< 10 m
Operational WTG (12 MW)	< 10 m	< 10 m
Operational WTG (18 MW)	< 10 m	< 10 m

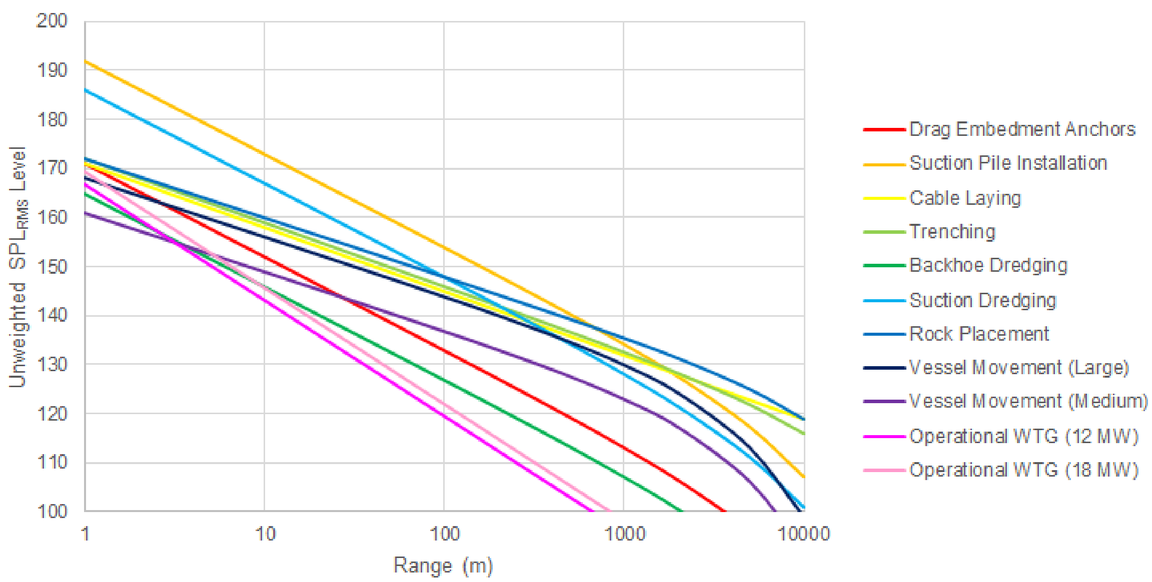

Figure 5-1 Level vs Range plot showing the predicted levels for each of the considered noise sources

Taking this, and all the results from the previous sections, into account it is clear that noise from impact piling and UXO clearance results in much greater noise levels and impact ranges, and hence should be considered the activity which has the potential to have the greatest effect during the construction and lifecycle of the Offshore Project.

6 Summary and conclusions

As part of the Environmental Impact Assessment (EIA) process for the Offshore Project, Subacoustech Environmental have undertaken underwater noise modelling and analysis in relation to marine fauna. The primary activities considered are associated with the ground preparation and installation of the turbines and their associated infrastructure.

UXO clearance, including high-order, low-order, and low-yield, have been considered at the Offshore Project, and for the expected UXO detonation noise, there is a risk of PTS up to 7.4 km for the largest UXO considered, a 309.4 kg device (TNT equivalent charge weight) using the Southall *et al*. (2019) criteria for VHF cetaceans. However, this is likely to be very precautionary as the impact range is based on worst-case criteria that do not account for any smoothing of the pulse over long ranges, which reduces the pulse peak and other characteristics of the sound that increase the risk of injury. If other clearance techniques, or bubble curtains are utilised, these impact ranges are expected to be greatly reduced.

Impact piling may be used to secure the WTG moorings and the OSP foundations. Impact ranges have been modelled at two locations assuming either 4 m diameter piles for OSP foundations or 2 m diameter piles for WTG moorings based on maximum blow energies of 2,500 and 800 kJ respectively. For marine mammals, maximum SEL_{cum} PTS ranges of up to 12 km were predicted for LF cetaceans for the OSP foundation scenario, with ranges for the mooring anchor scenarios of up to 6 km for the same criteria. For fish, maximum SEL_{cum} recoverable injury ranges of up to 14 km were predicted for stationary receptors, reducing to less than 100 m for fleeing receptors when considering the OSP foundation scenario.

The noise from the other proposed activities has been considered using a high-level, simple modelling approach, including drag embedment anchor and suction pile installation, cable installation, cable cutting and removal, ground preparation and protection, vessel movements and operational WTG noise. The predicted noise levels for these noise sources show that the risk of any potentially injurious effects to fish or marine mammals from these sources are expected to be minimal when considering a fleeing animal, as opposed to the animal remaining stationary, as the noise emissions from these are close to, or below, the appropriate injury criteria even when very close to the source of the noise. When considering a stationary receptor, PTS impact ranges increase to a maximum of 820 m for VHF cetaceans for noise from suction pile installation. However, it should be noted that assumptions associated with the suction installation methodology make these ranges highly precautionary.

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WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 12.B: Marine Mammal and Marine Turtle Cumulative Effects Assessment Report

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Glossary of Acronyms

Acronym	Definition
ADDs	Acoustic Deterrent Devices
Defra	Department for Environment, Food and Rural Affairs
EIA	Environmental Impact Assessment
EPS	European Protect Species
ES	Environmental Statement
EU	European Union
GIS	Geographical Information System
ha	Hectare
HRA	Habitats Regulation Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
IEMA	Institute of Environmental Management and Assessment
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservancy Council
km	Kilometre
Km^2	Square kilometre
m	Metre
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MPS	Marine Policy Statement
MSFD	Marine Strategy Framework Directive
MU	Management Units
MW	Megawatts
NAS	Noise Abatement Systems
NE	Natural England
nm	Nautical Mile
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OWL	Offshore Wind Ltd
PINS	Planning Inspectorate
PTS	Permanent Threshold Shift
RIAA	Report to Inform an Appropriate Assessment
SAC	Special Area of Conservation
SAR	Search and Rescue
SCANS-III	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SELss	Sound Exposure Level for a single strike
SLVIA	Seascape, Landscape and Visual Impact Assessment

Acronym	Definition
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
TTS	Temporary Threshold Shift
UK	United Kingdom
UKHO	UK Hydrographic Office
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

Glossary of Terminology

Defined Term	Description
Applicant	Offshore Wind Limited
Cumulative effects	The effect of the Project taken together with similar effects from a number of different projects, on the same single receptor/resource. Cumulative effects are those that result from changes caused by other past, present or reasonably foreseeable actions together with the Project.
Project Design Envelope	A description of the range of possible elements that make up the Project design options under consideration. The Project Design Envelope, or 'Rochdale Envelope' is used to define the Project for Environmental Impact Assessment (EIA) purposes when the exact parameters are not yet known but a bounded range of parameters are known for each key project aspect.
Development Area	The area comprising the Onshore Development Area and the Offshore Development Area
Environmental Impact Assessment (EIA)	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning.
Export Cable Corridor	The area in which the export cables will be laid, either from the Offshore Substation or the inter-array cable junction box (if no offshore substation), to the WPD Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor.
Floating substructure	The floating substructure acts as a stable and buoyant foundation for the WTG. The WTG is connected to the substructure via the transition piece and the substructure is kept in position by the mooring system.
Generation Assets	The infrastructure of the Project related to the generation of electricity within the windfarm site, including wind turbine generators, substructures, mooring lines, seabed anchors and inter-array cables
High Voltage Alternating Current	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
In-combination effects	In-combination effects are those effects that may arise from the development proposed in combination with other plans and projects proposed/consented but not yet built and operational.
Inter-array cables	Cables which link the wind turbines to each other and the Offshore Substation Platform, or at the inter-array cables junction box (if no offshore substation). Array cables will connect the wind turbines to one and other and to the Offshore Substation (if utilised). The intial section fo the inter-array cables will be freely suspended in the water column below the substructure (dynamic sections) while the on seabed sections of the cables will be buried where possible.
Landfall	Where the offshore export cables come ashore

Defined Term	Description
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean sea level	The average tidal height over a long period of time.
Mooring system	The equipment (mooring lines and seabed anchors) that keeps the floating substructure in position during operation through a fixed connection to the seabed.
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by OWL as the EIA process progresses.
Offshore Development Area	The Windfarm Site (including wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and Offshore Export Cable Corridor to MHWS at the Landfall. This encompasses the part of the project that is the focus of this application and Environmental Statement and the parts of the project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009
Offshore Export Cables	The cables which bring electricity from the Offshore Substation Platform or the inter-array cables junction box to the Landfall
Offshore Export Cable Corridor	The proposed offshore area in which the export cables will be laid, from Offshore Substation Platform or the inter-array cable junction box to the Landfall
Offshore Infrastructure	All of the offshore infrastructure including wind turbine generators, substructures, mooring lines, seabed anchors, Offshore Substation Platform and all cable types (export and inter-array). This encompasses the infrastructure that is the focus of this application and Environmental Statement and the parts of the project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009

Defined Term	Description
Offshore Substation Platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore
Offshore Transmission Assets	The aspects of the project related to the transmission of electricity from the generation assets including the Offshore Substation Platform (as applicable)) or offshore junction box, Offshore Cable Corridor to MHWS at the landfall
Offshore Transmission Owner	An OFTO, appointed in UK by Ofgem (Office of Gas and Electricity Markets), has ownership and responsibility for the transmission assets of an offshore windfarm.
Onshore Export Cable Corridor	The proposed onshore area in which the export cables will be laid, from MLWS at the Landfall to the White Cross Onshore Substation and onward to the WPD grid connection at East Yelland
Onshore Infrastructure	The combined name for all infrastructure associated with the Project from MLWS at the Landfall to the WPD grid connection point at East Yelland. The onshore infrastructure will form part of a separate Planning application to the Local Planning Authority (LPA) under the Town and Country Planning Act 1990
Project	The Project for the offshore Section 36 and Marine Licence application includes all elements offshore of MHWS. This includes the infrastructure within the windfarm site (e.g. wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and all infrastructure associated with the export cable route and landfall (up to MHWS) including the cables and associated cable protection (if required).
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water
Transition bay	Underground structures at the Landfall that house the joints between the offshore export cables and the onshore export cables
White Cross Offshore Windfarm	100MW capacity offshore windfarm including associated onshore and offshore infrastructure
Wind Turbine Generators (WTG)	The wind turbine generators convert wind energy into electrical power. Key components include the rotor blades, naccelle (housing for electrical generator and other electrical and control equipment) and tower. The final selection of project wind turbine model will be made post-consent application
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present
Works completion date	Date at which construction works are deemed to be complete and the windfarm is handed to the operations team. In reality, this may take place over a period of time.

1 Appendix 12.B: Marine Mammal and Marine Turtle Cumulative Effect Assessment Report

1.1 Process of Cumulative Effects Assessment Screening

1. The Cumulative Effect Assessment (CEA) screening is a two-part process in which an initial list of potential projects is identified with the potential to interact with the Offshore Project. This is based on the mechanism of interaction and spatial extent of the reference population for each marine mammal or marine turtle species. Following a tiered approach, the list of projects is then refined based on the level of information available for this list of projects to enable further assessment.

2. The plans and projects screened into the CEA are:

   - Projects and plans within the agreed reference population boundary for the given receptor
   - Offshore projects and developments, if there is the potential for cumulative effects during the construction, operation and maintenance, or decommissioning of the proposed projects
   - Offshore windfarm (OWF) developments, if the construction and/or piling period could overlap with the proposed construction and/or piling period of the projects, based on best available information on when the developments are likely to be constructed and piling.

3. The CEA will consider projects, plans and activities which have sufficient information available to undertake the assessment. Insufficient information will preclude a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances.

4. Given the fast-moving nature of offshore development, it is likely that new projects relevant to the assessment will arise throughout the pre-application period. In order to finalise an assessment, it will be necessary to have a cut-off period after which no more projects will be included.

5. For the marine mammal and marine turtle assessment, the different stages of project development, especially for other offshore windfarm projects have been taken into account within the CEA.

6. The types of plans and projects to be taken into consideration are:

   - Other OWFs
   - Other marine renewables (wave and tidal) developments
   - Geophysical surveys
   - Aggregate extraction and dredging

- Licenced disposal sites
- Construction of sub-sea cables and pipelines
- Oil and gas development and decommissioning, including seismic surveys
- Other offshore industries, including gas storage, offshore mines, and carbon capture projects
- Construction of coastal developments, including ports, harbours, and coastal defence schemes
- UXO clearance.

7. Commercial fishing activity and shipping and navigation are not considered in the CEA.

8. A wide range of data sources and information was used for the CEA and CEA screening, including, but not limited to:

- White Cross Offshore Windfarm Environmental Statement (ES)
- Developer websites
- 4C Offshore Winds Database (http://www.4coffshore.com/offshorewind/)
- Renewable UK website (http://www.renewableuk.com)
- Crown Estate website
- Oil and gas UK licensing rounds website (https://www.gov.uk/guidance/oil-and-gas-licensing-rounds#past-licensing-rounds)
- Oil and gas environmental submissions and determinations (https://www.gov.uk/guidance/oil-and-gas-environmental-data)
- Cefas (Centre for Environment, Fisheries and Aquaculture Science) website (e.g. http://data.cefas.co.uk/#/View/407)
- Planning Inspectorate National Infrastructure Planning website
- The Marine Management Organisation (MMO) public register
- European Marine Observation and Data Network (EMODnet) data.

1.1.1 Screening Area Considered in the CEA

9. The study area for marine mammals and marine turtles has been defined on the basis that marine mammals or marine turtles are highly mobile and transitory in nature. It is, therefore, necessary to examine species occurrence not only within the Offshore Project area, but also over a wider area.

10. The key species and therefore the focus of the assessments are:

- Harbour porpoise, *Phocoena phocoena*
    - Present throughout the year, although there may be variations in seasonal occurrence
- Bottlenose dolphin, *Tursiops truncates*

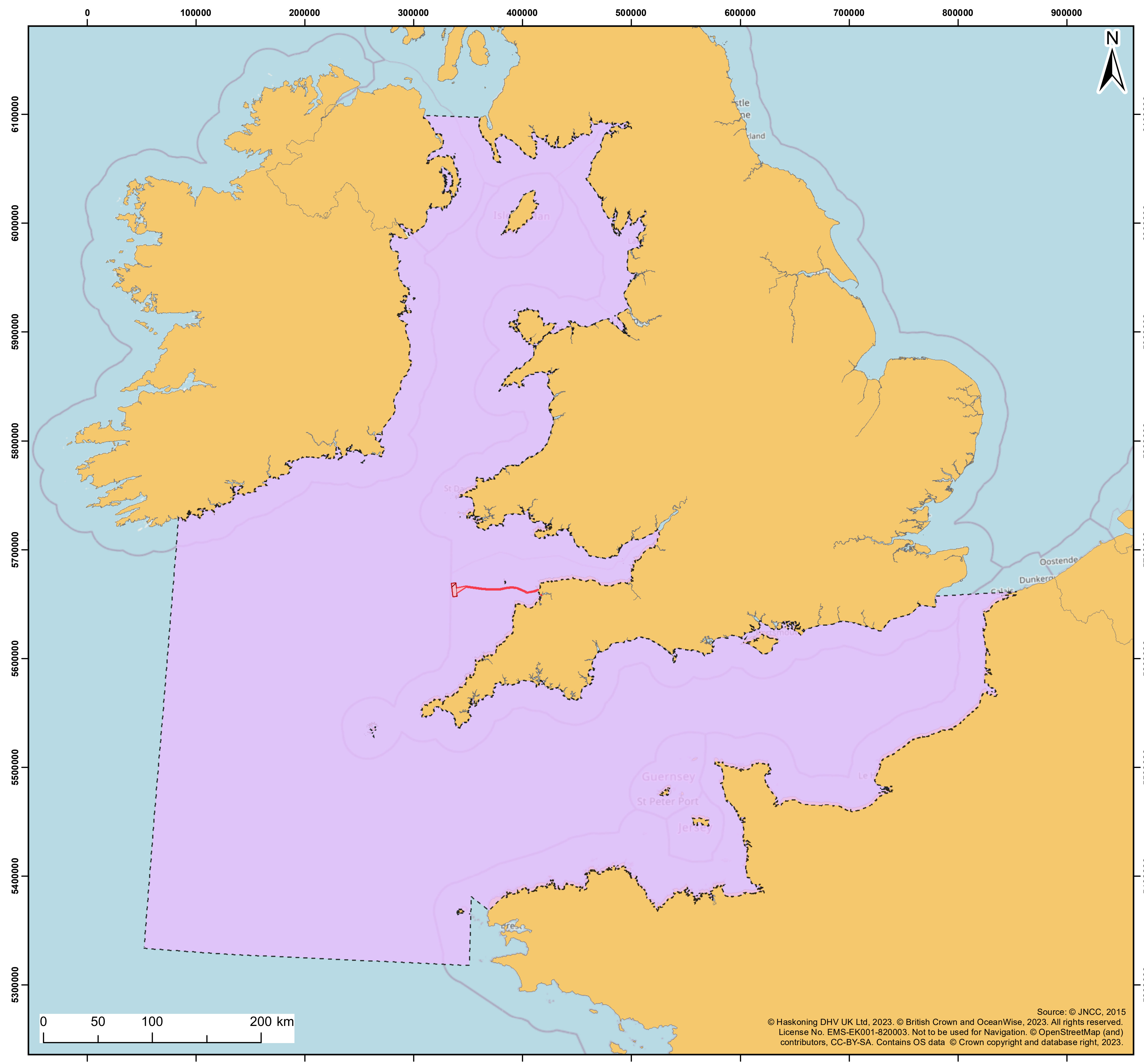
    - Historically not common in the area, with limited data. However, with a recent increase in sightings along the coast, the species has been included on a precautionary basis

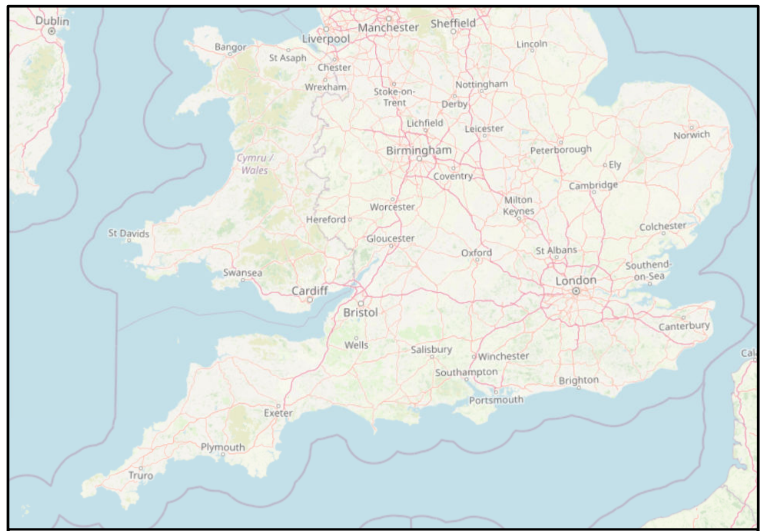
- Striped dolphin, *Stenella coeruleoalba*
    - Seasonal occurrence in low numbers
- Common dolphin, *Delphinus delphis*
    - Present throughout the year, although there may be variations in seasonal occurrence
- Minke whale, *Balaenoptera acutorostrata*
    - Seasonal occurrence in low numbers
- Grey seal, *Halichoerus grypus*
    - Present throughout the year
- Leatherback turtle, *Dermochelys coriacea*
    - Seasonal occurrence in low numbers.

11. For the marine mammal and marine turtle species in the assessments, the following study areas have been defined, based on the relevant Management Units (MUs) (Inter-Agency Marine Mammal Working Group (IAMMWG), 2022) and current knowledge and understanding of the biology of each species (see **Chapter 12: Marine Mammal and Marine Turtle Ecology**):

- Harbour porpoise – Celtic and Irish Sea (CIS) MU
- Bottlenose dolphin – Offshore Channel and Southwest England (OCSW) MU
- Common dolphin – Celtic and Greater North Seas (CGNS) MU
- Striped dolphin – SCANS-III aerial survey area (in absence of available population estimates)
- Minke whale – CGNS MU
- Grey seal – Southwest England and Wales MU, and Republic of Ireland (RoI) estimates combined.
- Leatherback turtle – no reference population

12. The area used for the CEA screening for projects is based on a reduced area of the Celtic and Irish Sea (CIS) MU (**Figure 1.1**) which is more representative of the predicted effects from the Offshore Project.





Legend:

- Windfarm Site
- Offshore Development Area
- Cumulatative Effect Assessment Study Area

Client:	Project:
Offshore Wind Ltd.	White Cross Offshore Windfarm

Title:

Cumulative Effects Assessment Screening Area

Figure: 1.1 | Drawing No: PC2978-RHD-ZZ-XX-DR-Z-0476

Revision:	Date:	Drawn:	Checked:	Size:	Scale:
P02	03/03/2023	AB	LA	A3	1:3,500,000
P01	19/01/2023	AB	LA	A3	1:3,500,000

Co-ordinate system: WGS 1984 UTM Zone 30N

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1.2 Identification of potential cumulative effects

13. The first step in the CEA is the identification of the effects assessed for the Offshore Project that have the potential for a cumulative effect with other plans, projects and activities (described as 'effect screening'). Only potential effects assessed as greater than negligible are considered in the CEA (i.e., those assessed as 'negligible' are not taken forward as there is no potential for them to contribute to a cumulative effect).

14. Initially the potential for cumulative effects were considered for:

- The risk of permanent change in hearing sensitivity (Permanent Threshold Shift (PTS)) from underwater noise
- The risk of temporary change in hearing sensitivity (Temporary Threshold Shift (TSS)) from underwater noise
- Disturbance from underwater noise
- Barrier effects due to OWFs
- Vessel collision risk
- Disturbance at seal haul-out sites
- Changes to water quality
- Changes to prey availability.

1.2.1 Permanent auditory injury due to underwater noise

15. PTS could occur as a result of pile driving during OWF installation, pile driving during oil and gas platform installation, underwater explosives (used occasionally during the removal of underwater structures and unexploded ordnance (UXO) clearance) and seismic surveys (JNCC, 2010a, 2010b). However, if there is the potential for PTS from any project, suitable mitigation would be put in place to reduce any risk to marine mammals and marine turtles. Other activities such as dredging, drilling, rock placement, vessel activity, operational OWFs, oil and gas installations or wave and tidal sites will emit broadband noise in lower frequencies, therefore PTS from these activities is very unlikely.

16. Therefore, the potential risk of PTS in marine mammals and marine turtles from cumulative effects has been **screened out** from further consideration in the CEA.

1.2.2 Screening of Temporary auditory injury and disturbance from underwater noise

17. Disturbance is likely to have greater effect ranges and areas than Temporary Threshold Shift (TTS), and the risk of TTS will be within disturbance ranges for marine mammals and marine turtles. The effects of either TTS or disturbance in

marine mammals and marine turtles are temporary. Where there is little information on the potential disturbance ranges for marine mammals and marine turtles, TTS has been used to indicate possible fleeing response.

18. Therefore, the potential risk of TTS in marine mammals and marine turtles from cumulative effects will be considered alongside that of disturbance from underwater noise, and the highest known potential effect ranges (of either TTS or disturbance) will be used to the inform the cumulative assessment.

19. The potential for disturbance to marine mammals and marine turtles from underwater noise has been **screened in** to the CEA. Where there are no known disturbance ranges for a particular effect or marine mammal and marine turtle species, the potential for TTS has been considered.

1.2.3 Screening of Barrier effects due to disturbance from offshore wind

20. The potential for a barrier effect to marine mammals and marine turtles, due to the cumulative underwater noise of multiple OWFs, has been **screened in** to the CEA.

1.2.4 Screening of Underwater Noise and Increase of Collision Risk due to Shipping and Navigation

21. Shipping is considered to part of the baseline environment. All shipping has been **screened out** from further consideration in the CEA.

1.2.5 Screening of Vessel collision risk

22. The potential for an increase in vessel collision risk, due to an increase in vessels across cumulative projects, has been **screened in** to the CEA.

1.2.6 Screening of Disturbance at seal haul-out sites

23. The potential for disturbance at seal haul-out sites has been **screened in** to the CEA.

1.2.7 Screening of Changes to water quality

24. No significant effects with regard to water quality are expected as a result of the Offshore Project (**Section 12.7.12** and **Section 12.8.11** of **Chapter 12: Marine Mammal and Marine Turtle Ecology**).

25. Aggregate and dredging projects have the potential for increased sediment suspension (and therefore effects to marine mammal and marine turtle species), however any changes to water quality as a result of aggregate extraction and dredging would be very localised and temporary. Therefore, no potential for

cumulative effect on marine mammal and marine turtle populations as a result of changes to water quality.

26. Therefore, changes to water quality (including from aggregate extraction and dredging) have been **screened out** from further consideration in the CEA.

1.2.8 Screening of Changes to prey availability

27. The potential for changes to prey availability has been **screened in** to the CEA.

1.3 Stages of plans and projects considered in the CEA

28. For this assessment, the Tiers used for assessment are based on guidance issued by the Joint Nature and Conservation Committee (JNCC) and Natural England in September 2013, and are presented in **Table 1.1**.

29. These Tiers are used as they are more appropriate to use compared to the Tiers in The Planning Inspectorate (2019) Advice Note 17 for the types of projects and plans considered in this assessment, in particular for the offshore windfarm (OWF) stages.

30. Any plans or projects that have the potential for a construction / commissioning (Tier 1 or 2) cumulative effect that commenced between the end of the baseline surveys in July 2020 to June 2022, and submission in March 2023 of the ES will not be taken forward in the CEA for this type of cumulative impact. It is assumed that construction / commissioning of those projects would be completed before the start of the Project's construction phase.

31. All Tier 1 projects are considered to be part of the existing baseline environment if operational prior to the start of the baseline surveys for the Project in July 2020.

32. The CEA screening is based on the widest possible range of offshore construction dates for the Offshore Project, of between 2025 and 2027. This is based upon the earliest possible offshore construction in Q2 2025, planned operational date of Q3 2027, and an expected 16-month offshore construction window.

33. The second step in the CEA screening is the identification of the plans and projects that may result in cumulative effects for inclusion in the CEA (described as 'project screening').

34. The types of plans and projects included in the CEA, and the approach to screening, are based on the current stage of the plan or project within the planning and development process, stages are grouped into tiers as seen in **Table 1.1**. This approach allows for the different levels of 'uncertainty' to be taken into account in

the CEA, as well as the quality of the data available (as outlined in **Section 12.10** of **Chapter 12: Marine Mammal and Marine Turtle Ecology**).

Table 1.1 Tier descriptions for use within the CEA

Project Stage	Relevance for CEA Screening	Types of Projects Screened for Project Stage
Tier 1: Built and operational projects	All built and operational projects are considered to be part of the existing baseline environment if operational prior to the start of the baseline surveys in July 2020.	United Kingdom (UK) and European (EU) projects: • Other OWFs • Marine Renewable Energy (MRE) developments (wave and tidal) UK projects only: • Aggregate extraction and dredging • Licensed disposal sites • Oil and gas development, operation and decommissioning, including seismic surveys • Planned construction of sub-sea cables and pipelines • Gas Storage • Offshore Mining • Carbon Capture Storage (CCS) activities • Unexploded ordnance (UXO) clearance
Tier 2: Projects under construction	Projects under construction are likely to be commissioned prior to the construction of the Project, and therefore there is no potential for any overlap in the construction of these projects with the construction and piling of the Project.	
Tier 3: Projects that have been consented (but construction has not yet commenced)	Relevant marine infrastructure projects which have been consented, but for which construction has not yet commenced. Therefore, there is more certainty that these projects will be constructed compared to projects for which an application has not yet been determined. For these OWFs, there is also more information on when construction is likely to be undertaken and an assessment of the potential effects during construction activities have been provided in the project Environmental Statements (ESs), which allows quantified assessment of the potential effects of these projects in the CEA. However, there is still significant uncertainty associated with these projects, for example, in terms of the scale of the final development that will be constructed, construction programme dates and the likely final effects. In particular, OWFs aim to get consent for a maximum design scenario, based on the worst-case parameters, and then these	

Project Stage	Relevance for CEA Screening	Types of Projects Screened for Project Stage
	parameters are generally refined and reduced prior to construction. OWFs could have possible cumulative construction effects.	
Tier 4: Projects that have an application submitted to the appropriate regulatory body that have not yet been determined	Relevant marine infrastructure projects which have an application submitted to the appropriate regulatory body but that have not yet been determined, or projects that are consented but currently on hold due to judicial challenge or appeal process. There is increased uncertainty about these projects, especially where the projects are currently on-hold, as to when or if they could be constructed and what changes could be made to the scale of the developments. OWFs could have possible cumulative construction effects.	UK and EU projects: • Other OWFs UK projects only: • MRE developments (wave and tidal) • Oil and gas development, operation and decommissioning, including seismic surveys • Planned construction of sub-sea cables and pipelines • Gas Storage • Offshore Mining • CCS activities
Tier 5: Projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects)	Relevant marine infrastructure projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects). For these projects, there is a lot of uncertainty and not enough information to allow a robust assessment. However, as a very precautionary approach, the OWFs that we are currently aware of have been considered in the CEA. OWFs could have possible cumulative construction effects.	UK and EU projects: • Other OWFs UK projects only: • MRE developments (wave and tidal) • Oil and gas development, operation and decommissioning, including seismic surveys • Planned construction of sub-sea cables and pipelines • Gas Storage • Offshore Mining • CCS activities
Tier 6: Projects that have been identified in	Projects that have been identified within strategic development plans or future development (e.g. those sites	None screened in.

Project Stage	Relevance for CEA Screening	Types of Projects Screened for Project Stage
relevant strategic plans or programmes	identified in early stages of the ScotWind process). For these projects, there is a lot of uncertainty and no information to allow a robust assessment, and there is no certainty as to whether these projects would be developed further, or when. Therefore, no projects that have been identified as a Tier 6 project have been included.	

1.4 Screening out of Certain Industries and Activities

1.4.1 Screening out of Underwater Noise from Operational Offshore Wind Turbines

35. The noise levels associated with operational OWFs is relatively low, with recorded levels of between 141 and 146 dB re 1µPs-m (RMS SPL) at four UK OWFs (MMO, 2015; Cheesman *et al*., 2016), and levels of 106 and 126 dB re 1µPa-m (RMS SPL) at three operational OWFs in Sweden and Denmark, which could not be audible for harbour porpoise at a distance of 70m from the wind turbine location (Tougaard *et al*., 2009).

36. It has also been predicted that within a few hundred metres of a wind turbine, noise would be comparable to background noise levels (MMO, 2015). Due to the low noise levels associated with operational OWFs, the Department for Business, Energy & Industrial Strategy (BEIS) (2020) Review of Consents (RoC) Habitats Regulation Assessment (HRA) for the Southern North Sea Special Area of Conservation (SAC), concluded that there would be no potential for significant impact from the operation of OWFs, alongside the construction of OWFs (BEIS, 2020).

37. Therefore, under the assumption a similar conclusion could be drawn from for the CIS area as for the North Sea (as described above from BEIS (2020)), and the Environmental Impact Assessment (EIA) which concluded the significance of effect to be **minor adverse** (not significant) within **Chapter 12: Marine Mammal and Marine Turtle Ecology**. Operational OWFs are **screened out** from further consideration within the CEA screening.

38. The potential for cumulative effects from operational wind turbines at the Offshore Project with other projects and activities has also been **screened out** from further consideration within the CEA screening.

1.4.2 Screening out of Underwater Noise from the Maintenance Activities Associated with OWFs

39. Maintenance activities at OWFs, such as additional rock placement or cable re-burial, will be very localised, short in duration and temporary.

40. The potential for cumulative effects from maintenance activities, including vessels at OWFs would be less than the cumulative effects assessed for construction activities other than piling (for further information, see **Appendix 12.A: Marine Mammal and Marine Turtle Underwater Noise Report**).

41. Therefore, maintenance of OWFs is **screened out** from further consideration within the CEA screening.

1.4.3 Screening out of Underwater Noise from the Decommissioning Activities of with Offshore Windfarms

42. There is currently no information on any OWFs that could be decommissioned during the construction of the Offshore Project. Therefore, decommissioning of OWFs is **screened out** from further consideration within the CEA screening.

43. The potential for cumulative effects during the decommissioning of the Offshore Project are currently unknown. The potential effects for the decommissioning of the Offshore Project including CEA will be assessed prior to any decommissioning activities being undertaken. Therefore, the decommissioning of the Offshore Project has also been **screened out** from further consideration within this CEA screening.

1.4.4 Screening of out Commercial Fishing

44. Commercial fisheries are **screened out** of the CEA, as it is an ongoing activity that is considered to be part of the baseline environment. Further detail on the reasoning for this scoping decision has been provided below.

45. Commercial fisheries within the CIS and underwater noise associated with fishing vessels, have the potential to cause a cumulative impact on marine mammals, through both the direct impact of by-catch and the indirect impact through the loss of marine mammal prey species (from commercial fisheries) and the disturbance from underwater noise (from vessel presence). This will not be the same for marine turtles, which predominately prey on jellyfish.

46. By-catch as a result of commercial fisheries is recognised as a historic and continuing cause of harbour porpoise mortality in the CIS and will therefore be a factor in shaping the size of the current CIS MU population. The available prey resource for harbour porpoise has also been influenced by historic and continuing commercial fishing. Noise from vessels are also considered to be part of the baseline conditions.

47. This approach is in accordance with the Planning Inspectorate (2019) Advice Note 17 Cumulative Effects Assessment, which states that:

> *"Where other projects are expected to be completed before construction of the proposed NSIP and the effects of those projects are fully determined, effects arising from them should be considered as part of the baseline".*

48. As an example, the potential for cumulative effects associated with commercial fisheries within the Southern North Sea SAC site has been considered in the RoC HRA (BEIS), 2020). With regard to effects to habitats, the RoC HRA states:

> *"18.120 There have been no quantified assessments undertaken on the extent impacts from commercial fishing may have within the SAC and therefore information to inform this assessment is not available.*

18.122 Without knowing the extent of impact on the seabed arising from the fishing industry …it is not possible to undertake an in-combination assessment that addresses all the potential impacts on the habitats within the SAC.”

49. With regard to direct effects on harbour porpoise, the RoC HRA (BEIS, 2020) also states that:

“18.203 Commercial fishing has occurred within the SAC for many years and has had, and will continue to have, direct and indirect impacts on harbour porpoise, their habitat and prey within the SAC. As the conservation status of harbour porpoise in UK waters and the SAC is considered favourable (Joint Nature Conservation Committee (JNCC), 2019; JNCC and Natural England, 2019) current and historical levels of fishing in the SAC are not considered to have affected the conservation status of the species.

18.210 There are no known plans to suggest that the level of fishing within the SAC will significantly increase over the period the consented windfarms are planned to be constructed, such that, it is predicted that the current level of impacts from fishing on harbour porpoise within the SAC will not increase.”

50. Natural England’s Deadline 4 Response to the Examining Authority’s Further Written Questions and Requests for information for Hornsea Project 3 (15th January 2019) (page 46, Q 2.2.73) was that:

“Where there is ongoing fishing activity in the site, it is important that the impacts of the activity are captured within the assessment in the context of the conservation objectives of the affected designated site(s). This assessment will likely take place as part of the baseline characterisation of the development area, however, as fishing activity is mobile, variable, and subject to change, there may be instances whereby fishing impacts are not adequately captured in the baseline characterisation and therefore may need to be considered as part of the in-combination assessment. This could be due to a change in effort; change in management; or a change in legislation amongst other things, and fishery managers (i.e. Marine Management Organisation (MMO)) would be best placed to advise on this.

In relation to the assessment of impacts on the SNS SAC, Natural England……. are not currently aware of anything that would have significantly altered the levels of fishing activity within the site; any current plans for new fisheries, or changes to existing fisheries that have not been captured, but we would look to fisheries managers to advise more definitively on these points.”

51. This, along with the RoC HRA (BEIS, 2020), suggests that by-catch has not affected a population considered to be in Favourable Conservation Status (FCS), whilst Natural England acknowledge that there is currently no evidence to suggest that the current levels of fishing would significantly alter in the future.

52. Therefore, the potential effects from commercial fishing (including by-catch and loss of prey species) and from the underwater noise associated with vessels are considered to be a part of the environmental baseline for marine mammals of

the CIS, including for harbour porpoise, and are **screened out** of further assessment.

1.5 CEA Screening for Marine Mammals and Marine Turtles

1.5.1 Screening of Other Offshore Windfarms

53. UK based projects were considered for potential construction cumulative effects, if the construction phases could overlap with the construction phase of the Offshore Project, and sufficient information and certainty in project programmes allowed for a meaningful assessment. In addition, projects for which the applications are currently in preparation have also been considered, where this is sufficient information to inform an assessment.

54. Where possible, known dates of OWF construction are used to assess whether there is the potential for construction periods to overlap with the Offshore Project. Where construction dates of OWFs are not known, as a precautionary approach and to allow for any delays and changes in schedule, the potential for overlap with the proposed construction of the Offshore Project is based on a seven year window in which construction could commence (although most projects have a five year consent window). For UK projects where the application has been submitted, the possible construction windows were based on the best available information.

55. The initial screening process resulted in a list of 96 OWF projects within the relevant screening areas for harbour porpoise, bottlenose dolphin, striped dolphin, common dolphin, minke whale, grey seal and leatherback turtle. The results of this initial screening for UK OWFs are presented in **Table 1.2**.

56. OWFs were considered part of the baseline if they were operational at the time of the start of the site-specific surveys (June 2020). There were 12 operational UK OWF projects and one operational Irish OWF projects that have been **screened out** at this stage.

57. Out of the UK OWF projects that are consented, or currently under construction phase to overlap with construction of the Offshore Project:

    - Erebus Floating OWF.
        - Only the Marine Licence is confirmed at this stage.

58. There are a total of 42 OWF projects in early development, with no submitted planning application. Of these, seven UK OWF projects and four Irish OWF projects are Tier 5 projects which have submitted scoping reports to regulators:

    - Codling OWF
    - Inis Ealga Floating OWF

- Llŷr 1 Floating OWF
- Llŷr 2 Floating OWF
- Mona OWF
- Morgan OWF
- Morgan and Morecambe Transmission Assets
- Morecambe OWF
- North Irish Sea Array OWF[1]
- Shelmalere OWF
- Twinhub.

59. Of those OWFs with the potential for construction phase overlaps, ten have the potential for an overlap in piling windows (of 2026 - 2027):

- Awel y Môr OWF
- Codling OWF
- Mona OWF
- Morgan OWF
- Morgan and Morecambe Transmission Assets
- Morecambe
- Celtic Sea Array
- Dubin Array
- North Celtic Sea
- South Irish Sea.

60. Of the OWFs, five projects have the potential for the operational phase to overlap with construction of the Offshore Project, as listed below:

- Erebus Floating OWF
- Llŷr 1 Floating OWF
- Llŷr 2 Floating OWF
- Clogherhead
- Dublin Array.

61. Of the Tier 2 projects there are three with construction phase which overlap with construction of the Offshore Project but are outwith the piling window:

- Inis Ealga Floating OWF
- Shelmalere OWF
- Morecambe.

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[1] Dates currently available have been deemed unrealistic within the current Irish consenting process but the project has been assessed on the current information

Table 1.2 CEA Screening for all UK Offshore Windfarm Projects within the Relevant Spatial Area for Each Species and Potential to Overlap with the Offshore Project Construction (2026-2028) (HP = harbour porpoise, BND = bottlenose dolphin, CGNS = Celtic and Greater North Sea

Name of Project	Country	Status	Project stage	HP - CIS	BND - IS	CGNS	Seal - MU 12	Seal - MU 13	Seal - MU 14	Seal RoI	Foundation Piling window	Construction window	Date operational	Potential for overlap of OWF construction with the Offshore Project construction?
Calvados	France	Under construction	2	N	N	Y	Y	N	N	N	2022-2024	2022-2024	2024	N
Fecamp	France	Under construction	2	N	N	Y	Y	N	N	N	2022	2022-2023	2023	N
Saint-Brieuc	France	Under construction	2	Y	N	Y	Y	N	N	N	2022-2023	2022-2023	2023	N
Dieppe - Le Treport	France	Consent authorised	3	N	N	Y	Y	N	N	N	2025-2026	2025-2026	2026	Y
Arklow Bank Phase 1	Ireland	Operational	1	Y	Y	N	Y	N	N	Y	N/A		2004	N
Arklow Bank Phase 2	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	2027-??	2028	Y
Banba Wind	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Blackwater	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	Floating	2028-??	2030	N
Bore Array	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Celtic Horizon	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Celtic Offshore Renewable Energy	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Celtic One	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Celtic Sea Array	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Floating	2030-??	Unknown	N
Celtic Two	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Floating	Unknown	Unknown	N
Clogherhead	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Codling	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	2026 - 2028	2026 - 2028	2028	Y
Cork Offshore Wind	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Dublin	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Dublin Array	Ireland	Scoping reports submitted applications	5	Y	Y	N	Y	N	N	Y	2025-2027	2025-2027	2027	Y
Dylan Extension	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
East Celtic	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Emerald	Ireland	Scoping submitted	5	Y	N	Y	Y	N	N	Y	Floating	2037-??	2038	N
Emerald (demonstration)	Ireland	Scoping submitted	5	Y	N	Y	Y	N	N	Y	Floating	2030-??	Unknown	N
Greystones	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Helvick Head	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	2028-??	2028-??	Unknown	N
Inis Ealga	Ireland	Scoping reports submitted applications	5	Y	N	Y	Y	N	N	Y	Floating	2035-??	Unknown	N
Inis Offshore Wind Kinsale	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Inis Offshore Wind Leinster	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Inis Offshore Wind Wicklow	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Kilmichael Point	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Latitude 52	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N

Name of Project	Country	Status	Project stage	HP - CIS	BND - IS	CGNS	Seal - MU 12	Seal - MU 13	Seal - MU 14	Seal RoI	Foundation Piling window	Construction window	Date operational	Potential for overlap of OWF construction with the Offshore Project construction?
Lir Offshore Array	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Loch Garman	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Mac Lir Offshore Wind	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	2030	N
North Celtic Sea	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
North Irish Sea Array	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	2026-??	2026-??	Unknown	Y
Oriel	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Pearla	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Sea Stacks	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Setanta Wind Park	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	2029-2030	2029-2030	2030	N
Shelmalere	Ireland	Scping reports submitted applications	5	Y	Y	N	Y	N	N	Y	2029-??	2029-??	2030	N
South Irish Sea	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	2026-2029	2026-2029	2029	Y
Sunrise Wind	Ireland	Concept/Early Planning	5	Y	Y	N	Y	N	N	Y	Unknown	Unknown	Unknown	N
Tulca Offshore Array	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Voyage Offshore Array	Ireland	Concept/Early Planning	5	Y	N	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Wexford	Ireland	Concept/Early Planning	5	Y	Y	Y	Y	N	N	Y	Unknown	Unknown	Unknown	N
Barrow	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	Unknown	2006	N
Burbo Bank	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	Unknown	2007	N
Burbo Bank Extension	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	Unknown	2017	N
Gwynt y Môr	UK	Operational	1	Y	Y	N	Y	N	Y	N	N/A	N/A	2015	N
North Hoyle	UK	Operational	1	Y	Y	N	Y	N	Y	N	N/A	N/A	2004	N
Ormonde	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	N/A	2012	N
Rampion	UK	Operational	1	N	N	Y	Y	N	N	N	Unknown	N/A	2018	N
Rhyl Flats	UK	Operational	1	Y	Y	N	Y	N	Y	N	N/A	N/A	2009	N
Robin Rigg	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	N/A	2010	N
Walney Extension	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	N/A	2018	N
Walney Phase 1	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	N/A	2011	N
Walney Phase 2	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	N/A	2012	N
West of Duddon Sands	UK	Operational	1	Y	Y	N	Y	N	N	N	N/A	N/A	2014	N
Awel y Môr Offshore Windfarm	UK	Consent Application Submitted	4	Y	Y	N	Y	N	Y	N	2027-2029	2027-2029	2030	Y
Erebus	UK	Consent Application Submitted	4	Y	N	Y	Y	N	Y	N	Floating	2026-2027	2027	Y
Aurora	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Floating	Unknown	Unknown	N
Celtic Deep phase 1	UK	Concept/Early Planning	5	Y	N	Y	Y	N	Y	N	Floating	Unknown	2030	N
Celtic Deep phase 2	UK	Concept/Early Planning	5	Y	N	Y	Y	N	Y	N	Floating	Unknown	2030	N
Celtic Sea A	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	Y	N	Unknown	Unknown	Unknown	N
Celtic Sea B	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N
Celtic Sea C	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N
Celtic Sea D	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N

Name of Project	Country	Status	Project stage	HP - CIS	BND - IS	CGNS	Seal - MU 12	Seal - MU 13	Seal - MU 14	Seal RoI	Foundation Piling window	Construction window	Date operational	Potential for overlap of OWF construction with the Offshore Project construction?
Celtic Sea E	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N
Celtic Sea Ocean Winds	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Floating	Unknown	2031	N
Celtic Sea Phase 2	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N
Draig y Môr	UK	Concept/Early Planning	5	Y	Y	N	Y	N	Y	N	Floating	Unknown	2030	N
Dylan	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	Y	N	Floating	2028-??	Unknown	N
Erebus commercial	UK	Concept/Early Planning	5	Y	N	Y	Y	N	Y	Y	Floating	2030-??	2032	N
Gwynt Glas	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	Y	N	Floating	2029-??	2032	N
Isle of Man	UK	Scoping reports submitted	5	Y	Y	N	Y	N	N	N	Unknown	Unknown	Unknown	N
Llŷr 1	UK	Scoping reports submitted	5	Y	N	Y	Y	Y	Y	N	Floating	Unknown	2026	N
Llŷr 2	UK	Scoping reports submitted	5	Y	N	Y	Y	Y	Y	N	Floating	Unknown	2026	N
Llywelyn	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Floating	2029-??	2029	N
Merlin	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Floating	Unknown	Unknown	N
Merlin 2	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N
Mona	UK	Scoping reports submitted	5	Y	Y	N	Y	N	Y	N	Unknown	Unknown	2028	N
Morecambe	UK	Scping reports submitted applications	5	Y	Y	N	Y	N	N	N	2026-2028	2026-2028	2028	Y
Morgan	UK	Scoping reports submitted	5	Y	Y	N	Y	N	Y	N	Unknown	Unknown	2030	N
Morwind	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	N
Nomadic Offshore Wind	UK	Concept/Early Planning	5	Y	N	N	Y	Y	N	N	Floating	Unknown	2030	N
North Channel Wind 1	UK	Concept/Early Planning	5	Y	Y	N	Y	N	N	N	Floating	2027-2030	2030	Y
North Channel Wind 2	UK	Concept/Early Planning	5	Y	Y	N	Y	N	N	N	Floating	2027-2029	2029	Y
Olympic Wind	UK	Concept/Early Planning	5	Y	Y	N	Y	N	N	N	Unknown	Unknown	Unknown	Unknown
Pembrokeshire Demonstration Zone	UK	Concept/Early Planning	5	Y	N	Y	Y	N	Y	N	Unknown	Unknown	Unknown	Unknown
Petroc	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Floating	Unknown	Unknown	Unknown
Rampion 2	UK	Concept/Early Planning	5	N	N	Y	Y	N	N	N	Unknown	Unknown	Unknown	Unknown
Trivane Demonstrator	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	N	N	Unknown	Unknown	Unknown	Unknown
TwinHub	UK	Scoping reports submitted	5	Y	N	Y	Y	Y	N	N	Floating	2024	2025	N
Valorous	UK	Concept/Early Planning	5	Y	N	Y	Y	Y	Y	N	Floating	2028-2029	2029	N
White Cross	UK	Scoping reports submitted applications	5	Y	N	Y	Y	Y	N	N	Floating	Unknown	2027	Unknown

1.5.2 Screening of Marine Renewable (Wave and Tidal) Projects

62. Both UK and EU MRE projects (e.g. wave and tidal) are considered in the CEA screening, however, no EU MRE projects have been included due to a lack of information.

63. The installation of wave/tidal projects is typically using drilled pins or gravity bases. Percussive piling is not anticipated to be used as an installation method and therefore the noise effects during construction will have a very limited impact range, especially compared to offshore windfarms.

64. The construction of wave or tidal developments is highly unlikely to significantly contribute to the cumulative effects of the disturbance of marine mammals and marine turtles from underwater noise sources. However, any projects with the potential for overlapping construction windows with that of the Offshore Project will be screened in for assessment within the CEA.

65. The operation and maintenance of wave and tidal projects are also highly unlikely to contribute to the cumulative effects of the disturbance of marine mammals and marine turtles from underwater noise sources and therefore have not been included in the CEA.

66. UK based projects were considered for potential construction, operational cumulative effects, if those phases could overlap with the proposed construction of the Offshore Project, and sufficient information was available to determine this. Where no information was known on the potential construction phases of the other renewable energy projects, it was assumed that all projects currently operational, under construction, or consented would have completed construction prior to the construction of the Offshore Project. It was also assumed that all operational MRE projects are considered to be part of the existing baseline environment. The results of the screening are in **Table 1.3**.

67. All currently operational MRE projects have been operational since the start of the baseline surveys for the Project (June 2020) and are therefore **screened out** from further consideration in the CEA.

68. A total of 13 projects were considered for the CEA, six of which are cancelled or inactive projects and have been screen out of further assessment. Of the remaining projects nine of which have the potential operational cumulative effects to overlap with the proposed construction of the Offshore Project. The remaining two MRE projects have unknown construction windows and are all in early development, therefore there is no certainty in the programmes of any construction activities, and have therefore all been **screened out** of further assessment due to a lack of information (**Table 1.3**).

Table 1.3 CEA Screening for UK Wave and Tidal Projects within the Relevant Spatial Areas and Potential to Overlap with the Offshore Project Construction (2026-2028) (HP = harbour porpoise, BND = bottlenose dolphin, CGNS = Celtic and Greater North Seas,

Name of Project	Type of project	Status	Status date	Project Status	HP - CIS	BD - IS	CG NS	Seal - 12	Seal - 13	Seal - 14
Holyhead Deep	Tidal	Operational	Jul-05	1	Y	Y	Y	Y	N	N
Wave site agreements: Falmouth Bay Test Site	Wave	Operational	Jan-11	1	Y	N	Y	N	N	N
META	Wave	Consented	Dec-20	3	Y	N	Y	Y	N	N
Morlais	Tidal	Consented	Dec-21	3	Y	Y	Y	Y	N	N
Perpetuus Tidal Energy Centre	Tidal	Consented	2025 start	3	N	N	Y	N	N	N
Pembrokeshire Demonstrator Zone	Wave	Scoping reports submitted		5	Y	N	Y	Y	N	N
Blue Eden Tidal Lagoon	Tidal	In planning	Oct-21	5	Y	N	Y	Y	N	N
Cardiff Tidal Lagoon	Tidal	Cancelled	Dec-20	6	Y	N	Y	Y	N	N
Duddon Estuary Tidal Lagoon	Tidal	Inactive	Oct-19	6	Y	Y	Y	N	Y	N
Morecambe Bay Tidal Lagoon	Tidal	Inactive	Jun-19	6	Y	Y	Y	N	Y	N
SeaGen Strangford Lough	Tidal	Decommissioned	Jan-20	6	Y	Y	Y	N	N	Y
Solway Energy Gateway	Tidal	Cancelled	Feb-11	6	Y	Y	Y	N	Y	N
Wyre Estuary Tidal Barrage	Tidal	Cancelled	Jun-18	6	Y	Y	Y	N	Y	N

1.5.3 Screening of Aggregate and Dredging Projects

69. Aggregate extraction and dredging projects considered for the CEA screening were operational projects (production agreement areas), and those expected to be used in the future (exploration and option areas), for UK based projects (**Table 1.4**). No European projects were screened in due to a lack of information on project locations, phases, and programmes.

70. UK based projects listed were initially considered for potential operational cumulative effects, if those phases could overlap with the proposed construction of the Offshore Project.

71. All aggregate extraction and dredging projects are considered to be part of the existing baseline environment if operational prior to the start of the baseline surveys for the Offshore Project, in March 2021. Out of the initial list of nine aggregate projects within the CEA screening area, six were initially **screened out** as being operational prior to March 2021, with two aggregate projects becoming operational after the onset of the baseline surveys but before construction at the Offshore Project. The remaining project is categorised as an Exploration and Option Area and is listed as a Tier 3 projects with further details unknown at this time

72. When in transit, noise arising from dredging vessels is comparable with that from similar sized vessels and can therefore be considered as part of the baseline noise levels.

73. When undertaking dredging activities, higher levels of broadband noise at frequencies above 1kHz are produced due to the impact or abrasion of aggregate material passing through the draghead, suction pipe and pump. The overall level of noise was found to be higher when extracting gravel compared to when extracting sand (Robinson *et al.*, 2011).

74. Taking into account the small potential impact ranges, distances of the aggregate extraction and dredging projects from the Offshore Project, the potential for contribution to cumulative effects is very small. Therefore, risk of Permanent Threshold Shift (PTS) or Temporary Threshold Shift (TTS) for all marine mammal and marine turtle species from aggregate extraction and dredging has been **screened out** from further consideration in the CEA.

75. As outlined in the BEIS (2020) RoC HRA for the Southern North Sea SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600m of the activities (Diederichs *et al.*, 2010). As a precautionary approach, a total of six aggregate extraction and dredging projects will be considered further for the potential cumulative disturbance of harbour porpoise.

76. The results of the screening aggregate extraction and dredging projects is presented in **Table 1.4**.

Table 1.4 CEA Screening for UK Aggregate and Dredging Projects within the Relevant Spatial Areas and Potential to Overlap with the Offshore Project Construction (2026-2028) (HP = harbour porpoise, BND = bottlenose dolphin, CGNS = Celtic and Greater North Seas, RoI = Republic of Ireland, SA = Screening Area, Y = Yes, N = No)

Name of Project	Area Number	Project status	Tier	Licence start date	Licence end date	HP - CIS	BnD - IS	BND - OCSW	Seal MU - 11	Seal MU - 12	Seal MU - 13	Seal MU - 14
Area 1 South	478	Production Agreement Area	1	Dec-12	Apr-24	N	N	Y	N	N	N	N
Liverpool Bay	457	Production Agreement Area	1	Dec-12	Jul-25	Y	Y	N	N	Y	Y	N
NOBEL Banks	476	Production Agreement Area	1	Dec-12	Jun-31	Y	N	N	Y	Y	N	N
South Hastings	530	Production Agreement Area	1	Jan-13	Jan-28	N	N	Y	N	N	N	N
Off Selsey Bill	395/1 + 395/2	Production Agreement Area	1	Mar-13	Mar-28	N	N	Y	N	N	N	N
St Catherine's	407 + 451	Production Agreement Area	1	Mar-13	Mar-28	N	N	Y	N	N	N	N
Hilbre Swash	393	Production Agreement Area	1	Jan-15	Dec-29	Y	Y	N	N	Y	Y	N
Needles Isle of Wight	137	Production Agreement Area	1	Jan-15	Dec-19	N	N	Y	N	N	N	N
South East Isle of Wight	340 + 351	Production Agreement Area	1	Jan-15	Dec-29	N	N	Y	N	N	N	N
South West Isle of Wight	127	Production Agreement Area	1	Jan-15	Dec-29	N	N	Y	N	N	N	N
South West Isle of Wight	500/4	Production Agreement Area	1	Jan-15	Dec-29	N	N	Y	N	N	N	N
North Middle Ground	455	Production Agreement Area	1	Jul-16	Jun-31	Y	N	N	Y	Y	N	N
North Middle Ground	459	Production Agreement Area	1	Jul-16	Jun-31	Y	N	N	Y	Y	N	N
Inner Owers North	488	Production Agreement Area	1	Apr-17	Jul-30	N	N	Y	N	N	N	N
Owers Extension	453	Production Agreement Area	1	Apr-17	Mar-32	N	N	Y	N	N	N	N
South of Needles Channel	500/3	Production Agreement Area	1	Apr-17	Mar-32	N	N	Y	N	N	N	N
South Wight	500/1	Production Agreement Area	1	Apr-17	Mar-32	N	N	Y	N	N	N	N
South Wight	500/2	Production Agreement Area	1	Apr-17	Mar-32	N	N	Y	N	N	N	N
Inner Owers	396/1 + 435/1 + 435/2	Production Agreement Area	1	Jul-17	Jul-30	N	N	Y	N	N	N	N
Culver Extension	526	Production Agreement Area	1	Jan-19	Dec-34	Y	N	N	Y	Y	Y	N
North Bristol Deep	1602	Production Agreement Area	1	Jul-21	Apr-30	Y	N	N	Y	Y	N	N
North Bristol Deep	1601	Production Agreement Area	1	Jul-21	Apr-30	Y	N	N	Y	Y	N	N
Median Deep	461	Production Agreement Area	1	Sep-21	Sep-26	N	N	Y	N	N	N	N
Greenwich Light East	473/1/2	Production Agreement Area	1	Nov-21	Nov-36	N	N	Y	N	N	N	N
West Bassurelle	458	Production Agreement Area	1	Sep-22	Sep-37	N	N	Y	N	N	N	N
West Bassurelle	464	Production Agreement Area	1	Sep-22	Sep-37	N	N	Y	N	N	N	N
EEC 1	529	Exploration and Option Area	5	Aug-17	Jan-31	N	N	Y	N	N	N	N
EEC 5 South	1807	Exploration and Option Area	5	Sep-19	Aug-24	N	N	Y	N	N	N	N
Liverpool Bay	1808	Exploration and Option Area	5	Sep-19	Aug-24	Y	Y	N	N	Y	Y	N
West Bassurelle Extension	1803	Exploration and Option Area	5	Sep-19	Aug-24	N	N	Y	N	N	N	N
West Wight	522/1	Production Agreement Area	1	Sep-21	Sep-36	N	N	Y	N	N	N	N
West Wight	522/2	Production Agreement Area	1	Sep-21	Sep-36	N	N	Y	N	N	N	N

1.5.4 Screening of Licenced Disposal Sites

77. All UK licensed disposal sites are considered to be part of the existing baseline environment as were all operational prior to the start of the baseline surveys in May 2020. All UK licensed disposal sites have been **screened out from further consideration in the CEA**.

78. The results of the CEA screening for UK licensed disposal sites **screened in** are presented in **Table 1.5**.

Table 1.5 CEA Screening for UK Disposal Sites

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Fishguard	IS010	8.82E-05	Closed	Y	Y	Y	Y	N	N
Aberystwyth South Beach	IS013	3.04E-07	Open	Y	Y	Y	Y	N	N
Dolau Beach	IS014	6.71E-07	Open	Y	Y	Y	Y	N	N
Newquay Track	IS015	1.64E-07	Open	Y	Y	Y	Y	N	N
South Beach	IS017	2.92E-08	Open	Y	Y	Y	Y	N	N
Shell Lagoon, Llanbedr	IS018	5.74E-07	Open	Y	Y	Y	Y	N	N
Tremadoc Bay	IS020	4.42E-04	Closed	Y	Y	Y	Y	N	N
Menai Strait	IS030	1.14E-05	Closed	Y	Y	Y	Y	N	N
Degabwy Beneficial Use	IS035	4.21E-08	Open	Y	Y	Y	Y	N	N
Holyhead Deep	IS040	7.78E-03	Closed	Y	Y	Y	Y	N	N
Holyhead South	IS041	1.67E-03	Closed	Y	Y	Y	Y	N	N
Holhead East	IS042	1.46E-03	Closed	Y	Y	Y	Y	N	N
Holyhead North	IS043	3.85E-03	Open	Y	Y	Y	Y	N	N
Point Lynas	IS050	3.65E-04	Closed	Y	Y	Y	Y	N	N
Conwy Bay	IS055	1.46E-03	Closed	Y	Y	Y	Y	N	N
Puffin Island	IS060	9.08E-05	Closed	Y	Y	Y	Y	N	N
Conmy Beneficial Use	IS065	4.21E-08	Open	Y	Y	Y	Y	N	N
Conwy Beneficial Use	IS066	4.21E-08	Open	Y	Y	Y	Y	N	N
Liverpool Bay (Sludge)	IS070	7.92E-03	Closed	Y	Y	Y	N	Y	N
Liverpool Bay (Sludge) B	IS071	8.40E-03	Closed	Y	Y	Y	N	Y	N
Liverpool Bay (Industrial)	IS080	2.08E-03	Closed	Y	Y	Y	N	Y	N
Site I (Nw Light Float)	IS090	3.65E-04	Closed	Y	Y	Y	N	Y	N
Point Of Ayr Foreshore	IS095	1.69E-07	Closed	Y	Y	Y	N	Y	N
Broughton	IS099	9.81E-07	Open	Y	Y	Y	N	Y	N
Dee Estuary	IS100	1.45E-05	Closed	Y	Y	Y	Y	N	N
Mostyn Deep	IS101	1.80E-04	Closed	Y	Y	Y	Y	N	N
Mostyn Deep (Maintenance)	IS102	8.93E-05	Open	Y	Y	Y	Y	N	N
Mostyn Breakwater	IS103	2.38E-06	Open	Y	Y	Y	Y	N	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Mersey (Garston Site)	IS110	8.84E-05	Open	Y	Y	Y	N	Y	N
Bramley Moore Dock	IS115	4.45E-06	Closed	Y	Y	Y	N	Y	N
Nelson Dock	IS116	3.45E-06	Closed	Y	Y	Y	N	Y	N
Mersey (Mid-River Site)	IS120	5.83E-05	Open	Y	Y	Y	N	Y	N
Mersey (Mid-River 2)	IS125	5.82E-05	Closed	Y	Y	Y	N	Y	N
Canning Half Tide	IS126	7.29E-08	Open	Y	Y	Y	N	Y	N
Mersey Of Bromborough	IS127	6.54E-05	Closed	Y	Y	Y	N	Y	N
Mersey Of Bromborough 2	IS128	6.54E-05	Disused	Y	Y	Y	N	Y	N
Mersey (Liverpool Marina)	IS129	1.70E-06	Open	Y	Y	Y	N	Y	N
Wallasey	IS130	1.69E-07	Closed	Y	Y	Y	N	Y	N
Formby & Taylors Point	IS132	-5.91E-04	Disused	Y	Y	Y	N	Y	N
Manx Waters	IS134	9.08E-05	Closed	Y	Y	Y	N	Y	N
Burbo Bank Extension Owf	IS135	5.37E-03	Open	Y	Y	Y	N	Y	N
Site Z	IS140	1.83E-04	Open	Y	Y	Y	N	Y	N
Site Z (Original Area)	IS145	1.07E-04	Closed	Y	Y	Y	N	Y	N
Bhp Pipeline Route	IS147	7.10E-04	Closed	Y	Y	Y	N	Y	N
Bhp Pipeline Route	IS148	7.30E-04	Closed	Y	Y	Y	N	Y	N
Bhp Pipeline Route	IS149	2.75E-04	Closed	Y	Y	Y	N	Y	N
Site Y	IS150	1.99E-03	Open	Y	Y	Y	N	Y	N
Preston	IS160	3.67E-04	Closed	Y	Y	Y	N	Y	N
East Lytham	IS163	8.59E-07	Open	Y	Y	Y	N	Y	N
Ribble Link	IS164	4.26E-08	Disused	Y	Y	Y	N	Y	N
Savick Brook	IS165	1.70E-07	Disused	Y	Y	Y	N	Y	N
Morecambe Bay: Lune Deep	IS170	2.36E-04	Open	Y	Y	Y	N	Y	N
Fleetwood Channel	IS171	1.47E-05	Closed	Y	Y	Y	N	Y	N
River Wyre Estuary	IS175	1.47E-05	Closed	Y	Y	Y	N	Y	N
Barrow A	IS180	1.85E-04	Disused	Y	Y	Y	N	Y	N
Lune River	IS190	1.71E-07	Closed	Y	Y	Y	N	Y	N
Glasson Dock	IS191	4.37E-08	Closed	Y	Y	Y	N	Y	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Lune River B	IS192	5.87E-06	Open	Y	Y	Y	N	Y	N
Gateway Gas Storage Project	IS195	2.87E-03	Disused	Y	Y	Y	N	Y	N
Morecambe Bay B	IS200	5.90E-05	Open	Y	Y	Y	N	Y	N
Barrow D	IS205	8.19E-04	Open	Y	Y	Y	N	Y	N
Barrow B	IS210	9.23E-05	Closed	Y	Y	Y	N	Y	N
Walney OWF	IS215	2.01E-02	Disused	Y	Y	Y	N	Y	N
Saltom Bay	IS220	1.74E-07	Closed	Y	Y	Y	N	Y	N
Whitehaven	IS230	9.36E-05	Closed	Y	Y	Y	N	Y	N
Harrington Harbour	IS231	1.34E-06	Disused	Y	Y	Y	N	Y	N
Solway Firth	IS240	3.76E-04	Open	Y	Y	Y	N	Y	N
Workington Anchorage	IS241	2.40E-04	Open	Y	Y	Y	N	Y	N
Maryport Harbour Dispersive Site B	IS244	4.36E-08	Disused	Y	Y	Y	N	Y	N
Maryport Harbour Dispersive	IS245	4.36E-08	Closed	Y	Y	Y	N	Y	N
Silloth	IS250	4.35E-05	Closed	Y	Y	Y	N	Y	N
Silloth B	IS251	4.35E-05	Open	Y	Y	Y	N	Y	N
Beauforts Dyke	IS260	2.08E-03	Closed	Y	Y	Y	N	Y	N
Middle Deep, Mersey	IS270	1.69E-07	Closed	Y	Y	Y	N	Y	N
Beauforts Dyke, Scotland	IS280	8.85E-02	Closed	Y	Y	Y	N	N	N
Drummore	IS285	4.65E-06	Closed	Y	Y	Y	N	N	N
Drummore A	IS286	6.00E-07	Closed	Y	Y	Y	N	N	N
Drummore B	IS287	6.06E-07	Closed	Y	Y	Y	N	N	N
Drummore C	IS288	7.81E-07	Closed	Y	Y	Y	N	N	N
Portpatrick	IS290	3.85E-05	Closed	Y	Y	Y	N	N	N
Burrow Head B	IS300	8.35E-05	Closed	Y	Y	Y	N	N	N
Burrow Head A	IS310	9.63E-05	Closed	Y	Y	Y	N	N	N
West Balnapaling	IS320	1.25E-07	Open	Y	Y	Y	N	N	N
Douglas (I.O.M)	IS400	9.25E-05	Open	Y	Y	Y	N	Y	N
Ramsey (I.O.M)	IS410	9.32E-05	Closed	Y	Y	Y	N	Y	N
Peel (I.O.M)	IS420	9.27E-05	Open	Y	Y	Y	N	Y	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Port St. Mary (I.O.M)	IS430	9.24E-05	Closed	Y	Y	Y	N	Y	N
MANX WATRS (Fish Waste)	IS435	9.08E-05	Closed	Y	Y	Y	N	Y	N
Castletown Bay (I.O.M)	IS440	9.23E-05	Closed	Y	Y	Y	N	Y	N
Douglas Harbour (I.O.M)	IS445	1.81E-04	Open	Y	Y	Y	N	Y	N
Laxey Bay (I.O.M)	IS450	9.27E-05	Closed	Y	Y	Y	N	Y	N
Isle Of Man Site C	IS460	1.23E-04	Closed	Y	Y	Y	N	Y	N
Black Head	IS500	3.76E-04	Closed	Y	Y	Y	N	N	Y
Eden	IS510	9.39E-05	Closed	Y	Y	Y	N	N	Y
Carrickfergus	IS520	9.39E-05	Closed	Y	Y	Y	N	N	Y
Folly Road	IS530	9.38E-05	Closed	Y	Y	Y	N	N	Y
Belfast Dredgings	IS540	1.38E-04	Closed	Y	Y	Y	N	N	Y
Belfast Reclamation	IS570	3.70E-05	Closed	Y	Y	Y	N	N	Y
Bangor	IS580	9.38E-05	Closed	Y	Y	Y	N	N	Y
Belfast Sludge	IS590	8.12E-04	Closed	Y	Y	Y	N	N	Y
Belfast Dredgings C	IS591	9.40E-05	Open	Y	Y	Y	N	N	Y
Belfast Dredgings B	IS595	9.38E-05	Closed	Y	Y	Y	N	N	Y
Copeland Island	IS600	9.38E-05	Closed	Y	Y	Y	N	N	Y
Ardmillon	IS610	9.33E-05	Closed	Y	Y	Y	N	N	Y
Portavogie	IS620	9.33E-05	Open	Y	Y	Y	N	N	Y
Dundrum Bay	IS630	9.27E-05	Closed	Y	Y	Y	N	N	Y
Ardglass	IS635	9.27E-05	Closed	Y	Y	Y	N	N	Y
Ardglass B	IS636	9.27E-05	Disused	Y	Y	Y	N	N	Y
Newcastle (Ni)	IS640	9.27E-05	Closed	Y	Y	Y	N	N	Y
Kilkeel	IS650	3.70E-04	Open	Y	Y	Y	N	N	Y
Carlingford	IS660	9.24E-05	Closed	Y	Y	Y	N	N	Y
Warrenpoint	IS670	9.22E-05	Closed	Y	Y	Y	N	N	Y
Warrenpoint B	IS671	9.22E-05	Open	Y	Y	Y	N	N	Y
Foul Ground	JE001	1.53E-04	Open	Y	N	Y	N	N	N
Grouville Bay	JE002	5.32E-05	Open	Y	N	Y	N	N	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Padstow Bay	LU010	8.55E-05	Open	Y	N	Y	N	N	N
Hartland Point	LU020	5.54E-03	Closed	Y	N	Y	N	N	N
Morte Bay	LU030	3.46E-04	Closed	Y	N	Y	N	N	N
Milford Haven Industrial	LU040	4.16E-02	Closed	Y	N	Y	N	N	N
Bristol Channel-Old	LU047	1.39E-03	Closed	Y	N	Y	N	N	N
Bristol Channel (Rough Weather)	LU050	1.39E-03	Closed	Y	N	Y	N	N	N
Watchet Harbour	LU055	1.79E-06	Open	Y	N	Y	N	N	N
River Parrett	LU057	4.02E-08	Closed	Y	N	Y	N	N	N
Bristol Deep	LU060	1.55E-04	Closed	Y	N	Y	N	N	N
Bristol Holm Deep	LU065	8.03E-04	Disused	Y	N	Y	N	N	N
Clevedon Lake	LU067	2.58E-07	Disused	Y	N	Y	N	N	N
Clevedon Lake	LU068	7.75E-07	Open	Y	N	Y	N	N	N
Portishead	LU070	2.55E-05	Open	Y	N	Y	N	N	N
Avonmouth (Inner)	LU080	6.97E-05	Open	Y	N	Y	N	N	N
Royal Portbury Entrance	LU083	2.40E-05	Disused	Y	N	Y	N	N	N
Royal Portbury Pier	LU084	3.72E-06	Open	Y	N	Y	N	N	N
Royal Edward Entrance	LU085	5.67E-06	Open	Y	N	Y	N	N	N
Bristol City Docks Entrance	LU086	4.90E-06	Disused	Y	N	Y	N	N	N
Oldbury Power Station	LU087	1.40E-06	Disused	Y	N	Y	N	N	N
Oldbury Power Station B	LU088	5.03E-06	Disused	Y	N	Y	N	N	N
Avonmouth (Outer)	LU090	5.14E-05	Closed	Y	N	Y	N	N	N
Denny Island Beacon	LU100	1.88E-05	Closed	Y	N	Y	N	N	N
New Denny Island	LU101	1.27E-05	Closed	Y	N	Y	N	N	N
Cardiff Grounds	LU110	2.75E-04	Open	Y	N	Y	Y	N	N
Cardiff Outfall Temporary Depo	LU111	1.06E-04	Closed	Y	N	Y	Y	N	N
Merkur Buoy	LU115	2.50E-06	Open	Y	N	Y	Y	N	N
Swansea Bay (Inner)	LU120	3.52E-04	Closed	Y	N	Y	Y	N	N
Monkstone Cill	LU125	8.81E-08	Disused	Y	N	Y	Y	N	N
Swansea Bay (Outer)	LU130	7.86E-04	Open	Y	N	Y	Y	N	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Newport	LU140	6.15E-05	Open	Y	N	Y	Y	N	N
Burry Port	LU145	2.97E-05	Disused	Y	N	Y	Y	N	N
Mumbles Head	LU150	1.62E-07	Closed	Y	N	Y	Y	N	N
Bristol Channel	LU160	1.39E-03	Closed	Y	N	Y	Y	N	N
Milford Haven 2	LU168	6.13E-04	Open	Y	N	Y	Y	N	N
Milford Haven 3	LU169	3.50E-04	Open	Y	N	Y	Y	N	N
Milford Haven	LU170	5.12E-04	Closed	Y	N	Y	Y	N	N
St Anns Head	LU180	1.81E-05	Closed	Y	N	Y	Y	N	N
Neyland (Off Milford Haven)	LU190	1.69E-05	Open	Y	N	Y	Y	N	N
Weston Foreshore	LU191	3.03E-06	Disused	Y	N	Y	N	N	N
Weston Foreshore 2	LU192	6.96E-08	Disused	Y	N	Y	N	N	N
Weston Foreshore 3	LU193	2.27E-06	Open	Y	N	Y	N	N	N
Uskmouth	LU200	1.39E-07	Closed	Y	N	Y	Y	N	N
Hinkley Outfalls	LU201	1.91E-06	Disused	Y	N	Y	N	N	N
Hinkley C	LU202	-1.01E-05	Disused	Y	N	Y	N	N	N
Hinkley Intake 1	LU203	1.43E-06	Disused	Y	N	Y	N	N	N
Hinkley Intake 2	LU204	1.44E-06	Disused	Y	N	Y	N	N	N
Hinkley Intake 3	LU205	1.44E-06	Disused	Y	N	Y	N	N	N
Hinkley Intake 4	LU206	1.44E-06	Disused	Y	N	Y	N	N	N
Kirkcudbright	MA01		Open	Y	Y	Y	N	N	N
North Channel, Scotland	MA010	3.77E-04	Open	Y	Y	Y	N	N	N
Stranraer	MA015	3.77E-04	Closed	Y	Y	Y	N	N	N
Carnlough	MA580	9.45E-05	Closed	Y	Y	Y	N	N	Y
Carnlough A	MA581	9.45E-05	Closed	Y	Y	Y	N	N	Y
Carnlough B	MA585	9.45E-05	Closed	Y	Y	Y	N	N	Y
Larne	MA600	9.42E-05	Closed	Y	Y	Y	N	N	Y
Larne B	MA601	9.43E-05	Closed	Y	Y	Y	N	N	Y
Larne A	MA605	9.43E-05	Disused	Y	Y	Y	N	N	Y
Herbrandston Marine, Milford Haven	MH001	1.63E-07	Closed	Y	Y	Y	Y	N	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Castle Point	PL005	1.36E-05	Closed	Y	N	Y	N	N	N
Kingswear	PL007	1.36E-05	Closed	Y	N	Y	N	N	N
Start Bay	PL010	1.77E-04	Closed	Y	N	Y	N	N	N
Salcombe A	PL015	4.00E-07	Closed	Y	N	Y	N	N	N
Salcombe B	PL018	7.49E-07	Closed	Y	N	Y	N	N	N
Bolt Head	PL019	5.09E-06	Closed	Y	N	Y	N	N	N
Plymouth	PL020	2.01E-03	Closed	Y	N	Y	N	N	N
Fort Picklecombe Y	PL021	2.79E-08	Disused	Y	N	Y	N	N	N
Fort Picklecombe Y	PL022	1.37E-07	Disused	Y	N	Y	N	N	N
Weston Mill Lake	PL025	1.46E-06	Closed	Y	N	Y	N	N	N
Rame Head	PL030	3.40E-04	Closed	Y	N	Y	N	N	N
Rame Head South	PL031	1.76E-04	Open	Y	N	Y	N	N	N
Plymouth Deep	PL035	1.89E-04	Open	Y	N	Y	N	N	N
Eddyston	PL040	1.35E-05	Closed	Y	N	Y	N	N	N
Rame Head A	PL050	1.22E-04	Closed	Y	N	Y	N	N	N
Lantic Bay	PL060	2.01E-04	Open	Y	N	Y	N	N	N
Truro	PL069	1.60E-07	Open	Y	N	Y	N	N	N
Falmouth Bay	PL070	3.39E-04	Closed	Y	N	Y	N	N	N
Truro River	PL071	3.38E-06	Closed	Y	N	Y	N	N	N
Falmouth Marina	PL072	4.01E-07	Disused	Y	N	Y	N	N	N
Falmouth Bay (B)	PL075	1.32E-04	Open	Y	N	Y	N	N	N
Falmouth Bay	PL080	2.09E-03	Closed	Y	N	Y	N	N	N
Gerran Corras Creek, Falmouth	PL090	5.40E-07	Closed	Y	N	Y	N	N	N
Marazion Beach	PL095	1.70E-06	Disused	Y	N	Y	N	N	N
Mounts Bay	PL100	8.46E-05	Open	Y	N	Y	N	N	N
Newlyn Harbour	PL110	3.91E-05	Closed	Y	N	Y	N	N	N
Weymouth	PO010	4.33E-04	Closed	Y	N	Y	N	N	N
West Bay	PO020	3.43E-04	Closed	Y	N	Y	N	N	N
Lyme Bay	PO025	1.37E-05	Closed	Y	N	Y	N	N	N

Name of Project	Reference	Area (km2)	Status	HP-CIS	BD - IS	CGNS	Seal MU - 12	Seal MU - 13	Seal MU - 14
Seaton	PO026	5.63E-07	Open	Y	N	Y	N	N	N
Lyme Bay 1	PO030	2.30E-02	Closed	Y	N	Y	N	N	N
Dartmouth Psa	PO040	2.86E-03	Closed	Y	N	Y	N	N	N
Lyme Bay 2	PO050	1.37E-03	Open	Y	N	Y	N	N	N
Exe Estuary	PO060	3.41E-06	Closed	Y	N	Y	N	N	N
Sprey Point	PO070	8.55E-05	Open	Y	N	Y	N	N	N
Sprey Point (Amended)	PO075	1.23E-04	Closed	Y	N	Y	N	N	N
Teignmouth Ness Long Sea Outfall	PO076	7.19E-06	Closed	Y	N	Y	N	N	N
The Salty, Teignmouth	PO080	1.59E-07	Closed	Y	N	Y	N	N	N
Teignmouth Railway Embankment	PO085	1.59E-07	Closed	Y	N	Y	N	N	N
Bundle Head	PO090	3.97E-05	Disused	Y	N	Y	N	N	N
Meadfoot Beach	PO100	1.51E-05	Closed	Y	N	Y	N	N	N
Grove Point	PO110	3.42E-04	Closed	Y	N	Y	N	N	N
Deep Water Relocation	PO111	1.24E-05	Open	Y	N	Y	N	N	N
Portland Harbour Deep Water Relocation	PO112	1.78E-05	Open	Y	N	Y	N	N	N
St Helier	PO500	8.30E-05	Closed	Y	N	Y	N	N	N
St.Aubins	PO501	2.40E-07	Open	Y	N	Y	N	N	N
St. Aubins East	PO502	1.71E-05	Disused	Y	N	Y	N	N	N
St Bredlades Bay	PO503	1.82E-05	Open	Y	N	Y	N	N	N
Greve d'Azette	PO504	7.86E-06	Open	Y	N	Y	N	N	N

1.5.5 Screening of Oil and Gas Projects

79. Oil and gas production and decommissioning projects could have the potential for cumulative effects during the construction of the Offshore Project. Plans or projects considered during the CEA screening were either operational, those with either construction or decommissioning currently underway, consented, or with an application submitted, for UK based projects. No European projects are assessed due to a lack of information on project locations, phases, and programmes.

80. These projects were initially considered for potential cumulative effects if they could overlap with the construction of the Offshore Project.

81. As outlined in the BEIS (2020) RoC HRA for the Southern North Sea SAC, the use of cutting equipment is predicted to be required primarily during decommissioning activities. There is limited information on the level of noise arising from cutting equipment. However, one published study measured the level of noise from a diamond wire cutter at an offshore gas platform (Pangerc *et al.*, 2017). The results indicated that increases in noise of between 4dB and 15dB at frequencies predominantly above 5kHz could be attributed to the cutting equipment. There was no increase in sound above that from the associated vessels detected at lower frequencies.

82. Based on currently available information, underwater noise during decommissioning of oil and gas installations would be less than levels for PTS to occur, and any disturbance would be localised and not be significantly greater than that arising from vessels. Therefore, potential cumulative effects from decommissioning activities, such as cutting equipment has been **screened out** from further consideration in the CEA.

83. The potential for cumulative effects from vessels associated with the decommissioning of oil and gas installations has also been **screened out** from further consideration in the CEA. he potential effects of any vessels associated with the decommissioning of oil and gas installations is unlikely to be significantly greater than vessel activity at these sites during the operational phase of the oil and gas installations. Therefore, potential cumulative effects from vessels during decommissioning of oil and gas installations has been **screened out** from further consideration in the CEA.

84. Of the 112 oil and gas projects considered, 12 were in the CEA screening area. Two projects are in the process of being decommissioned and the potential for any significant contribution to cumulative effect, any potential cumulative effects during decommissioning of oil and gas installations has been **screened out** from further consideration in the CEA. Of the other ten projects considered, there are

no projects with the potential to overlap with the construction of the Offshore Project.

85. The results of the screening for Oil and Gas projects are presented in **Table 1.6.**

Table 1.6 CEA Screening for Oil and Gas Projects (both Decommissioning and Production Projects are Included) within Relevant Spatial Areas and with the Potential to Overlap with the Offshore Project Construction (2026-2027) (HP = harbour porpoise, BND = bottlenose dolphin, CGNS = Celtic and Greater North Seas, RoI = Republic of Ireland, SA = Screening Area, Y = Yes, N = No)

Name of Project	Type of project	Status	Expected Date of Activity	HP - CIS	BND - IS	CGNS	SEAL MU - 12	SEAL MU - 13	SEAL MU 14
Bains	Decommissioning	Completed	2002 - Decom 2018	Y	Y	Y	Y	N	N
Calder	Production increase	Underway	2004	Y	Y	Y	N	Y	N
Conwy	Production increase	Underway	2013 start, unknown end	Y	Y	Y	Y- Border	N	N
Dalton	Production increase	Underway	1999-2071	Y	Y	Y	Y	N	N
Douglas	Production increase	Underway	1996- 3031	Y	Y	Y	Y - Border	N	N
Hamilton East	Production increase	Underway	1997-2023	Y	Y	Y	Y	N	N
Hamilton North	Production increase	Underway	1994- 2025	Y	Y	Y	Y	N	N
Lennox	Production increase	Underway	1996-2024	Y	Y	Y	Y	N	N
Millom	Production increase	Underway	1999-2030	Y	Y	Y	Y- Border	Y	N
North Morecambe	Production increase	Underway	1994- 2026	Y	Y	Y	Y - Both	Y - Both	N
Rhyl	Production increase	Underway	2013-2028	Y	Y	Y	Y	N	Y

Name of Project	Type of project	Status	Expected Date of Activity	HP - CIS	BND - IS	CGNS	SEAL MU - 12	SEAL MU - 13	SEAL MU 14
South Morecambe DP3-DP4 Decommissioning Programme	Decommissioning	Approved	Decommissioned by 2023	Y	Y	Y	N	Y	N

1.5.6 Screening of Subsea Cables and Pipelines

86. Subsea cables and pipelines only have the potential for cumulative effects with the Offshore Project during their construction. Plans or projects initially considered for the CEA screening were operational, those with construction underway, consented, and with an application submitted.

87. All of the operational projects identified during screening were already installed and are therefore considered part of the baseline and have been **screened out** from further consideration in the CEA.

88. Of the 10 sub-sea cables and pipelines for which some information was currently available, two were **screened out** from further consideration in the CEA as are already operational. A further project was **screened out** on the basis that construction would be completed prior to construction at the Offshore Project. The remaining two projects are in concept / early planning of the pipeline projects and have unknown construction windows.

89. The results of the CEA screening for subsea cables and pipelines are presented in **Table 1.7.**

Table 1.7 CEA Screening for Subsea Cables and Pipelines within Relevant Spatial Areas and with the Potential to Overlap with the Projects Construction (2026-2028) (HP = harbour porpoise, BND = bottlenose dolphin, CGNS = Celtic and Greater North Seas, RoI = Republic of Ireland

Name of Project	Project Status	Landfall Point 1	Landfall Point 2	Notes	Type of Cable	HP - CIS	BD - IS	CGNS MU	Seal MU - 12	Seal MU - 13	Seal MU - 14
Channel Islands: Guernsey-France (GF1)	5	Guernsey	France		100mw	Y	N	Y	N	N	N
EWIC	1	Shotton, Wales	Rush North Beach, County Dublin	Operational in 2012	500 MW	Y	Y	Y	Y	N	N
IFA2	1	Sangatte, France	Folkestone, UK	Operational in 2021	HVDC 2,000MW	N	N	Y	N	N	N
MaresConnect	5	UK	Ireland		750MW	Y	Y	Y	Y	Y	N
Greenlink	3	Pembrokeshire	County Wexford, RoI	Operational by 2023	500MW	Y	Y	Y	Y	N	N
Hynet North West Crabon Dioxide Pipeline	3	Grinsome Road AGI in Cheshire Talacre Beach in North Wales	Talacre Beach in North Wales		Pipeline	Y	Y	Y	Y	N	N
Hynet North West Hydrogen Pipeline	3	Stanlow	Talacre Beach in North Wales		Pipeline	Y	Y	Y	Y	N	N

Name of Project	Project Status	Landfall Point 1	Landfall Point 2	Notes	Type of Cable	HP - CIS	BD - IS	CGNS MU	Seal MU - 12	Seal MU - 13	Seal MU - 14
Moffat to RoI	1	Moffatt, UK	County Dublin, RoI	Operational by 1991	Gas pipeline	Y	Y	Y	N	N	N
X-links 1	5	Cornborough, Devon	Morocco	Construction 2025-2030	2 x 1800MW	Y	N	Y	N	N	N
X-links 2	5	Pembrokeshire	Morocco	Construction 2025-2030	2 x 1800MW	Y	N	Y	N	N	N

1.5.7 Screening of Other Industries

1.5.7.1 Screening of Gas Storage Projects

90. For gas storage projects, there are three within the relevant species MUs, one of which is on hold (Gateway Project), and one of which under judicial review (Larne Lough) and the third listed as an area offered for applications (EIS Area 1). Therefore, gas storage projects have been **screened out** from further consideration in the CEA. The results of the CEA screening for gas storage projects are presented in **Table 1.8**.

1.5.7.2 Screening of Offshore Mining Projects

91. No UK mining project was identified in the CIS and therefore no mining projects considered further in the CEA. Four Exploration and Option licencing blocks (Areas 1901 - 1904) that have been licenced from 2020 and are classed as Tier 3 projects but no further information is available at this time. The results of the CEA screening for offshore mines are presented in **Table 1.8**.

92. No European projects were considered due to a lack of information on project locations, phases, and programmes.

1.5.7.3 Screening of Carbon Capture Projects

93. One project (project Acorn) was identified as either under construction or consented, and all of the operational projects identified by screening were already active and are therefore considered part of the baseline.

94. Carbon capture projects are unlikely to contribute significantly to any potential cumulative effects for underwater noise, as most construction work will be on land and use existing offshore infrastructure. Therefore, all carbon capture projects have been **screened out** of the CEA. The results of the CEA screening for carbon capture projects are presented in **Table 1.8**.

95. All European projects were **screened out** due to a lack of information on project locations, phases, and programmes.

Table 1.8 Screening for Other Industries (Offshore Mines and Carbon Capture Projects) within the Relevant Spatial Areas and with the Potential to Overlap with the Project Construction (2026-2028) (HP = harbour porpoise, BND = bottlenose dolphin, GS = grey seal, H

Name of Project	Status	HP - CIS	BD - IS	CG NS	Seal - 12	Seal - 13	Seal - 14	Seal RoI	CEA SA	Potential for overlap of with the Project construction?
Gas Storage Projects										
Gateway Project - Stag Energy	Oh Hold	Y	Y	Y	N	Y	N	N	Y	Unknown
Larne Lough	Under judicial review	Y	Y	Y	N	N	Y	N	Y	No
EIS Area	Concept & Early planning	Y	Y	Y	N	Y	N	N	Y	Unknown
Offshore Mining Projects										
Area 1901	Exploration and Option Agreement	Y	N	Y	N	N	Y	N	Y	Unknown
Area 1902	Exploration and Option Agreement	Y	N	Y	N	N	Y	N	Y	Unknown
Area 1903	Exploration and Option Agreement	N	N	Y	N	N	N	N	N	Unknown
Area 1904	Exploration and Option Agreement	N	N	Y	N	N	N	N	N	Unknown
Carbon Capture Projects										
ENI	Portfolio for development	Y	Y	y	Y	Y	N	Y	Y	Consented by 2022, construction in 2023 and operational by 2026

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WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 12.C: Draft Marine Mammals Mitigation Protocol

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Glossary of Acronyms

Acronym	Definition
ADDs	Acoustic Deterrent Devices
CEMP	Construction Environmental Management Plan
ECC	Export Cable Corridor
ELO	Environmental Liaison Officer
EOD	Explosive Ordnance Disposal
EPP	Evidence Plan Process
ETG	Expert Topic Group
JNCC	Joint Nature Conservancy Council
kJ	Kilojoule
LAT	Lowest Astronomical Tide
m	Metre
MA	Monitoring Area
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
OSP	Offshore Substation Platform
OWL	Offshore Wind Ltd
PAM	Passive Acoustic Monitoring
PTS	Permanent Threshold Shift
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SEL_{cum}	Cumulative effect from Sound Exposure Level
SEL_{ss}	Sound Exposure Level for a single strike
SIP	Site Integrity Plan
SNCB	Statutory Nature Conservation Bodies
SPL_{peak}	Peak Sound Pressure Level
TWT	The Wildlife Trusts
UK	United Kingdom
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator

Glossary of Terminology

Defined Term	Description
Applicant	Offshore Wind Limited
Development Area	The area comprising the Onshore Development Area and the Offshore Development Area
Engineer, Procure, Construct and Install	A common form of contracting for offshore construction. The contractor takes responsibility for a wide scope and delivers via own and subcontract resources.
Export Cable Corridor	The area in which the export cables will be laid, either from the Offshore Substation or the inter-array cable junction box (if no offshore substation), to the National Grid (NGC) Onshore Substation comprising both the Offshore Export Cable Corridor and Onshore Export Cable Corridor.
Floating substructure	The floating substructure acts as a stable and buoyant foundation for the WTG. The WTG is connected to the substructure via the transition piece and the substructure is kept in position by the mooring system.
Generation Assets	The infrastructure of the Offshore Project related to the generation of electricity within the Windfarm Site, including wind turbine generators, substructures, mooring lines, seabed anchors and inter-array cables
In-combination effects	In-combination effects are those effects that may arise from the development proposed in combination with other plans and projects proposed/consented but not yet built and operational.
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean sea level	The average tidal height over a long period of time.
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined: • Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by OWL as the EIA process progresses.

Defined Term	Description
Offshore Development Area	The Windfarm Site (including wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and Offshore Export Cable Corridor to MHWS at the Landfall (up to MHWS). This encompasses the part of the Offshore Project that is the focus of this application and Environmental Statement and the parts of the Offshore Project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009
Offshore Infrastructure	All of the offshore infrastructure including wind turbine generators, substructures, mooring lines, seabed anchors, Offshore Substation Platform and all cable types (export and inter-array). This encompasses the infrastructure that is the focus of this application and Environmental Statement and the parts of the Offshore Project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009
Offshore Substation Platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore
Project	The Offshore Project for the offshore Section 36 and Marine Licence application includes all components offshore of MHWS. This includes the infrastructure within the Windfarm Site (e.g. wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and all infrastructure associated with the export cable route and landfall (up to MHWS) including the cables and associated cable protection (if required).
Safety zones	A marine zone outlined for the purposes of safety around a possibly hazardous installation or works / construction area
Service operation vessel	A vessel that provides accommodation, workshops and equipment for the transfer of personnel to turbine during OMS. Vessels in service today are typically up to 85m long with accommodation for about 60 people.
White Cross Offshore Windfarm	100MW capacity offshore windfarm including associated onshore and offshore infrastructure
Wind Turbine Generators (WTG)	The wind turbine generators convert wind energy into electrical power. Key components include the rotor blades, naccelle (housing for electrical generator and other electrical and control equipment) and tower. The final selection of project wind turbine model will be made post-consent application
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present
Works completion date	Date at which construction works are deemed to be complete and the windfarm is handed to the operations team. In reality, this may take place over a period of time.

1. Draft Marine Mammal Mitigation Protocol

1.1 Purpose of this document

1. The purpose of this draft marine mammal mitigation protocol (MMMP) is to demonstrate the principles of the final MMMP which will be submitted for approval by the Marine Management Organisation (MMO) for the White Cross Offshore Windfarm (hereafter referred to as 'the Offshore Project') prior to any construction works commencing. The Offshore Project is a proposed floating offshore windfarm located in the Celtic Sea with a capacity of up to 100MW.

2. Using the current precautionary worst-case scenarios for the Offshore Project, both unexploded ordnance (UXO) clearance and piling have the potential to produce underwater noise capable of causing auditory injury to marine mammals and marine turtles. It is important to note that the guidance from JNCC *et al.*, (2010a; 2010b) includes turtles and states the following:

   "JNCC notes that other protected fauna, for example turtles, occur in waters where these guidelines may be used, and would suggest that, whilst the appropriate mitigation may require further investigation, the protocols recommended for marine mammals would also be appropriate for marine turtles."

3. This draft MMMP details how Offshore Wind Ltd (OWL) would further reduce the risk of underwater noise of UXO clearance and piling from causing auditory injury to marine mammals and marine turtles that could be present in and around the Offshore Project. A final MMMP will be produced closer to construction commencing, when the Offshore Project design has been further refined post consent.

4. It should be noted that, pre-construction, a separate Marine Licence for UXO clearance will be sought, with the necessary information (including the final MMMP for UXO clearance), being provided through the marine licensing process. Proposed measures to mitigate potential impacts from UXO clearance have been provided within this draft MMMP for information purposes only. The measures proposed are consistent with Natural England's advice to include an assessment of potential UXO clearance.

5. As such, separate MMMPs for piling and UXO clearance will be developed at the pre-construction stage. These final MMMPs will take account of the most suitable mitigation measures and up to date scientific understanding at the time of construction. These measures will be consulted upon with the MMO, Statutory Nature Conservation Bodies (SNCBs) and The Wildlife Trusts (TWT).

6. This draft MMMP for UXO clearance and piling sets out the protocol of how the Offshore Project would:

- Mitigate impacts to reduce the likelihood of injury to marine mammals and marine turtles as a result of underwater noise during UXO clearance
- Mitigate impacts to reduce the likelihood of injury to marine mammals and marine turtles as a result of underwater noise during piling operations.

7. The draft MMMP will be shared with the relevant SNCBs. The comments received will then be actioned upon before the final MMMP is submitted. The final MMMP will be submitted to the MMO at least six months prior to construction, for approval in consultation with the relevant SNCBs.

8. The final MMMP will be developed in the pre-construction period and will be based upon best available information, methodologies, and industry good practice, latest scientific understanding, current guidance and detailed project design. Current guidance includes Joint Nature and Conservation Committee (JNCC) guidelines for minimising the risk of injury to marine mammals and marine turtles from using explosives (JNCC, 2010a) and statutory nature conservation agency protocol for minimising the risk of injury to marine mammals and marine turtles from piling noise (JNCC, 2010b).

9. Following Natural England's request, **Appendix 5.A: Outline Construction Environmental Management Plan** (CEMP) provides further information on the proposed good practice and code of conduct that will be undertaken by vessel operators to reduce any risk of collisions with marine mammals and marine turtles.

10. In addition to the draft MMMP, **Appendix 12.D: In Principle Site Integrity Plan (SIP) for the Bristol Channel Approaches Special Area of Conservation (SAC)** will be submitted. The In Principle SIP sets out the approach for delivery of the required mitigation measures for the Offshore Project to ensure the avoidance of Adverse Effect on Integrity (AEoI) of the Bristol Channel Approaches SAC in-combination with other plans and projects.

11. Vessel management measures are also provided within **Section 1.3** of this draft MMMP, in line with the requirements set out in **ES Chapter 12 Marine Mammal and Marine Turtle Ecology**.

12. A Project Environmental Management Plan (PEMP) will also be created prior to construction once the Offshore Project design has been further refined. The PEMP sets out the approach for delivery of the required mitigation measures for the Offshore Project to ensure the effects of entanglement are monitored throughout

the construction, operation and maintenance, and decommissioning phases of the Offshore Project.

1.1.1 Description of the Offshore Project

13. The Applicant is seeking a Section 36 consent and appropriate Marine Licences for the creation of a floating offshore windfarm located in the Celtic Sea for up to 100MW, see **Chapter 5: Project Description** for further information.

14. The Windfarm Site will cover an area of 49.35km^2 and the closest point to the coast is 52.5km. Depths range from 60m to 80m below Lowest Astronomical Tide (LAT) in the Windfarm Site.

15. Water depths within the Offshore Export Cable Corridor (ECC) range from 80m below LAT in the offshore part closest to the Windfarm Site and then decreasing progressively to 0m at the coast.

16. Once built, the Windfarm Site would comprise the following offshore components:

- Wind Turbine Generators
- Semi-submersible floating platforms
- Subsea catenary mooring lines
- Anchoring solutions (drag embedment anchors, suction anchor or pin piles)
- Inter-array cables and associated protection
- Offshore Substation Platform (OSP)
- Offshore export cable
- Other associated offshore infrastructure, such as navigational markers.

17. The detailed design of the Offshore Project (e.g. number of wind turbines, layout configuration, mooring type and requirement for scour protection) will be determined post-consent. Therefore, the key parameters presented in **Table 1.1** are indicative based on current information and assumptions. These parameters have formed the worst-case scenario for the underwater noise assessment as presented in **Chapter 12: Marine Mammal and Marine Turtle Ecology**.

18. The earliest any offshore construction works would start is assumed to be 2025. Offshore construction works would require up to 16 months (excluding pre-construction activities such as surveys).

19. It should be noted that the construction programme is dependent on numerous factors including consent timeframes and funding mechanisms.

Table 1.1 Key relevant parameters

Parameter	Details
Approximate offshore construction duration	16 months
Windfarm Site area (excluding offshore temporary works area) (km^2)	49.35
Offshore ECC area (excluding offshore temporary works area) (km^2)	94.94
Windfarm Site water depth range (m)	60 - 80
Distance from Windfarm Site to coast (closest point) (km)	52.5
Number of wind turbine generators (WTG)	6 - 8
Number of OSP/s	0 - 1
Maximum number of moorings per WTG	6
Maximum number of foundations per OSP	6 legs
WTG mooring type options	Catenary mooring system
WTG anchor type options	Drag embedment anchors Suction piles Driven piles Drilled piles
WTG mooring line type options	Anchor chain Mooring cables Polyester mooring lines
OSP foundation type options	Jacket piles Suction Anchor
Maximum number of piles for each WTG	3 - 6
Maximum number of piles for OSP	4
Hammer energies (kilojoules) (kJ)	Jacket pile – 2,500 Pin pile - 800
Maximum pile diameter (m)	Jacket pile – 4m Pin pile – 2m

1.2 Draft protocols for UXO clearance and piling

20. A Marine Wildlife Licence application will be made for all activities that have the potential for injury or disturbance on European Protected Species (EPS) (cetaceans). The activities that may require an EPS licence are:

- UXO clearance
- Piling and offshore construction activities.

21. Prior to any of these activities taking place, an EPS risk assessment will be undertaken, following the staged approach as outlined in JNCC *et al.* (2010). Mitigation will be put in place following current guidelines and advice, see **Sections 1.2.1** and **1.2.2** below for further information.

1.2.1 UXO clearance

22. Whilst the preference would be to avoid any underwater UXO that are identified, it is necessary to consider the potential for underwater UXO detonation where retrieval is deemed to be unsafe, and avoidance is not possible. The purpose of this draft MMMP is to demonstrate the principles of the final MMMP for any UXO clearance.

23. This draft MMMP outlines the mitigation to reduce the risk of injury, including permanent auditory injury / a permanent shift in hearing sensitivity (Permanent Threshold Shift (PTS)), to marine mammals and marine turtles during any UXO clearance work associated with the Offshore Project (including the Windfarm Site and Offshore ECC).

24. As set out in **Section 1.1**, the final MMMP for UXO clearance will be submitted for approval under a future Marine Licence application. This future application will be in addition to the consent Application under Section 36 of the Electricity Act 1989 and relevant Marine Licences under the Marine and Coastal Access Act 2009 for the Offshore Project.

25. The exact number, type or size of UXO and duration of UXO clearance operations is not known at this stage. Therefore, the final detailed MMMP for UXO clearance will be developed pre-construction based on the latest survey information which will provide detailed information on the UXO clearance which could be required. The final MMMP for UXO clearance will provide details of the predicted impact (PTS) ranges and areas from UXO clearance.

26. The final MMMP for UXO clearance will ensure there are embedded mitigation measures, as well as any additional mitigation, if required, to reduce the risk of physical or permanent auditory injury (PTS) to marine mammals and marine turtles. This will incorporate the most appropriate mitigation measures based upon best available information and proven methodologies at that time.

27. The Applicant is committed to using the best practicable means at the time to mitigate the impacts of the Offshore Project.

28. The mitigation in the final MMMP will be based on current good practice, guidance and information, including updated underwater noise modelling, if required, and will be updated no later than six months prior to UXO clearance activities being undertaken.

1.2.1.1 Mitigation

29. The final MMMP would involve the establishment of a suitable Monitoring Area (MA) around the UXO location before any UXO clearance. The MA is the entire mitigation area for the maximum PTS ranges.

30. The Applicant will ensure that the mitigation measures are adequate to reduce the risk of any physical or permanent auditory injury (PTS) within the MA during all UXO clearance.

31. The methods for establishing the MA and reducing the potential impacts of any UXO clearance will be agreed with the MMO in consultation with the relevant SNCBs and TWT and will be secured as commitments within the final MMMP.

32. Where possible and safe to do so, the preferred options would be as follows, in order of preference:

- UXO will be avoided and left in situ
  - Micro-siting of infrastructure, if possible, to avoid any potential UXO, so clearance is not required.
- If the UXO appears structurally sound and there is no risk, the UXO could potentially be relocated to a location that is not in a sensitive area
  - E.g. a designated site or in close proximity to existing or planned infrastructure) for subsequent clearance, subject to a proportional assessment of the risk posed to the vessel and staff from a health and safety perspective.
- If these options are not possible, and UXO clearance is the only option, then;
  - Low-order clearance will be the preferred method (three attempts at a low-order clearance will be made)
  - High-order detonation will only be used if the three low-order clearance attempts were unsuccessful, or the UXO device is unsafe for low-order clearance.

33. The UXO clearance mitigation measures could include:

- All UXO clearance to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less)
- The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO
- Establishment of a MA with minimum of 1km radius. The observation of the MA will be by dedicated and trained marine mammal observers (MMObs) during

daylight hours and suitable visibility, pre- and post-detonation (see **Section 1.2.1.1.4** and **1.2.1.1.5**)

- Deployment of passive acoustic monitoring (PAM) in the MA (see **Section 1.2.1.1.6**), if the equipment can be safely deployed and retrieved
- The activation of acoustic deterrent device (ADD) (see **Section 1.2.1.1.3**) prior to all UXO low-order clearance or high-order detonation (with or without bubble curtains)
- Low-order disposal techniques (see **Section 1.2.1.1.1**), this would be the preferred method for all UXO clearance
- The use of bubble curtains if high-order UXO detonation is required (see **Section 1.2.1.1.2**), taking into account the environmental conditions within which they could be effective
- Unmitigated high order clearance is the least favoured action and last UXO clearance methodology, once all other options have been exhausted.

34. It is important to note these techniques and options are presented as current examples, but the mitigation options will be reviewed and updated based on the latest information and guidance in the final MMMP.

1.2.1.1.1 Low-order UXO clearance techniques

35. Low-order UXO clearance techniques, where the ordnance is disposed of or rendered safe without a high-order detonation is the preferred option for clearance for this work. Examples of low-order techniques include (NPL, 2020):

- Freezing the munition to render it inactive
- Water abrasive suspension jet cutting in order to physically disrupt the munition
- Disposal in a Static Detonation Chamber
- Photolytic destruction of the munition
- Low-order deflagration.

36. Freezing the munition to render it inactive is the technique for salvaging UXOs by using liquid nitrogen or supercooling equipment (Mayer, 2007). Freezing the UXO will encase the filling and provide a high resistance, thus stabilising and sealing the object during treatment and transport. The UXO can then be transported to a safe location to be disposed of safely (Koschinski and Kock, 2015).

37. Water abrasive suspension jet cutting is a technique used to deactivate fused ammunition. It works by using remotely controlled jet cutting which renders the UXO unnecessary. The springs in the mechanical fuses should be simply severed and cables disconnected during cutting. However, the technique may require the

development of custom designed manipulators to cope with difficulties occurring in buried UXO that are piled up or covered in thick rust (Kochinski and Kock, 2015).

38. Disposal in a Static Detonation Chamber is the technique of allowing a safe destruction and cleaned off-gas release, disposing of the UXO in a chamber at approximately 500-550^{o}C. The chamber has a feeding system to ensure the cleaned off-gas, and this can be operated without personnel involved close to the chamber (Kochinski and Kock, 2015).

39. Photolytic ammunition removal is a common method used, which works by flushing out warfare related organic substances from contaminated water with hot water, to then be collected in a reservoir on a barge. The organic explosive substances are then removed from the water using photolysis allowing a quick and complete mineralization and taken back to a laboratory for removal of the main components (Kochinski and Kock, 2015).

40. Deflagration is a technique whereby the explosive within the UXO is rapidly burned at subsonic speeds using plasma from a small, shaped charge that generates insufficient shock to detonate the UXO (Merchant and Robinson, 2020; NPL, 2020). The explosive material inside the UXO reacts with a rapid burning rather than a chain reaction that would lead to a full explosion (NPL, 2020).

41. Substantial noise reduction for deflagration over high-order (peak sound pressure level (SPL_{peak}) and Sound Exposure Level (SEL) are more than 20 dB lower) and acoustic output for deflagration depends only on the size of the shaped charge (rather than the size of the UXO) (NPL, 2020; Robinson *et al.,* 2020).

42. The technique of low-order clearance appears to present a viable option to avoid high-order explosive detonation. Low-order techniques, such as deflagration, are relatively new to civilian applications but have been used by the UK military since 2005 (Merchant and Robinson, 2020). It is expected that the low-order technique used at the Offshore Project would be deflagration, however all options will be considered.

43. Currently, in the unlikely event that low-order clearance was unsuccessful or deemed unsuitable for a specific UXO (e.g., due to its condition) high-order detonation may need to be undertaken.

1.2.1.1.2 Bubble Curtains

44. Where possible, bubble curtains will be used for any high-order detonations to reduce underwater noise impacts from the explosion.

45. Bubble curtains are a flexible system of tubes fitted with special nozzle openings which can be installed on the seabed at a sufficient radius around the UXO. A specialist vessel that is designed specifically for the launch and recovery of the bubble curtain will be used and fitted with large hose reels and a number of air compressors. Compressed air will be discharged via the hose nozzles prior to and during the detonation, causing a curtain of continually rising air bubbles that surround the water column around the UXO location. This process changes the physical condition of the water column with regard to underwater acoustics and upon detonation, acoustic waves are repeatedly broken, theoretically limiting their spatial extent.

46. It is important to consider the environment that the bubble curtains will be deployed in prior to deployment, to ensure that they are effective. Key considerations are water depth, current speeds and wave height.

47. Bubble curtains can be deployed for UXO detonation under the following scenarios:

- UXO is larger than 50kg charge weight
- Water depths are between approximately 5m and 40m
- Significant wave heights are less than 1m
- Maximum wind speed is less than 8m/s
- Current speeds are less than 1.5 knots.

48. It should be noted that bubble curtains are unlikely to be a viable option for UXO clearance at the windfarm site due to the water depths of over 70m, however, they may be possible for any UXO clearance required in the export cable corridor.

49. Once the bubble curtain is in place and prior to the bubble curtain being activated an explosive charge will be attached to, or placed next to, the UXO by a Remotely Operated Vehicle (ROV), and detonation will be undertaken remotely.

50. Once the charge has been detonated, a visual inspection survey using an ROV will be undertaken to confirm that the UXO has been successfully detonated.

1.2.1.1.3 Acoustic deterrence devices (ADD)

51. ADDs are a form of technology that sends out a high-pitched frequency of sound which is uncomfortable for the intended target to hear, and therefore will move away from the preferred location. An ADD will be activated prior to all UXO clearances, from low-order clearance to high-order detonation to ensure marine mammals and marine turtles are deterred from the area and reduce the risk of any physical or auditory injury.

52. ADDs have proven to be effective mitigation for harbour porpoise, dolphin species, and grey seals (Sparling *et al.*, 2015; McGarry *et al.*, 2017; 2020). ADDs have been widely used as mitigation to deter marine mammals and marine turtles during offshore wind farm piling and UXO clearance at sites in Europe (for example, Brandt *et al.*, 2011, 2012, 2013a; 2013b) and offshore Windfarm Sites in the UK, including but not limited to, Galloper, Dudgeon Offshore Windfarm, East Anglia ONE and Moray East.

53. The type and model of ADD will be determined in the final MMMP for UXO clearance, based on the latest information and advice, and will provide sufficient evidence to demonstrate that it is effective at deterring the marine mammal and marine turtle species that could be present in the MA.

54. The ADD will be tested prior to the pre-clearance search to ensure it is working correctly. If there are any technical problems with the ADD then, if required, the UXO clearance would be delayed until these issues are resolved. A back-up ADD will be present on board, in case there are issues with activation of the primary system.

55. The ADD will be deployed and ready to be activated prior to UXO clearance, and be positioned within the water column to ensure that sound can be emitted in all directions. The ADD will be deployed from a vessel in close proximity to the clearance site, where it is safe to be positioned prior to the commencement of the UXO clearance.

56. The best locations to deploy the ADD, and the method to provide power to the device, will be decided through a pre-deployment survey of the vessel or vessels by the ADD operator(s), MMObs, Explosive Ordnance Disposal (EOD) supervisor and vessel operational manager. Once the best locations for the ADD have been determined, the control unit and power supply would be temporarily installed. For deployment of the ADD, the transducer part of the device will be lowered over the side of the deck to a water depth that is below the draft of the vessel to ensure the sound can be emitted in all directions and not dampened by the presence of the vessel.

57. The ADD will be activated at a time so that the end of ADD activation coincides with the end of the monitoring period, immediately prior to either the bubble curtain activation (if being used) or clearance event to allow marine mammals and marine turtles to move beyond the area of potential PTS risk.

58. The ADD will not be activated during transit to another clearance event and will only be activated prior to all clearance events.

59. After the ADD has been activated for the required duration, the ADD operator will deactivate and recover the ADD and undertake routine checks to ensure it is still working correctly, ready for the next deployment and activation.

60. The ADD activation times for low-order clearance, high-order detonation with bubble curtain and high-order detonation without bubble curtain will be determined based on the maximum potential area for PTS and approved by the MMO in the final MMMP.

1.2.1.1.4 Monitoring Area

61. The MA is the area which a pre-detonation search will be undertaken by trained, dedicated, and experienced MMObs. The MA, based on current guidance (JNCC, 2010a) and the distance over which MMObs can undertake effective observations, will have a radius of 1km from the UXO location.

62. The 1km radius of the MA will be measured out from the UXO detonation site with a 360° coverage, representing an area of 3.14km^2.

63. The MA will be monitored for a minimum of 1 hour prior to UXO clearance.

1.2.1.1.5 Marine mammal observers

64. Marine mammal and marine turtle observations will be undertaken by JNCC accredited MMObs. This may be subcontractors or assigned installation vessel crew members that have undertaken the JNCC MMOb course and will be available as dedicated and experienced MMObs, when required, taking into account their other duties.

65. 'Dedicated' is defined as a trained MMOb with the sole purpose of undertaking visual observations to detect marine mammals and marine turtles.

66. 'Experienced' is defined as minimum of 20 weeks experience of implementing JNCC guidelines in UK water within the previous five years.

67. At least two MMObs will conduct surveys to cover the entire MA. Marine mammal and marine turtle observations will be carried out from vantage points to allow unobstructed observations of the entire MA.

68. The MMObs will be equipped with binoculars and a tool to estimate distance i.e. range finding stick or binoculars with reticles and reporting forms. The MMObs will scan the MA with the unaided eye and use binoculars when needed to look in detail at an area where a possible sighting has been made. Binoculars should not be used continually as they restrict peripheral vision and views close to the vessel.

69. Marine mammal and marine turtle observations will be carried out to monitor the MA before, during and after UXO clearance.

70. The pre-clearance search will commence prior to all clearance events, or after any break in the clearance event, and at the end of a clearance event. The visual observations by the MMObs will commence at least one hour prior to the clearance event. This will continue until one hour has passed and no marine mammals and marine turtles have been detected within the MA, the MMObs will then advise that the UXO clearance can commence. The ADD will be activated during the monitoring period at a time so that the end of ADD activation coincides with the end of the monitoring period prior to the UXO clearance.

71. If a marine mammal or marine turtle is detected within the MA during the pre-clearance search, then the commencement of the UXO clearance procedure will be delayed. If a marine mammal has been sighted within the MA, it will be monitored and tracked until it is clear of the MA and the EOD team notified. The marine mammal(s) or marine turtle(s) must be clear of the MA for at least 30 minutes before the UXO clearance commences.

72. During ADD activation, if animals are sighted within the MA, they will be tracked and monitored. If, at the end of the ADD activation period, the individual(s) remains within the MA, then the clearance event will be delayed, and the full mitigation procedure, including the pre-clearance search, will be undertaken again.

73. If the marine mammal(s) or marine turtle(s) remains clear of the MA for at least 30 minutes and the one-hour pre-search has been completed, and the required ADD activation time has been completed, then the UXO clearance can commence. A precautionary approach will always be used. Therefore, if the MMObs cannot be sure whether a marine mammal or marine turtle is within the MA or not, then the UXO clearance will be delayed accordingly until the MMObs are sure that there are no marine mammals or marine turtles present within the MA.

74. All MMObs must be a safe distance from the clearance site prior to any UXO clearance.

75. The MMObs will continue observations during ADD activation, bubble curtain activation (if required) and all UXO clearances.

76. Marine mammal and marine turtle observations will be carried out to monitor the MA during:

- The pre-detonation search
- ADD activation

- Bubble curtain activation (if it is required)
- UXO clearance
- The post-detonation search.

77. The MMObs will record all periods of marine mammal and marine turtle observations, including start and finish time of pre-detonation searches, ADD activation, bubble curtain activation (if required), and conditions during observations (e.g. sea state, visibility, weather, etc.). Any sightings of marine mammals or marine turtles around the vessel(s) will also be recorded. The MMObs will complete the relevant marine mammal recording form(s) and reporting (see **Section 1.2.1.2**).

78. There will be clear communication channels between the MMObs, the ADD operator and the EOD team (see **Section 1.2.1.3**). The communication procedures will be established and agreed prior to any UXO clearance with regards to the communication of any marine mammals or marine turtles observed within the MA, the deployment of ADD, and when the MA is clear for the UXO clearance to commence.

1.2.1.1.6 Passive acoustic monitoring (PAM)

79. The use of PAM is unlikely to be required, as all clearances will take place in daylight and in favourable conditions with good visibility (sea state 3 or less).

80. If required, the use of PAM will be undertaken by trained, dedicated and experienced PAM Operators (PAM-Ops). PAM-Ops will be trained to JNCC standards, with an appropriate level of field experience. The PAM equipment will be appropriate to detect vocalising cetaceans in the MA. PAM-Ops will be responsible for deployment, operation and maintenance of the equipment, including spare equipment, in relation to all UXO clearance.

1.2.1.2 Reporting

81. Reports detailing all UXO clearance activity and mitigation measures will be prepared. This will include, but not necessarily be limited to:

- A record of UXO clearance operations detailing date, location and times including information on the clearance methods and size of charges used
- A record of mitigation measures used such as:
  - ADD deployment, including the date, location, times, any operational issues, start and end times of watches by MMObs,
  - start and end times of any acoustic monitoring using PAM
  - details of all explosive activity during the relevant watches

- A record of all occasions when UXO detonation occurred, including details of the activities used to ensure the MA is established and any occasions when activity was delayed or stopped due to presence of marine mammals and marine turtles
- Any relevant details on the efficiency of the marine mammal or marine turtle exclusion methodology
- A record of marine mammal or marine turtle observations, conditions, description of any marine mammal or marine turtle sightings and any actions taken
- Details of any problems encountered including any instances of non-compliance with the agreed mitigation protocol.

82. A final report will be submitted to the MMO. The final report will include any data collected during UXO clearance operations, details of all mitigation measures, a detailed description of any technical problems encountered and what, if any, actions were taken. The report will also discuss the protocols followed and put forward any recommendations and lessons learned based on the mitigation measures used that could benefit future projects.

1.2.1.3 Communication and responsibilities

83. The final MMMP will detail the communication protocol to ensure that all marine mammal and marine turtle mitigation measures are successfully undertaken for all UXO clearance operations.

84. The final MMMP will also detail all key personnel and their responsibilities to ensure that all marine mammal and marine turtle mitigation measures are successfully undertaken. This will be developed based on the mitigation measures and personnel required (e.g. ADD operator, MMObs, PAM-Ops, EOD team / UXO Manager, Environmental Liaison Officer (ELO)) with the titles and responsibilities being refined depending on the contractual agreement.

1.2.2 Piling

85. Depending on the installation method for the installation of the mooring and anchors for the WTGs and the OSP (if required), impact piling could be required. The purpose of this draft MMMP is to demonstrate the principles of the final MMMP for piling that could be required.

86. This draft MMMP for piling outlines the proposed mitigation to reduce the likelihood of any injury, including any PTS, to marine mammals and marine turtles during all piling operations at the Offshore Project.

87. The final MMMP for piling will be developed in the pre-construction period, when there is more detailed information on the Offshore Project design and will incorporate the most appropriate mitigation measures based upon the latest and best available information and proven methodologies at that time. The final MMMP will be developed in consultation with the MMO, relevant SNCBs and TWT.

88. The final MMMP will include details of the additional mitigation, such as the soft-start and ramp-up, as well as details of the MA and any additional mitigation measures required to minimise potential impacts of any physical injury or PTS. Consideration will be given to the requirements following any breaks in piling as well as prior to piling commencing.

89. The Applicant is committed to using the best practicable means at the time to mitigate the potential impacts of Offshore Project.

90. The mitigation in the final MMMP will be based on current good practice, guidance and information, including updated underwater noise modelling, if required, and will be updated no later than six months prior to piling operations.

91. The aim of the MMMP for piling is to reduce the risk of PTS during piling for either WTG or OSP mooring and anchors from:

- First strike of the starting hammer energy of the soft start
- Single strike of the maximum hammer energy
- Cumulative exposure during installation, based on worst-case for six pin-piles installed in the same 24-hour period or four OSP jacket piles installed in the same 24-hour period.

92. Underwater noise modelling will be used to derive the maximum potential PTS ranges once the design of the Offshore Project has been finalised.

1.2.2.1 Mitigation

93. The final MMMP would involve the establishment of a MA around the pile location before each pile driving activity, based on the maximum predicted distance for PTS. The final MMMP for piling will provide details of the maximum predicted impact (PTS) ranges and areas for piling.

94. The Applicant will ensure that the mitigation measures are adequate to minimise the risk of marine mammals and marine turtles being present within the MA prior to piling activity commencing, to reduce the risk of any physical or auditory injury (PTS).

95. The methods for establishing the MA and reducing the potential impacts of piling operations would be agreed with the MMO in consultation with the relevant SNCBs and TWT and would be secured as commitments within the final MMMP.

96. The piling mitigation measures could include:

- Establishment of a MA with a minimum 500m radius (see **Section 1.2.2.1.1**)
  - The observation of the MA will be conducted by trained, dedicated and experienced MMObs during daylight hours and when conditions allow suitable visibility (visibility of entire MA; sea state 3 or less)
  - Deployment of PAM devices in the MA during poor visibility or at night.
- The activation of ADD (see **Section 1.2.2.1.4**)
- Soft-start and ramp-up (see **Section 1.2.2.1.5**)
- Procedure for breaks in piling (see **Section 1.2.2.1.6**).

1.2.2.1.1 Monitoring area

97. The MMMP will involve the establishment of a MA with a minimum radius of 500m around each WTG and OSP (if required) location before piling.

98. The radius of the MA will be greater than the maximum predicted impact range for PTS for marine mammal or marine turtle species that could be present in or around the Windfarm Site.

99. The requirement for a minimum radius of 500m is in line with the current JNCC (2010b) guidelines, to reduce the risk of PTS.

100. The MA will be monitored for a minimum of 30 minutes prior to soft-start commencing.

1.2.2.1.2 Marine mammal observers

101. Marine mammal and marine turtle observations (MMObs) will be undertaken by JNCC accredited MMObs. This may be subcontractors or assigned installation vessel crew members that have undertaken the JNCC MMOb course and will be available as dedicated and experienced MMObs, when required, taking into account their other duties.

102. ‘Dedicated’ is defined as a trained MMOb with the sole purpose of undertaking visual observations to detect marine mammals and marine turtles.

103. ‘Experienced’ is defined as minimum of 20 weeks experience of implementing JNCC guidelines in UK water within the previous five years.

104. At least two MMObs will conduct surveys to cover the entire MA around each pile location. Marine mammal and marine turtle observations will be carried out from vantage points to allow unobstructed observations of the entire MA.

105. The MMObs will be equipped with binoculars and a tool to estimate distance i.e. range finding stick or binoculars with reticules and reporting forms. The MMObs will scan the MA with the unaided eye and use binoculars when needed to look in detail at an area where a possible sighting has been made. Binoculars should not be used continually as they restrict peripheral vision and views close to the vessel.

106. Marine mammal and marine turtle observations will be carried out to monitor the MA:

- During ADD activation
- During the soft-start and ramp-up procedure
- During any breaks in piling prior to piling recommencing.

107. Where possible, MMObs will continue monitoring during piling to allow for any breaks in piling (for further information see **Section 1.2.2.1.6**).

108. The pre-piling monitoring will commence prior to all piling events, or after any break in piling. The visual observations by the MMObs will commence at least 30 minutes prior to the soft-start commencing. This will continue until 30 minutes have passed and no marine mammals or marine turtles have been detected within the MA, the MMObs will then advise that the soft-start can commence. The ADD will be activated during the monitoring period at a time so that the end of ADD activation coincides with the end of the monitoring period prior to the soft-start.

109. If a marine mammal or marine turtle is detected within the MA during the pre-piling monitoring, then the commencement of the soft-start will be delayed. If a marine mammal or marine turtle has been sighted within the MA, it will be monitored and tracked until it is clear of the MA and the Piling Supervisor notified. The marine mammal(s) or marine turtle(s) must be clear of the MA for at least 30 minutes before the soft-start commences.

110. During ADD activation, if animals are sighted within the MA, they will be tracked and monitored. If, at the end of the ADD activation period, the individual(s) remains within the MA, then the soft-start will be delayed, and the full mitigation procedure, including the pre-monitoring, will be undertaken again.

111. If the marine mammal(s) or marine turtle(s) remains clear of the MA for at least 30 minutes and the pre-piling monitoring has been completed, and the required ADD

activation time has been completed, then the soft-start can commence. A precautionary approach will always be used. Therefore, if the MMObs cannot be sure whether a marine mammal or marine turtle is within the MA or not, then the soft-start will be delayed accordingly until the MMObs are sure that there are no marine mammals and marine turtles present within the MA based on their expert judgement.

112. The MMObs will record all periods of marine mammal and marine turtle observations, including start and finish time of observations, when soft-start and piling commenced and conditions during observations (e.g. sea state, visibility, weather, etc.). Any sightings of marine mammals or marine turtles around the piling vessel will also be recorded. The MMObs will complete the relevant marine mammal recording form(s) and reporting (for further information see **Section 1.2.2.2**).

113. There will be clear communication channels between the MMObs, the ADD operator and the Piling Supervisor (see **Section 1.2.2.3**). The communication procedures will be established and agreed prior to any piling to ensure clear communication of any marine mammal or marine turtle observations within the MA, the deployment of ADD, and when the MA is clear for the piling soft-start to commence.

1.2.2.1.3 Passive acoustic monitoring

114. The use of PAM will be undertaken by trained, dedicated and experienced PAM-Ops during periods of poor visibility and darkness prior to piling.

115. PAM-Ops will be trained to JNCC standards, with an appropriate level of field experience. The PAM equipment will be appropriate to detect vocalising cetaceans in the MA. PAM-Ops will be responsible for deployment, operation and maintenance of the equipment, including spare equipment, in relation to all piling activities.

116. The PAM-Ops will ensure that the equipment and spares are functioning correctly prior to the start of the mitigation. Hydrophones and software should be configured to detect the species relevant to the area (including harbour porpoise and dolphin species). If the PAM equipment is to be deployed from the deck of the piling vessel, a survey of the piling vessel will be conducted, prior to when deployment may be needed, to agree the best locations for deployment and monitoring. PAM-Ops will assist in preparation and update of risk assessment for hydrophone deployment in collaboration with vessel personnel.

117. If required, PAM will be carried out to monitor the MA:

- During pre-piling monitoring period
- During ADD activation

- During the soft-start and ramp-up procedure
- During any breaks in piling prior to piling recommencing.

118. Where possible, PAM will continue monitoring during piling to allow for any breaks in piling.

119. The PAM-Ops will record and report all periods of PAM, including start and finish time of monitoring, if and when marine mammals or marine turtles were detected, especially in relation to when ADDs were activated and, when soft-start, ramp-up and piling was underway. The PAM-Ops will provide the necessary data and information to be included in the reporting (see **Section 1.2.2.2**).

120. There will be clear communication channels between the PAM-Ops, MMObs, the ADD operator and the Piling Supervisor (see **Section 1.2.2.3**).

1.2.2.1.4 Acoustic deterrent device (ADD)

121. An ADD will be activated prior to the soft-start as mitigation to reduce the risk of PTS during piling.

122. The type and model of ADD will be determined in the final MMMP for piling, based on the latest information and advice, and will provide sufficient evidence to demonstrate that it is effective at deterring the marine mammal or marine turtle species that could be present in the MA.

123. The ADD will be tested prior to the pre-piling monitoring to ensure it is working correctly. If there are any technical problems with the ADD then, if required, the soft-start would be delayed until these issues are resolved. A back-up ADD will be present on board, in case there are issues with activation of the primary system.

124. The ADD will be deployed and ready to be activated prior to soft-start commencing.

125. The ADD will be positioned within the water column to ensure that sound can be emitted in all directions. The ADD will be deployed from the piling vessel in close proximity to the piling location, where it is safe to be positioned prior to the commencement of the soft-start.

126. For deployment of the ADD, the transducer part of the device will be lowered over the side of the deck to a water depth that is below the draft of the vessel to ensure the sound can be emitted in all directions and not dampened by the presence of the vessel. The depth for the ADD deployment will be predetermined to ensure it is below the draft of the vessel, and well above the seabed (preferably in the middle of the water column) at the piling location.

127. The ADD will be activated at a time so that the end of ADD activation coincides with the end of the monitoring period, immediately prior to soft-start commencing to allow marine mammals and marine turtles to move beyond the area of potential PTS risk.

128. The duration of the ADD activation time will be determined based on the maximum range for PTS. The maximum duration of the ADD activation time will also be determined to reduce risk of increased disturbance. This is deemed as 62 minutes for OSP jacket piles, or 31 minutes for mooring pin piles (for further information see **Chapter 12: Marine Mammal and Marine Turtle Ecology**).

129. Further information on ADDs is provided in Section 1.2.1.1.3.

130. The MA will be monitored by MMObs and / or PAM-Ops during the ADD activation period. Once the soft-start proceeds, the ADD will be switched off.

131. The procedures for ADD activation for breaks in piling is outlined in **Section 1.2.2.1.6**. ADD will not be operated intermittently during any breaks in piling.

132. The ADD will be deployed from the deck of the piling vessel, with the control unit and power supply on board the piling vessel in suitable positions on deck. Prior to deployment, a survey of the piling vessel will be conducted to agree the best location and method of providing power supply and communications. ADD equipment will have sufficient cable from the power point on the vessel to be deployed in the mid-water column.

133. The ADD operator will maintain a detailed record of all ADD deployments and activation (see **Section 1.2.2.2**). These reports will include a record of all ADD start and stop times, a record of each verification of ADD activation and a record of any issues with ADD deployment and activation.

1.2.2.1.5 Soft-start and Ramp-up

134. Following the activation period of the ADD, the soft-start procedure will commence. The soft-start starting hammer energy will be the lowest possible starting hammer energy.

135. A ramp-up period will follow the soft-start, with the energy used per hammer blow gradually increasing so that if any marine mammals or marine turtles are in the area, despite the pre-piling activation of the ADD, they are encouraged to leave by the initial low levels of underwater noise prior to the noise reaching levels which could cause PTS.

136. The Applicant would ensure that a soft-start and ramp-up procedure for piling is conducted for a minimum of 30 minutes.

137. It is proposed that each piling event would commence with a minimum of 10 minutes at 10% of the maximum hammer energy, followed by a gradual ramp-up for at least 20 minutes up to 80% of the maximum hammer energy for all pile driving activities.

138. This 30-minute soft start and ramp-up procedure is more precautionary than the current JNCC (2010b) guidance, which recommends that the soft-start and ramp-up duration should be a period of not less than 20 minutes.

139. During the 30 minutes for the soft-start and ramp-up it is estimated that marine mammals and marine turtles would move at least 2.7km from the piling location. This would be greater than the maximum predicted distance for PTS from a single strike at the maximum hammer energy:

- During the 10-minute soft-start it is estimated that marine mammals would move a minimum of 0.9km from the piling (based upon a precautionary swimming speed of 1.5m/s (Otani *et al.*, 2000))
- During the 20-minute ramp-up it is estimated that marine mammals would move a minimum of 1.8km from the piling location (based upon a precautionary average swimming speed of 1.5m/s (Otani *et al.*, 2000)).

140. In the event that piling activity is stopped for more than 10 minutes, the Applicant would ensure that the soft-start and ramp-up procedure is conducted prior to piling re-commencing.

141. The soft-start and ramp-up procedure would be embedded mitigation for all piling operations.

1.2.2.1.6 Breaks in piling

142. For any breaks in piling the following mitigation is proposed, depending on the duration of the break:

- For any breaks in piling of less than 10 minutes, piling may continue as required (i.e. as if there was no break)
- For any breaks in piling of more than 10 minutes then the full mitigation procedure (as outlined above) is required, including 30-minute monitoring of the MA by MMObs and / or PAM, ADD deployment and activation for the required time, followed by the soft-start and ramp-up procedure (for a minimum of 20 minutes)

- Monitoring of the MA during any breaks in piling will be conducted by MMObs during daylight hours and suitable visibility or by PAM-Ops during poor visibility or at night
- If monitoring was conducted during piling prior to any breaks and the MA has been confirmed as having no marine mammals or marine turtles, then it may be possible to commence the soft-start immediately. The soft-start and ramp-up procedure would be for a minimum of 20 minutes as outlined in the JNCC guidance.

1.2.2.1.7 Piling at night / poor visibility

143. If piling is to commence in poor visibility or at night, the monitoring of the MA will be done by PAM as outlined in **Section 1.2.2.1.3**.

144. The deployment and activation of the ADD in poor visibility and at night will follow the same procedure as outlined in **Section 1.2.2.1.4**, as will the soft-start and ramp-up procedure as outlined in **Section 1.2.2.1.5**.

1.2.2.2 Reporting

145. Reports detailing the piling activity and mitigation measures would be prepared for all piling activity. This would include, but not necessarily be limited to:

- A record of piling operations detailing date, location, times (including soft-starts and ramp-up) and any technical or other issues for each pile
- A record of mitigation measures such as ADD deployment and activation, detailing date, location, times and any operational issues
- A record of all occasions when piling occurred, including details of the activities used to ensure the MA is established and any occasions when piling activity was delayed or stopped due to presence of marine mammals or marine turtles
- Any relevant details on the efficiency of the marine mammal and marine turtle exclusion methodology
- A record of marine mammal and marine turtle observations, conditions, description of any marine mammal or marine turtle sightings and any actions taken
- Details of any problems encountered during the piling process including instances of non-compliance with the agreed piling and / or mitigation protocol.

146. The reporting schedule is to be agreed with the MMO post-consent and may include weekly reports and a final report. Any final report would include information, such as:

- Data collected during piling operations
- Details of ADD deployment and / or other mitigation measures
- A detailed description of any technical problems encountered and what, if any, actions were taken.

147. The report would also discuss the protocols followed and put forward any recommendations and lessons learned based on the mitigation measures used that could benefit future construction projects.

1.2.2.3 Communication and responsibility

148. The final MMMP for piling will detail the communication protocol to ensure that all marine mammal and marine turtle mitigation measures, including any delays in commencing piling due to marine mammals and marine turtles being present in the area, are successfully undertaken for all piling activity.

149. The final MMMP for piling will also detail all key personnel and their responsibilities to ensure that all marine mammal and marine turtle mitigation measures are successfully undertaken for all piling activity. This will be developed based on the mitigation measures and personnel required (e.g. ADD operators, MMOs, PAM operators, ELO, Piling Supervisor / Offshore Installation Manager) with the titles and responsibilities being refined depending on the contractual agreement.

1.3 Vessel Management Measures

150. Management measures will be implemented to reduce the potential for vessel collision with marine mammals and marine turtles. These measures will also reduce the potential for disturbance to marine mammals due to an increase in vessel presence.

151. The management measures that will be implemented throughout the construction, operation and maintenance, and decommissioning phases are;

- Vessel movements, where possible, will follow set vessel routes and hence areas where marine mammals and marine turtles are accustomed to vessels
- All vessel movements will be kept to the minimum number that is required

- Additionally, vessel operators will follow best practice guidance to reduce any risk of collisions with marine mammals and marine turtles, such as following the Cornwall Marine and Coastal Code for Vessels[1]
- All vessels will transit to and from the Windfarm Site at less than 10 knots, at all times, to further reduce the potential for collision risk
- No vessel will transit within 600m of any known seal haul out site at any time, or within 2km of Lundy

152. The above listed vessel management measures will be secured within the final MMMP.

[1] https://www.cornwallwildlifetrust.org.uk/sites/default/files/2019-03/Cornwall%20Marine%20and%20Coastal%20Code%20Guidelines.pdf

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WHITE CROSS

White Cross Offshore Windfarm Environmental Statement

Appendix 12.D: In Principle Site Integrity Plan for the Bristol Channel Approaches Special Area of Conservation

Document History

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Glossary of Acronyms

Acronym	Definition
AA	Appropriate Assessment
AEOI	Adverse Effect on Integrity
BEIS	Department for Business, Energy and Industrial Strategy
CI	Confidence Interval
CIS	Celtic and Irish Sea
CV	Coefficient of Variation
dB	Decibel
DML	Deemed Marine Licence
EDR	Effective Deterrent Radius
EPS	European Protect Species
ES	Environmental Statement
ETG	Expert Topic Group
FCS	Favourable Conservation Status
IAMMWG	Inter-Agency Marine Mammal Working Group
JNCC	Joint Nature Conservancy Council
km	Kilometre
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effect
m	Metre
MLW	Mean Low Water
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MRE	Marine Renewable Energy
MU	Management Units
OSP	Offshore Substation Platform
OWF	Offshore Windfarm
OWL	Offshore Wind Ltd
PCoD	Population Consequences of Disturbance
RIAA	Report to Inform an Appropriate Assessment
SAC	Special Area of Conservation
SIP	Site Integrity Plan
SNCB	Statutory Nature Conservation Body
TWT	The Wildlife Trust
UK	United Kingdom
UXO	Unexploded Ordnance
WDC	Whale and Dolphin Conservation
WTG	Wind Turbine Generator

Glossary of Terminology

Defined Term	Description
Applicant	Offshore Wind Limited
Project Design Envelope	A description of the range of possible elements that make up the Offshore Project design options under consideration. The Offshore Project Design Envelope, or 'Rochdale Envelope' is used to define the Offshore Project for Environmental Impact Assessment (EIA) purposes when the exact parameters are not yet known but a bounded range of parameters are known for each key project aspect.
Development Area	The area comprising the Onshore Development Area and the Offshore Development Area
Engineer, Procure, Construct and Install (EPCI)	A common form of contracting for offshore construction. The contractor takes responsibility for a wide scope and delivers via own and subcontracted resources.
Environmental Impact Assessment (EIA)	Assessment of the potential impact of the proposed Project on the physical, biological and human environment during construction, operation and decommissioning.
Floating substructure	The floating substructure acts as a stable and buoyant foundation for the WTG. The WTG is connected to the substructure via the transition piece and the substructure is kept in position by the mooring system.
Generation Assets	The infrastructure of the Offshore Project related to the generation of electricity within the Windfarm Site, including wind turbine generators, substructures, mooring lines, seabed anchors and inter-array cables
In-combination effects	In-combination effects are those effects that may arise from the development proposed in combination with other plans and projects proposed/consented but not yet built and operational.
Mean high water springs	The average tidal height throughout the year of two successive high waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean low water springs	The average tidal height throughout a year of two successive low waters during those periods of 24 hours when the range of the tide is at its greatest.
Mean sea level	The average tidal height over a long period of time.
Mitigation	Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts, and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels. For the purposes of the EIA, two types of mitigation are defined:

Defined Term	Description
	• Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the EIA • Additional mitigation: consisting of mitigation measures that are identified during the EIA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by OWL as the EIA process progresses.
Offshore Development Area	The Windfarm Site (including wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and Offshore Export Cable Corridor to MHWS at the Landfall. This encompasses the part of the Offshore Project that is the focus of this application and Environmental Statement and the parts of the Offshore Project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009
Offshore Infrastructure	All of the offshore infrastructure including wind turbine generators, substructures, mooring lines, seabed anchors, Offshore Substation Platform and all cable types (export and inter-array). This encompasses the infrastructure that is the focus of this application and Environmental Statement and the parts of the Offshore Project consented under Section 36 of the Electricity Act and the Marine and Coastal Access Act 2009
Offshore Substation Platform	A fixed structure located within the Windfarm Site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore
Project	The Offshore Project for the offshore Section 36 and Marine Licence application includes all elements offshore of MHWS. This includes the infrastructure within the Windfarm Site (e.g. wind turbine generators, substructures, mooring lines, seabed anchors, inter-array cables and Offshore Substation Platform (as applicable)) and all infrastructure associated with the export cable route and landfall (up to MHWS) including the cables and associated cable protection (if required).
Service operation vessel	A vessel that provides accommodation, workshops and equipment for the transfer of personnel to turbine during OMS. Vessels in service today are typically up to 85m long with accommodation for about 60 people.
White Cross Offshore Windfarm	100MW capacity offshore windfarm including associated onshore and offshore infrastructure
Wind Turbine Generators (WTG)	The wind turbine generators convert wind energy into electrical power. Key components include the rotor blades, naccelle (housing for electrical generator and other electrical and control equipment) and tower. The final selection of project wind turbine model will be made post-consent application
Windfarm Site	The area within which the wind turbines, Offshore Substation Platform and inter-array cables will be present

Defined Term	Description
Works completion date	Date at which construction works are deemed to be complete and the windfarm is handed to the operations team. In reality, this may take place over a period of time.

1. Appendix 12.D: In Principle Site Integrity Plan for the Bristol Channel Approaches Special Area of Conservation

1.1 Introduction

1. This In Principle Site Integrity Plan (SIP) for the Bristol Channel Approaches / Dynesfeydd Môr Hafren Special Area of Conservation (SAC) (referred to as the Bristol Channel Approaches SAC) is for the proposed White Cross Offshore Windfarm Project (the Offshore Project) on behalf of Offshore Wind Limited (OWL), hereby referred to as the 'Applicant'.

2. The In Principle SIP for the Bristol Channel Approaches SAC sets out the approach to delivering measures for the Offshore Project to ensure the avoidance of significant disturbance of harbour porpoise (*Phocoena phocoena*) during piling works, in relation to the Bristol Channel Approaches SAC Conservation Objectives.

3. The Bristol Channel Approaches SAC was designated for harbour porpoise in February 2019. Harbour porpoise is the primary and only listed feature of the site.

4. The Bristol Channel Approaches SAC has been recognised as an area with persistent high densities of harbour porpoise (Joint Nature and Conservation Committee (JNCC), 2017; JNCC *et al*., 2019).

1.1.1 Purpose of this document

5. The purpose of the In Principle SIP is to set out the approach to deliver potential mitigation measures that may be required to ensure the avoidance of Adverse Effect on Integrity (AEOI) of the designated feature of Bristol Channel Approaches SAC (**Figure 7.1** of the **Report to Inform Appropriate Assessment** (**RIAA**)) shows the Bristol Channel Approaches SAC in relation to the Offshore Project.

6. The approach and measures in this In Principle SIP are in relation to the Offshore Project only and are in response to the conclusions of the **RIAA**. The **RIAA** concludes that (subject to the final design of the Offshore Project, and the actual in-combination scenario for offshore windfarm projects that could be constructed at the same time) further mitigation and management measures may be necessary. This is in relation to the potential in-combination effects of underwater noise during pile driving in order to ensure there will be no adverse effect on the designated feature of the Bristol Channel Approaches SAC. It should be noted that this is the only effect from the RIAA that is considered within in this SIP. This SIP considers piling at the Offshore Project only, as UXO is not currently being consented for.

7. Following completion of the Appropriate Assessment (AA) by the Competent Authority, it is acknowledged that the In Principle SIP may require revision to reflect the conclusions of the AA, the final design of the Offshore Project, and the actual in-combination scenario for offshore windfarm projects that could be constructed at the same time. Therefore, the SIP should be considered a 'live' document. The mitigation and management measures that may need to be secured in the final SIP at the pre-construction stage will be based on the AA as well as the final design of the Offshore Project. This is in relation to the potential barrier effects as a result of underwater noise, in order to ensure there will be no AEOI on the designated feature of the Bristol Channel Approaches SAC.

8. It is also possible that mitigation and management measures will be required for other plans and projects located within the vicinity of the Offshore Project as part of the in-combination AA. However, it is not possible at this stage for the Applicant to detail what these will be, or how they will be secured. Therefore, they are outside the scope of the In Principle SIP.

9. The draft In Principle SIP is based on the most appropriate project related measures, taking into account the current requirements, guidance, knowledge and proven available technology at the time of writing.

10. In its final form, the SIP will include any updated information on management measures, advice or guidance for the Bristol Channel Approaches SAC and the final design of the Offshore Project.

1.1.2 Scope of the document

11. The scope of this document covers the potential for any significant barrier effects of harbour porpoise from underwater noise at the Offshore Project. This was the only effect that was identified in the RIAA as requiring further action to avoid AEOI.

12. Any offshore unexploded ordnance (UXO) clearance required will be assessed and mitigation determined as part of a separate Marine Licence application at the pre-construction stage. Therefore, disturbance from underwater noise during UXO clearance at the Windfarm Site has not been included in this In Principle SIP as it will not be authorised under the Section 36 application for the Offshore Project.

13. It should be noted that the final Marine Mammal Mitigation Protocol (MMMP) to be produced at the pre-construction stage in accordance with **Appendix 12.C: Draft MMMP**. This will provide details of the mitigation requirements during piling at the Windfarm Site in relation to any physical or auditory injury to marine mammals, including harbour porpoise. In addition, any requirements to reduce disturbance in

relation to European Protected Species (EPS) will be captured through the EPS licensing process.

14. Indicative mitigation measures are outlined which would be developed in consultation with the Marine Management Organisation (MMO) and other relevant bodies (see **Section 1.3.2**) at the pre-construction stage, based on the final design of the Offshore Project. This document sets out how the Marine Licence will be met and provides a framework for further discussion and consultation by the Applicant with the MMO and other relevant stakeholders. This Includes Statutory Nature Conservation Bodies (SNCBs) and The Wildlife Trusts (TWT), to agree the exact details of any required project related management measures.

1.1.3 Project background

15. The Windfarm Site is located in the Celtic Sea off the coast of Wales and Cornwall. The Windfarm Site will cover an area of approximately 49.36km^2. The closest point to the coast is 52.5km from the Windfarm Site. Depths range from 69.07m to 78.12m below Lowest Astronomical Tide (LAT).

16. The detailed design of the Offshore Project (e.g. numbers of wind turbine generators (WTGs) and foundation / mooring type) will not be determined until the post-consent stage. Therefore, realistic worst-case scenarios have been adopted within the assessment which ensures the mitigation and management measures within this In Principle SIP are precautionary and robust.

17. The indicative construction programme assumes that the earliest any offshore construction works would start is 2025. Offshore construction works would require up to 16 months (excluding pre-construction activities such as surveys).

1.1.4 Requirement for this document

18. Due to the long lead-in times for the development of offshore windfarms, it is not possible to provide final detailed method statements for piling prior to consent. As a result, the detail of any required mitigation cannot be agreed at this stage. The agreement of guiding principles to mitigation are made through this In Principle SIP as part of the consenting process. Therefore, permits for the final mitigation as part of the Marine Licence are to be specified pre-construction as part of the detailed design and allows refinements to be made based on the best practice, available knowledge and technology at that time. The binding commitment of the Applicant is to implement measures in agreement with the SNCBs to ensure piling works will avoid AEOI on Bristol Channel Approaches SAC.

19. This In Principle SIP reflects the commitment of the Applicant to undertake required measures to reduce the potential for any significant disturbance of harbour porpoise in the Bristol Channel Approaches SAC. Whilst allowing scope for refinement of the measures through consultation once the final construction methods for the Offshore Project have been confirmed. This will enable use of the most appropriate project related measures to be confirmed based on best knowledge, evidence and proven available technology at the time of construction.

20. A final SIP will be produced, and agreed with SNCBs, at least four months prior to the commencement of offshore construction, following revision and consultation, as per the outline schedule in **Section 1.2.1**.

21. The Applicant acknowledges that any required mitigation or management measures should be precise, effective and deliverable in a timely manner to maintain the integrity of the Bristol Channel Approaches SAC for harbour porpoise. The SIP is designed to ensure that this will be the case once any required measures have been defined. **Section 1.2.1** provides an outline of the proposed schedule for refinement and sign-off for the final SIP.

22. The Applicant considers that the In Principle SIP is an appropriate mechanism to ensure mitigation is applied where necessary, whilst allowing scope for refinement of the precise mitigation measures to be agreed and adopted through consultation once final construction methods for the Offshore Project have been confirmed. This will enable use of the most appropriate project related measures to be confirmed based on best knowledge, evidence and proven available technology at the time of construction. This approach will also enable the mitigation, if required, to be specific to the level of impact reduction deemed necessary. This approach will remove the need to revise the Marine Licence condition should the most suitable measures to be adopted change between the time of consent and construction.

23. Any requirements to implement noise abatement technology would be subject to additional marine licensing processes, if required.

1.2 Consultation

24. Consultation on the structure and content of the final SIP will be conducted with the MMO and other relevant SNCBs throughout its development and a full consultation log will be maintained.

25. There will be an ongoing requirement to review the need for project mitigation and management measures with the MMO and other relevant organisations. The Applicant will consult with NE (NE), TWT, and the Whale and Dolphin Conservation

(WDC) on the development of the SIP as project design and construction plans are progressed.

26. A consultation programme will be developed at the pre-construction stage.

1.2.1 Schedule of agreement

27. It is not possible at this stage to determine exact dates for agreement and refinement of the final SIP. However, the key milestones have been outlined in **Table 1.1** to indicate the likely development of the SIP from its current in principle status to the final version between consent award and the start of construction. As the Offshore Project progresses, the time period in which stages take place will be updated as the final SIP is refined.

Table 1.1 Indicative milestones for refinement of the In Principle SIP towards agreement of the final SIP pre-construction

Indicative Stage	When	Action for the Applicant	Relevant Authority / Consultee	Status
In Principle SIP	Section 36 and Marine Licences submission	In principle SIP to be submitted with Section 36 application	MMO	This document
Update to In Principle SIP	During Section 36 and Marine Licences determination process	If required, the In Principle SIP will be reviewed and updated during the Section 36 determination process	MMO, NE and TWT	To be completed
Consent determination and AA	Upon consent determination	Review In Principle SIP, identify areas for revisions/updates which will need to be carried forward into the final SIP.	White Cross Project Internal only	To be completed
Engineering Design	Pre-construction	Any updates or changes during the pre-construction period, within the consented envelope. Any updated project design will also require consideration in the SIP.	White Cross Project Internal only	To be completed
Preparation and consultation on draft Final SIP	Approximately 12 months prior to commencement of construction	The SIP will be updated to capture all relevant assessments and mitigation measures.	MMO, NE and TWT	To be completed

Indicative Stage	When	Action for the Applicant	Relevant Authority / Consultee	Status
Final design	Approximately six to nine months prior to construction	Provide project details relevant to the SIP. In addition, accompanying environmental information, including an assessment of the efficacy of mitigation or management measures will be provided.	MMO, NE; with copies sent to TWT	To be completed
Final SIP approval	Approximately four months prior to commencement of construction	The SIP will be updated and finalised. Within the final SIP, an implementation plan and details of any monitoring requirements to assess the effectiveness of mitigation measures will be included. The final SIP will be submitted for approval approximately four months prior to the commencement of pile driving for written approval from the MMO prior to any piling works commencing.	MMO for approval. (NE role is advisory)	To be completed
Construction monitoring and reporting	Construction	Monitoring/management reports will be submitted to the MMO.	MMO. (NE role is advisory)	To be completed

1.3 Bristol Channel Approaches SAC for harbour porpoise

28. The Bristol Channel Approaches SAC is an area recognised to have a seasonal variation in abundances of harbour porpoise. Harbour porpoise occur within the site year round, but are seen in persistently higher densities during winter, compared to other parts of the Management Unit (MU) (Joint Nature Conservation Committee (JNCC), 2021).

29. The Bristol Channel Approaches SAC covers an area of 5,850km^2, and supports a diversity of habitat types, from reefs to mudflats. Water depths range from Mean

Low Water (MLW) down to 70m along the western boundary. The site area is 5,850km^2 and it is only important during the winter period (182 days from October to March inclusive) (JNCC *et al.*, 2020).

30. The closest point to the Offshore Project's Windfarm Site is approximately 1.5km from the Bristol Channel Approaches SAC, with the cable corridor running directly through the SAC (**Table 1.2**).

Table 1.2 Distances of the Offshore Project to the Bristol Channel Approaches SAC winter area

Location	Closest point to Bristol Channel Approaches SAC
Windfarm Site	1.5km
Export cable corridor	Overlaps
Landfall location	23km

31. The Bristol Channel Approaches SAC is estimated to support 4.7% of the UK Celtic and Irish Sea (CIS) MU. This site is recognised as important for harbour porpoises, specifically during the winter months, when high densities persistently occur.

32. Distribution and abundance maps have been developed by Waggitt *et al.* (2020) for harbour porpoise and show a consistent presence in the Bristol Channel Approaches SAC, and the coasts off south-west England and south Wales, for both January and July (Waggitt *et al.*, 2020). Examination of this data, including all 10km grids that overlap with the Offshore Project, including export cable corridor areas, indicates an average annual density estimate of:

- 0.57995 individuals/km^2 of the Windfarm Site and export cable corridor.

33. The Offshore Project's offshore sites are in the SCANS-III survey block D (Hammond *et al.,* 2021) where:

- Abundance estimate = 5,734 harbour porpoise (95% Confidence Interval (CI) = 1,697-12,452)
- Density estimate = 0.118 harbour porpoise/km^2 (Coefficient of Variation (CV) = 0.489).

34. Data from the Offshore Project's site-specific surveys have also been used to generate abundance and density estimates for the sites with a 4km buffer (for further details see **Chapter 12: Marine Mammal and Marine Turtle Ecology**). The average of the winter months, summer months, and annual density has then been calculated based on the maximum calculated for each month. **Table 1.3** shows the densities for harbour porpoise, from both the APEM site-specific surveys

(and considering all individuals that have the potential to be harbour porpoise), and the data from Waggit *et al*. (2020).

Table 1.3 Maximum harbour porpoise summer, winter and annual density estimate for the Offshore Project's survey areas plus 4km buffer

Season	Maximum density estimate (corrected) for whole survey area (animals/km2)
Waggit *et al*., (2020) densities	
Average winter	0.576
Average summer	0.584
Average annual	0.580
APEM (2022) densities	
Average winter	0.108
Average summer	0.918
Average annual	0.594

35. Although the density calculations from Waggit *et al*. (2020) do not show seasonal variation, this is not the case with the site-specific surveys conducted (APEM, 2022; **Table 1.3**). The site-specific surveys indicate a seasonal pattern in the abundance of harbour porpoise, with higher numbers present in the summer months within the survey area. There is no evident pattern of harbour porpoise distribution within the survey area, with no indication of a particular area of importance (for further details see **Chapter 12: Marine Mammal and Marine Turtle Ecology**). Due to the APEM (2022), densities showing a higher estimate during the summer (0.918; **Table 1.3**), this will be used going forward in this assessment.

36. The Inter-Agency Marine Mammal Working Group (IAMMWG, 2022) define three MUs for harbour porpoise. The Offshore Project's offshore sites are located in the CIS MU (for further information, see **Section 12.6.1** of **Chapter 12: Marine Mammal and Marine Turtle Ecology**).

37. The IAMMWG estimate of harbour porpoise abundance in the CIS MU is 62,517 (CV = 0.13; 95% CI = 48,324 – 80,877) (IAMMWG, 2022). This is the reference population for harbour porpoise used in the assessments (as supported by NE – see **Chapter 12: Marine Mammal and Marine Turtle Ecology**).

38. The Bristol Channel Approaches SAC Site Selection Report (JNCC, 2017a) identifies that the Bristol Channel Approaches SAC site supports approximately 2,147 individuals (95% Confidence Interval: 810 – 5,693) for at least part of the year (JNCC, 2017a). However, JNCC *et al*. (2019), states that because this estimate is from a one-month survey in a single year (the SCANS-II survey in July 2005) it cannot be considered as an estimated population for the site. It is therefore not appropriate to use site population estimates in any assessments of effects of plans

or projects on the site (i.e. HRA), as they need to take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals (JNCC *et al*., 2019).

1.3.1 Conservation objectives

39. The Conservation Objectives for the Bristol Channel Approaches SAC are designed to help ensure that the obligations of the Habitats Directive can be met. Article 6(2) of the Habitats Directive requires that there should be no deterioration or significant disturbance of the qualifying species or to the habitats upon which they rely.

40. The Conservation Objectives (JNCC *et al*., 2019) for the Bristol Channel Approaches SAC are:

"To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters

In the context of natural change, this will be achieved by ensuring that:

1. *Harbour porpoise is a viable component of the site*
2. *There is no significant disturbance of the species*
3. *The condition of supporting habitats and processes, and the availability of prey is maintained"*

41. These Conservation Objectives are:

"*a set of specified objectives that must be met to ensure that the site contributes in the best possible way to achieving Favourable Conservation Status (FCS) of the designated site feature(s) at the national and biogeographic level*' (JNCC et al., 2019).

1.3.1.1 Conservation Objective 1: Harbour porpoise is a viable component of the site

42. This Conservation Objective is designed to minimise the risk of injury and killing or other factors that could restrict the survivability and reproductive potential of harbour porpoise using the SAC. Specifically, this objective is primarily concerned with operations that would result in unacceptable levels of those impacts on harbour porpoise using the SAC. Unacceptable levels can be defined as those having an impact on the FCS of the population of the species in their natural range.

43. Harbour porpoise are considered to be a viable component of the SAC if they are able to live successfully within it. The Bristol Channel Approaches SAC has been selected primarily based on the long term, relatively higher densities of porpoise in

contrast to other areas of the Celtic and Irish Sea. The implication is that the SAC provides relatively good foraging habitat and may also be used for breeding and calving. However, because the number of harbour porpoise using the site naturally varies there is no exact value for the number of animals expected within the site (JNCC *et al*., 2019).

44. The Conservation Objectives (JNCC *et al.*, 2019) state that, with regard to assessing impacts, "*the reference population for assessments against this objective is the MU population in which the SAC is situated*"

45. Harbour porpoise are listed as EPS under Annex IV of the Habitats Directive, and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Under the Habitats Regulations, it is an offence if harbour porpoise are deliberately disturbed in such a way as to:

- Impair their ability to survive, to breed or reproduce, or to rear or nurture their young
- To affect significantly the local distribution or abundance of that species.

46. The term deliberate is defined as any action that is shown to be "by a person who knows, in the light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action".

47. In addition, Article 12(4) of the Habitats Directive is concerned with incidental capture and killing. It states that Member States "*shall establish a system to monitor the incidental capture and killing of the species listed on Annex IV (all cetaceans). In light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned*".

1.3.1.2 Conservation Objective 2: There is no significant disturbance of the species

48. The disturbance of harbour porpoise typically, but not exclusively, originates from operations that cause underwater noise, including activities such as seismic surveys, pile driving and sonar.

49. Disturbance is considered to be significant if it leads to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time. The current Statutory Nature Conservation Bodies (SNCBs) guidance for the assessment

of significant noise disturbance on harbour porpoise in the Bristol Channel Approaches SAC (JNCC *et al.,* 2020) is that:

"*Noise disturbance within an SAC from a plan/project individually or in-combination is considered to be significant if it excludes harbour porpoise from more than:*

- *20% of the relevant area*[1] *of the site in any given day*[2]*, or*
- *An average of 10% of the relevant area of the site over a season*[3,4]."

1.3.1.3 Conservation Objective 3: The condition of supporting habitats and processes, and the availability of prey is maintained

50. Supporting habitats, in this context, means the characteristics of the seabed and water column. Supporting processes encompass the movements and physical properties of the habitat. The maintenance of these supporting habitats and processes contributes to ensuring prey is maintained within the site and is available to harbour porpoise using the SAC. Harbour porpoise are strongly reliant on the availability of prey species year round due to their high energy demands, and their distribution and condition may strongly reflect the availability and energy density of prey.

51. This Conservation Objective is designed to ensure that harbour porpoise are able to access food resources year round, and that activities occurring in the Bristol Channel Approaches SAC will not affect this.

1.3.2 Management measures

52. Specific management measures are yet to be developed for the Bristol Channel Approaches SAC, however JNCC *et al*., (2019) advise that:

"*the site should be managed in a way that ensures that its contribution to the maintenance of the harbour porpoise population at FCS is optimised, and that this may require management of human activities occurring in or around the site if they*

[1] The relevant area is defined as that part of the SAC that was designated on the basis of higher persistent densities for that season (summer defined as April to September inclusive, winter as October to March inclusive).
[2] To be considered within the Habitats Regulation Assessment and, if needed, licence conditions should ensure that daily thresholds are not exceeded. Day to day monitoring of compliance is not practicable and therefore retrospective compliance monitoring is required to test whether the licence conditions are being adhered to.
[3] Summer defined as April to September inclusive, winter as October to March inclusive.
[4] For example, a daily footprint of 19% for 95 days would result in an average of 19x95/183 days (summer) =9.86%

are likely to have an adverse impact on the site's Conservation Objectives either directly or indirectly identified through the assessment process."

53. For the purposes of the assessments, the potential effects considered in relation to the Bristol Channel Approaches SAC Conservation Objectives are outlined in **Table 1.4**.

Table 1.4 Potential effects of the Offshore Project in relation to the Conservation Objectives of the Bristol Channel Approaches SAC for harbour porpoise

Conservation Objective for harbour porpoise	Potential Effect
Harbour porpoise is a viable component of the site	Physical and permanent auditory injury from underwater noise will be mitigated and therefore there is no potential for Likely Significant Effect (LSE).
	Significant disturbance and displacement due to increased underwater noise levels has the potential to have an adverse effect on harbour porpoise from the Bristol Channel Approaches SAC and will be considered further.
	Any potential increased collision risk with vessels could cause a potential LSE which will be considered further.
There is no significant disturbance of the species	Significant disturbance and displacement due to increased underwater noise levels has the potential to have an adverse effect on harbour porpoise from the Bristol Channel Approaches SAC and will be considered further.
The condition of supporting habitats and processes, and the availability of prey is maintained	Changes in water quality and prey availability have the potential to affect the harbour porpoise from the Bristol Channel Approaches SAC and will be considered further.

1.3.3 Advice on activities

54. JNCC and NE (2019) have provided advice on activities that specifically occur within or near to the Bristol Channel Approaches SAC site that could be expected to impact on site integrity. The key impacts and activities that JNCC and NE (2019) consider as having the greatest impact on the population of UK harbour porpoise and therefore the Bristol Channel Approaches SAC are:

- Fisheries (commercial and recreational) with harbour porpoise bycatch
- Discharge/run-off from landfill, terrestrial/offshore industries
- Shipping
- Pile driving
- Dredging and disposal
- Aggregate extraction
- Geophysical surveys (including seismic)

- Recreational boating activity
- Acoustic deterrent/mitigation devices
- Pinger devices
- Military activity
- UXOs
- Wet renewable energy installations.

55. The aim is that the advice should help identify the extent to which existing activities are, or can be made, consistent with the Conservation Objectives, and thereby focus the attention of Relevant and Competent Authorities and surveillance programmes to areas that may need management measures (JNCC and NE, 2019).

1.4 Project description

56. A full description of the Offshore Project's design envelope is presented in the Environmental Statement (ES) (see **Chapter 5: Project Description** and **Chapter 12: Marine Mammal and Marine Turtle Ecology**). Updated project information will be included within the SIP once the final project design is confirmed at the pre-construction stage.

1.5 Approach to assessing potential in-combination effects

57. The approach to the in-combination assessment for the potential disturbance of harbour porpoise in the Bristol Channel Approaches SAC winter area from underwater noise follows the current advice from the SNCBs (currently JNCC *et al.*, 2020), that:

- "*Displacement of harbour porpoise should not exceed 20% of the relevant area of the site in any given day or on average exceed 10% of the relevant area of the site over a season.*"

58. The JNCC guidance (JNCC *et al.,* 2020) states that for pin piles, a distance of 15km Effective Deterrent Radius (EDR)[5] from an individual percussive piling location should be used to assess the area of SAC habitat that harbour porpoise may be disturbed from during piling operations for pin-piles, with a potential disturbance area of 706.9km^2.

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[5] An EDR is the range at which a species is expected to be disturbed to, for a specific activity. The EDR is sufficiently precautionary enough that it covers the range at which the majority of individuals would respond, and is based on literature on the reported deterrence distances for that species and that activity.

59. The JNCC *et al.* (2020) recommended EDRs are not equivalent to 100% deterrence/disturbance in the associated area (i.e. some animals show greater reaction than others) but nor do they represent the limit range at which effects have been detected.

60. The winter area is approximately 5,850km^2 and the winter period is from 1st October to 31st March (182 days) (JNCC *et al.,* 2020).

61. The seasonal averages are calculated by multiplying the average potential area of effect on any one day by the proportion of days within the season piling could occur (i.e. taking into account the average area of overlap with the winter area of the Bristol Channel Approaches SAC and number of piling days in that season). For example, a daily footprint of 19% for 95 days would result in an average of 19x95/182 days (winter) = 9.92% (JNCC *et al.,* 2020).

62. Seasonal averages are assessed based on the number of piling days in the summer period that could overlap with the winter period that could overlap with the winter area of the SAC. This is based on the worst-case and includes an additional two day recovery period (as assessed in Department for Business, Energy and Industrial Strategy (BEIS) (2020)). It is important to note that the Bristol Channel Approaches SAC is only designated for the winter period.

63. The number of harbour porpoise that could be disturbed is based on the latest density estimates from the SCANS-III survey (Hammond *et al.*, 2021). The reference population for harbour porpoise is the CIS MU. Currently the population estimate for the harbour porpoise CIS MU is 62,517 (CV = 0.13; 95%; CI = 48,324 – 80,877; IAMMWG, 2022).

1.5.1 Assessment of potential in-combination effects

64. There is the potential for in-combination effects from underwater noise with other projects and activities during piling at the Windfarm Site to disturb harbour porpoise in the Bristol Channel Approaches SAC winter area.

65. The approach to the in-combination assessments for the disturbance of harbour porpoise follows the current advice from the SNCBs (JNCC *et al.,* 2020), using the recommended EDRs for activities that could generate underwater noise. Further details are provided in **Section 7.2.1.5** of the **RIAA**.

66. The in-combination assessments are based on the maximum potential overlap with Bristol Channel Approaches SAC winter area, including those projects that are within 26km at closest point to the Bristol Channel Approaches SAC. While the EDR for piling at the Offshore Project is 15km based on the EDR for pin piles, the EDRs for

both monopiles (unmitigated) and UXO clearance are both 26km, and therefore all other projects within 26km of the Bristol Channel Approaches SAC are considered within the in-combination assessment.

67. For the potential in-combination scenarios, other noise generating activities where there is a high likelihood that the activity could occur at the same time as piling at the Windfarm Site has been determined. This is to ensure that the SIP provides a realistic in-combination assessment for the activities that could be occurring at the same time.

68. The potential sources of in-combination effects of underwater noise which could disturb harbour porpoise are:

- Piling at other Offshore Windfarms (OWFs)
- Other construction activities at OWFs (other than piling) including vessels, cable installation works, dredging, seabed preparation and rock placement
- Marine Renewable Energy (MRE) projects (wave and tidal) – construction phase only
- Aggregate extraction and dredging
- Oil and gas installation projects
- Oil and gas seismic surveys
- Subsea cable and pipelines
- Other marine projects (gas storage, offshore mines and carbon capture)
- Geophysical surveys at OWFs
- UXO clearance.

69. The potential piling period for the Offshore Project has been based on the widest likely range of offshore construction and piling dates, dependent on the construction scenario, as a very precautionary approach. It should be noted that while the projects included within the assessment have the potential to overlap with the Offshore Project, there is a lot of uncertainty on when OWFs could be piling. This assessment is therefore considered worst-case.

70. Under the SNCB guidance for assessing the potential for effect from disturbance as a result of piling (JNCC *et al*., 2020), it is important to consider projects that have the potential for disturbance effects to overlap with the Bristol Channel Approaches SAC.

71. Of the UK and European OWFs screened in for having a construction period that could potentially overlap with the construction of the Offshore Project, and that are

within the CIS MU, seven OWFs could be piling at the same time, which is estimated to take place in either 2026 or 2027:

- Dieppe - Le Treport
- Codling
- Dublin Array
- North Irish Sea Array
- South Irish Sea
- Awel y Môr Offshore Wind Farm
- Morecambe.

72. Of these, none overlap or are within 26km of the Bristol Channel Approaches SAC.

73. The in-combination assessment has been based on a single piling event within the Windfarm Site, with single piling occurring in the other OWFs, as it is considered unlikely that all OWFs would or could be undertaking simultaneous piling all at the same time.

74. The approach to the in-combination assessment, based on single piling, would allow for some of the OWFs not to be piling at the same time while others could be simultaneously piling. This is considered to be the most realistic worst-case scenario, as it is highly unlikely that all OWFs would or could be simultaneously piling at exactly the same time or even on the same day as piling at the Windfarm Site.

75. The assessments for all OWFs are based on the worst-case for piling of monopiles with no noise abatement or reduction (26km EDR). For other OWFs undertaking UXO clearance, the EDR would also be 26km and therefore have the same overall effect as presented for piling at those projects. It should be noted that the potential areas of disturbance assume that there is no overlap in the areas of disturbance between different projects and are therefore highly conservative.

76. The potential in-combination effects from all potential noise sources during piling at the Windfarm Site are summarised in **Table 1.5**.

77. Based on the worst-case scenarios and precautionary approach, the average seasonal overlap with the Bristol Channel Approaches SAC winter area is 3.01% and the number of marine mammals potentially disturbed as a percentage of the CIS MU is 3,808.9 (6.09%) (**Table 1.5**).

78. Therefore, the development of the SIP for White Cross and SIPs for other OWF projects will be required to deliver the appropriate mitigation and management measures across projects and management by the MMO. This is to ensure that there

would be no significant disturbance and no AEOI of the Bristol Channel Approaches SAC in relation to the conservation objectives for harbour porpoise.

79. As White Cross is located inside the Bristol Channel Approaches SAC winter area, and the windfarm site is less than 15km from the SAC (i.e. less than the EDR for pin piles), there is the potential for several options to reduce the potential contribution to the underwater noise in-combination effects, as outlined in **Section 1.6**.

Table 1.5 Quantified in-combination assessment for the potential disturbance of marine mammals from cumulative underwater noise sources during construction of the Offshore Project (worst-case)

Offshore Project and Industry	Spatial Overlap with the Bristol Channel Approaches SAC Winter Area (km^2 (% of Winter Area))	Average Seasonal Overlap with the Bristol Channel Approaches SAC Winter Area ((% of Winter Area)	Assessment Against the CIS MU (Number of Marine Mammals Potentially Disturbed (% of CIS MU))
Worst-case disturbance from the Offshore Project	463.51km^2 (7.92%)	1.55%	648.9
Piling at other offshore wind farms	0km^2 (0%)	0%	2,847.9
Construction activities at other offshore wind farms	0km^2 (0%)	0%	293.8
Aggregates and dredging	0km^2 (0%)	0%	0.50
Cable and pipelines	100.6km^2 (1.72%)	1.46%	11.9
Coastal works	0km^2 (0%)	0%	5.9
Total for all noisy activities	**564.11km^2 (9.64%)**	**3.01%**	**3,808.9 (6.09%)**

1.6 In Principle management and mitigation measures

80. This section of the In Principle SIP outlines the measures currently available, or likely to be available in the future, which could be applicable to reduce the in-combination effects of underwater noise disturbing harbour porpoise in the Bristol Channel Approaches SAC during construction at the Offshore Project.

81. For each of the measures, information will be provided in the final SIP to detail how the measure will result in the avoidance of significant disturbance to harbour porpoise, and hence allow the conclusion of no AEOI on the Bristol Channel Approaches SAC. The final SIP will also provide details of measures that will not be implemented with appropriate justification for the exclusion.

82. It should be noted that the following factors need to be considered and taken into account in the final SIP:

- The Bristol Channel Approaches SAC management measures are currently unavailable
- The final design parameters for the Offshore Project have not yet been determined, and the **RIAA** was based on the predicted worst-case scenario and a series of conservative assumptions underlying the assessments
- The final design and programme of other plans and projects has not yet been determined and the actual in-combination scenario is currently unknown. Therefore, the in-combination scenario is based on the worst case and is considered to be highly precautionary.
- Potential strategic management measures such as scheduling of pile driving (**Section 1.6.3**) would need to be carefully managed to achieve a coordinated approach with other developers. Work to progress such coordination cannot begin until the final project design approach and pile strategy is better known.

83. The adopted project measures would be agreed and secured in the period between consent and well before the commencement of piling, following an updated assessment of the potential impacts and an assessment of the efficacy of proposed management measures.

84. Potential measures are outlined in this section of the In Principle SIP. However, as previously noted, confirmation of any measure(s) that will be employed cannot be confirmed until project design parameters are finalised, and the management measures are known for the Bristol Channel Approaches SAC. At that point, it will be clear, what the actual impact is likely to be and if AEoI can be ruled out in the

light of more refined project information or what any required measures will be seeking to achieve in terms of mitigation.

85. Potential mitigation that could be delivered by the Offshore Project's management measures include:

- Spatial: Minimising the total area of 'significant disturbance' at any one time. This could be a reduction in the area of the Bristol Channel Approaches SAC which is subject to noise levels that may cause significant disturbance to harbour porpoise
- Temporal: Minimising the duration of additional underwater noise generated through piling events over any given time frame that may cause 'significant disturbance' to harbour porpoise in the CIS MU or the Bristol Channel Approaches SAC.

1.6.1 Measure 1: Different mooring types and installation method

86. The use of different mooring types and installation methods within the consented project envelope, such as drag embedment anchors, mooring pin piles and jacket piles (for the offshore substation platform (OSP)), will be considered and assessed during the final design of the Offshore Project. This will include consideration of relevant technologies or methodologies, based on technical feasibility and commercial availability. This would be informed by pre-construction site investigation and technology developments. The use of mooring types and/or installation methodologies other than pile driving would be expected to result in lower noise levels during the construction of the windfarm.

87. Pile technological innovations and developments are also under investigation in relation to various methods (such as double walled piles), which also have the potential to greatly reduce the area of potential disturbance from pile driving.

1.6.2 Measure 2: Noise mitigation systems

88. Noise mitigation systems are currently in use and are being refined, that enable a reduction of pile driving noise (decibels (dB)) at source. These methods currently include various types of bubble curtain, hydro-sound dampers, screens or tubes.

89. A reduction in the noise at source would reduce the total area of potential disturbance to harbour porpoise. However, it should also be noted that many of these measures may increase the total duration of disturbance from underwater noise during foundation installation and this should be a consideration in an assessment of their efficacy.

90. It should be noted that suitability of any noise mitigation system will be dependent on a number of factors including pile diameter and length, ground conditions, and water depth. These factors will be considered in any assessment of the efficacy of the measure. The information to inform this selection will be contingent on the selection of the chosen foundation type and supplier which will only be available once contracts are being finalised post consent.

1.6.3 Measure 3: Scheduling of pile driving

91. Subject to the final design and programme of the Offshore Project, alongside other offshore windfarms, and the potential for other management measures, refinement of the piling programme could potentially allow a reduction in the total in-combination area of disturbance from multiple projects, if required. This would reduce the area of the Bristol Channel Approaches SAC that harbour porpoise may be displaced from at any one time. It could also be used as a measure to reduce the duration of any in-combination continuous disturbance within a given time period (month, season or year).

92. The Windfarm Site is not located within the Bristol Channel Approaches SAC winter area. However, based on a 15km EDR for pin-piles (without mitigation), there is the potential for the disturbance area to overlap with the Bristol Channel Approaches SAC (**Table 1.2**). Therefore, the location and season in which piling is undertaken will be considered to reduce the potential impacts on the seasonal area.

1.6.4 Other potential measures

93. Given the time lag between consent and the start of offshore construction, it is possible that new measures and innovations will become available. As such, the final SIP will not be restricted only to potential measures outlined above. Rather, the SIP allows the consideration and assessment of other relevant technologies or methodologies that may have emerged by the time of offshore construction. This will ensure that any new technologies or methods that may be developed can be used during construction of the Offshore Project.

1.6.5 Assessment of efficacy of measures and implementation

94. Prior to the potential implementation of project mitigation or management measures, an assessment of the ability of each measure (alone or in conjunction with other measures) will be required to ensure the approach is able to contribute to a reduction in disturbance to harbour porpoise within the Bristol Channel Approaches SAC. The assessment is expected to include a degree of likely confidence in each measure.

95. The Applicant will work with the MMO and other consultees to ensure that any approach to such assessment is done in a timely manner and using the most robust approach possible.

96. Following assessment of project mitigation and management measures, the Applicant will work with the MMO to develop a timescale for the delivery of any measures, an implementation plan, as well as agreeing any reporting or monitoring requirements. The implementation plan will include the approach to enforcement of the measures, and how any failures will be rectified.

1.6.6 Population modelling

97. If required, population modelling, such as Population Consequences of Disturbance (PCoD) or disturbance effects of noise on the harbour porpoise population in the CIS MU, will be considered in developing the SIP. Population modelling would allow consideration of the biological fitness consequences of disturbance from underwater noise, and the conclusions of a quantitative assessment to be put into a population level context.

1.6.7 European Protected Species (EPS) licence

98. An EPS Licence will be sought from the MMO. Supported by a detailed risk assessment of the potential risk to harbour porpoise (and any other EPS deemed necessary at the time of application) based on the finalised project parameters and piling schedule / details.

1.6.8 Additional marine licence(s)

99. Any requirements to implement noise abatement technology could be subject to additional marine licensing processes, as required.

1.7 Summary

100. The final SIP will be used to identify and assess any potential management or mitigation measures that could ensure no AEOI on the Bristol Channel Approaches SAC for the significant disturbance of harbour porpoise based on the final design of the Offshore Project. The final SIP will also be used to record all consultation on the proposed project management or mitigation measures it contains.

1.8 References

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