DOGGER BANK D WIND FARM

Preliminary Environmental Information Report

Volume 1
Chapter 12 Marine Mammals

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Glossary

Term	Definition
Additional Mitigation	Measures identified through the EIA process that are required as further action to avoid, prevent, reduce or, if possible, offset likely significant adverse effects to acceptable levels (also known as secondary (foreseeable) mitigation). All additional mitigation measures adopted by the Project are provided in the Commitments Register.
Array Area	The area within which the wind turbines, inter-array cables and Offshore Platform(s) will be located.
Commitment	Refers to any embedded mitigation and additional mitigation, enhancement or monitoring measures identified through the EIA process and those identified outside the EIA process such as through stakeholder engagement and design evolution. All commitments adopted by the Project are provided in the Commitments Register.
Design	All of the decisions that shape a development throughout its design and pre-construction, construction / commissioning, operation and, where relevant, decommissioning phases.
Development Consent Order (DCO)	A consent required under Section 37 of the Planning Act 2008 to authorise the development of a Nationally Significant Infrastructure Project, which is granted by the relevant Secretary of State following an application to the Planning Inspectorate.
Effect	An effect is the consequence of an impact when considered in combination with the receptor's sensitivity / value / importance, defined in terms of significance.
Embedded Mitigation	Embedded mitigation includes: • Measures that form an inherent part of the project design evolution such as modifications to the location or design of the development made during the pre-application phase (also known as primary (inherent) mitigation); and • Measures that will occur regardless of the EIA process as they are imposed by other existing legislative requirements or are considered as standard or best practice to manage commonly occurring environmental impacts (also known as tertiary (inexorable) mitigation). All embedded mitigation measures adopted by the Project are provided in the Commitments Register.
Enhancement	Measures committed to by the Project to create or enhance positive benefits to the environment or communities, as a result of the Project. All enhancement measures adopted by the Project are provided in the Commitments Register.

Term	Definition
Environmental Impact Assessment (EIA)	A process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information and includes the publication of an Environmental Statement.
Environmental Statement (ES)	A document reporting the findings of the EIA which describes the measures proposed to mitigate any likely significant effects.
Evidence Plan Process (EPP)	A voluntary consultation process with technical stakeholders which includes a Steering Group and Expert Topic Group (ETG) meetings to encourage upfront agreement on the nature, volume and range of supporting evidence required to inform the EIA and HRA process.
Expert Topic Group (ETG)	A forum for targeted technical engagement with relevant stakeholders through the EPP.
Impact	A change resulting from an activity associated with the Project, defined in terms of magnitude.
Inter-Array Cables	Cables which link the wind turbines to the offshore platform(s).
Landfall	The area on the coastline, south-east of Skipsea, at which the offshore export cables are brought ashore, connecting to the onshore export cables at the transition joint bay above Mean High Water Springs.
Mitigation	Any action or process designed to avoid, prevent, reduce or, if possible, offset potentially significant adverse effects of a development. All mitigation measures adopted by the Project are provided in the Commitments Register.
Mitigation Hierarchy	A systematic approach to guide decision-making and prioritise mitigation design. The hierarchy comprises four stages in order of preference and effectiveness: avoid, prevent, reduce and offset.
Monitoring	Measures to ensure the systematic and ongoing collection, analysis and evaluation of data related to the implementation and performance of a development. Monitoring can be undertaken to monitor conditions in the future to verify any environmental effects identified by the EIA, the effectiveness of mitigation or enhancement measures or ensure remedial action are taken should adverse effects above a set threshold occur. All monitoring measures adopted by the Project are provided in the Commitments Register.
Offshore Development Area	The area in which all offshore infrastructure associated with the Project will be located, including any temporary works area during construction, which extends seaward of Mean High Water Springs. There is an overlap with the Onshore Development Area in the intertidal zone.

Term	Definition
Offshore Export Cable Corridor (ECC)	The area within which the offshore export cables will be located, extending from the DBD Array Area to Mean High Water Springs at the landfall.
Offshore Export Cables	Cables which bring electricity from the Offshore Platform(s) to the transition joint bays at landfall.
Offshore Platform(s)	Fixed structures located within the DBD Array Area that contain electrical equipment to aggregate and, where required, convert the power from the wind turbines, into a more suitable voltage for transmission through the export cables to the Onshore Converter Station. Such structures could include (but are not limited to): Offshore Converter Station(s) and an Offshore Switching Station.
Project Design Envelope	A range of design parameters defined where appropriate to enable the identification and assessment of likely significant effects arising from a project's worst-case scenario. The Project Design Envelope incorporates flexibility and addresses uncertainty in the DCO application and will be further refined during the EIA process.
Safety Zones	A statutory, temporary marine zone demarcated for safety purposes around a possibly hazardous offshore installation or works / construction area.
Scoping Opinion	A written opinion issued by the Planning Inspectorate on behalf of the Secretary of State regarding the scope and level of detail of the information to be provided in the Applicant's Environmental Statement. The Scoping Opinion for the Project was adopted by the Secretary of State on 02 August 2024.
Scoping Report	A request by the Applicant made to the Planning Inspectorate for a Scoping Opinion on behalf of the Secretary of State. The Scoping Report for the Project was submitted to the Secretary of State on 24 June 2024.
Scour Protection	Protective materials used to avoid sediment erosion from the base of the wind turbine foundations and offshore platform foundations due to water flow.
Study Areas	A geographical area and / or temporal limit defined for each EIA topic to identify sensitive receptors and assess the relevant likely significant effects.
The Applicant	SSE Renewables and Equinor acting through 'Doggerbank Offshore Wind Farm Project 4 Projco Limited'.
The Project	Dogger Bank D Offshore Wind Farm Project, also referred to as DBD in this PEIR.
Transition Joint Bays (TJB)	An underground structure at the landfall that houses the joints between the offshore and onshore export cables.
Wind Turbines	Power generating devices located within the DBD Array Area that convert kinetic energy from wind into electricity.

12 Marine Mammals

12.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) presents the preliminary results of the Environmental Impact Assessment (EIA) of the Dogger Bank D Offshore Wind Farm (OWF) Project (hereafter 'the Project' or 'DBD') on marine mammals.

2. **Chapter 4 Project Description** provides a description of the key infrastructure components which form part of the Project and the associated construction, operation and maintenance (O&M) and decommissioning activities.

3. The primary purpose of the PEIR is to support the statutory consultation activities required for a Development Consent Order (DCO) application under the Planning Act 2008. The information presented in this PEIR chapter is based on the baseline characterisation and assessment work undertaken to date. The feedback from the statutory consultation will be used to inform the final design where appropriate for consents and presented in an Environmental Statement (ES), which will be submitted with the DCO application.

4. This PEIR chapter:

- Describes the baseline environment relating to marine mammals;
- Presents an assessment of the likely significant effects on marine mammals during the construction, operational and decommissioning phases of the Project;
- Identifies any assumptions and limitations encountered in compiling the environmental information; and
- Sets out proposed mitigation measures to avoid, prevent reduce or, if possible, offset potential significant adverse environmental effects identified during the EIA process and, where relevant, monitoring measures or enhancement measures to create or enhance positive effects.

5. This chapter should be read in conjunction with the following related chapters. Inter-relationships are discussed further in **Section 12.10**:

- **Chapter 8 Marine Physical Processes** (assessments inform this chapter due to indirect effects);
- **Chapter 9 Marine Water and Sediment Quality** (assessments inform this chapter due to indirect effects on prey species);
- **Chapter 10 Benthic and Intertidal Ecology** (assessments inform this chapter due to indirect effects on prey species);
- **Chapter 11 Fish and Shellfish Ecology** (assessments inform this chapter due to indirect effects on prey species);
- **Chapter 14 Commercial Fisheries** (assessments inform this chapter due to indirect effects on prey species); and
- **Chapter 15 Shipping and Navigation** (assessments inform this chapter due to vessel disturbance and collision risk effects).

6. Additional information to support the marine mammal assessment includes:

- **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**;
- **Volume 2, Appendix 12.2 Marine Mammals Technical Report**;
- **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**;
- **Volume 2, Appendix 12.4 Unexploded Ordnance Assessment**;
- **Volume 2, Appendix 12.5 Marine Mammals Cumulative Assessment Screening Report**; and
- **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance to Marine Mammals**.

12.2 Policy and Legislation

12.2.1 National Policy Statements

7. Planning policy on energy Nationally Significant Infrastructure Projects (NSIP) is set out in the National Policy Statements (NPS). The following NPS by the Department for Energy Security & Net Zero (DESNZ) are relevant to the marine mammal assessment:

- Overarching NPS for Energy (EN-1) (DESNZ, 2023a); and
- NPS for Renewable Energy Infrastructure (EN-3) (DESNZ, 2023b).

8. The marine mammal chapter has been prepared with reference to specific requirements in the above NPS. The relevant parts of the NPS are summarised in **Table 12-1**, along with how and where they have been considered in this PEIR chapter.

Table 12-1 Summary of Relevant National Policy Statement Requirements for Marine Mammals

NPS Reference and Requirement	How and Where Considered in the PEIR
NPS for Energy (EN-1)	
Paragraph 5.4.17: "Where the development is subject to EIA the Applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats."	Any internationally, nationally, and locally designated sites where marine mammals are a qualifying feature were identified in the Habitats Regulation Assessment (HRA) Screening Report and any potential effects on these sites were assessed in the **Report to Inform Appropriate Assessment (RIAA)** (document reference 5.3).
Paragraph 5.4.19: "The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests."	Measures to conserve the biodiversity of marine mammals by means of mitigation are presented in **Section 12.4.3** and in the **Outline Marine Mammal Mitigation Protocol (MMMP)** (document reference 8.1).
Paragraph 5.4.22: "The design of energy NSIP proposals will need to consider the movement of mobile / migratory species such as birds, fish and marine and terrestrial mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development."	Detailed consideration and assessment of all marine mammal species (**Section 12.6**) that have the potential to interact with the Project is provided throughout the ES.
Paragraph 5.4.35: "Applicants should include appropriate avoidance, mitigation, compensation, and enhancement measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works; • The timing of construction has been planned to avoid or limit disturbance; • During construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements; and • Habitats will, where practicable, be restored after construction works have finished."	The proposed mitigation measures relevant to marine mammals are specifically outlined in **Section 12.4.3** and in the **Outline MMMP** (document reference 8.1). The latter also points to further consideration that would be given post-consent to any potential for cumulative noise effects and any management measures required. A **Vessel Management Plan** will also be developed, reducing risk of collision and disturbance to marine mammals. • During construction, **Section 4.3.1** in **Chapter 4 Project Description**, highlights the construction area for the project that the works will be confined to; • The current five-year construction timeline would be further reduced throughout the Project development, reducing the overall time of disturbance to marine mammals. Further, there are no expected seasonal restrictions required, and the Project will not affect important seal haul-out sites for resting and breeding. Appropriate mitigation measures would be in place to limit disturbance to marine mammal receptors**;** • Best practice, as detailed in the **Outline Project Environmental Management Plan (PEMP) (**document reference 8.6) and **Outline MMMP** (document reference 8.1) will be followed during construction and operation; and • Returning habitats, where practicable, after construction works have finished is assessed in **Section 10.7** in **Chapter 10 Benthic and Intertidal Ecology**.

NPS Reference and Requirement	How and Where Considered in the PEIR
NPS for Renewable Energy Infrastructure (EN-3)	
Paragraph 2.8.51 and 2.8.52: "The UK Government has obligations to protect the marine environment with a network of well managed Marine Protected Areas (MPAs), which also includes Highly Protected Marine Areas (HPMAs). MCZs together with HPMAs, SACs SPAs, and Ramsar sites and marine elements of SSSIs form an ecologically coherent network of MPAs. Government has set a target for MPA condition under the Environment Act 2021. Given the scale of offshore wind deployment required to meet 2030 and 2050 ambitions, applicants will need to give close consideration to impacts on MPAs, either alone or in combination, and employ the mitigation hierarchy, and if necessary, provide compensation (both individually and in combination with other plans or projects) which may be needed to approve their projects."	The Project's offshore ECC is located within the Southern North Sea (SNS) Special Areas of Conservation (SAC), where harbour porpoise is a qualifying feature. Other relevant protected sites were identified during the HRA screening process and any potential effects, whether alone or in combination, on these sites have been assessed in the **RIAA** (document reference 5.3).
Paragraph 2.8.101: "Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ assessments (See Sections 4.3 and 5.4 of EN-1)."	The PEIR provides a detailed assessments for all phases of the lifespan of the Project, the construction phase (**Section 12.7.13**), the O&M phase (**Section 12.7.2**) and the decommissioning phase (**Section 12.7.3**). Equally, the **RIAA** (document reference 5.3) has considered these phases of the Project in the assessment. The Marine Conservation Zone (MCZ) assessment has also considered these phases but it is not relevant to marine mammals.
Paragraph 2.8.103: "Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity, as well as negative effects."	All potential effects from the Project on marine mammals, have been assessed in **Section 12.7**.
Paragraph 2.8.104: "Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations / non-governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken."	Consultation on assessment methodologies and baseline data collection as part of the EPP has been detailed in **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**.
Paragraph 2.8.105: "In developing proposals applicants must refer to the most recent best practice advice originally provided by Natural England under the Offshore Wind Enabling Action Programme, and / or their relevant SNCB."	Best practice guidance by Natural England and other Statutory Nature Conservation Bodies (SNCB) (e.g. Joint Nature Conservation Committee (JNCC), Department for Environment, Food and Rural Affairs (Defra)) have been applied and referenced where appropriate throughout the PEIR.
Paragraph 2.8.106: "Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate."	Relevant ecological data from existing offshore wind farms were provided in **Section 12.2.4.2** in the baseline information in **Volume 2, Appendix 12.2 Marine Mammals Technical Report** and have been incorporated in the PEIR (**Section 12.6**).

NPS Reference and Requirement	How and Where Considered in the PEIR
Paragraph 2.8.127 to 2.8.129: "Construction activities, including installing wind turbine foundations by pile driving, geophysical surveys, and clearing the site and cable route of unexploded ordnance (UXOs) may reach noise levels which are high enough to cause disturbance, injury, or even death to marine mammals. All marine mammals are protected under Part 3 of the Habitats Regulations (cetaceans within Schedule 2 and seal species within Schedule 4). 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), applicants will need to apply for a wildlife licence to allow the activity to take place"	**Section 12.7** provides an assessment of the underwater noise levels and maximum impacts ranges that could cause injury or disturbance to marine mammals from piling and other noise sources. The assessment in **Section 12.8** addresses the cumulative effects of underwater noise from other plans and projects. An indicative assessment for Unexploded Ordnance (UXO) is detailed in **Volume 2, Appendix 12.4 Unexploded Ordnance Assessment**. A Wildlife License would be applied as required under the Habitats Regulations prior to applicable work.
Paragraph 2.8.130: "The development of offshore wind farms can also impact fish species (see paragraphs 2.8.235 – 2.8.239), which can have indirect impacts on marine mammals if those fish are prey species."	Any indirect effects on marine mammals arising due to impacts on prey species has been assessed in **Section 12.6**.
Paragraph 2.8.131: "Impacts Where necessary, assessment of the effects on marine mammals 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 sites; • baseline noise levels; • predicted construction and soft start noise levels in relation to mortality, Permanent Threshold Shift (PTS) and temporary threshold shift (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; • entanglement risk; and • barrier risk."	**Section 12.6** and **Volume 2, Appendix 12.2 Marine Mammals Technical Report** provide a description of the existing and future environment, including likely feeding areas and prey, seal haul-out sites, migration routes and protected areas. **Section 12.7.1.1** and **243**details the assessment for PTS, TTS and disturbance from underwater noise, including during construction from pile driving and soft-start noise levels. **Section 12.7.2.1** provides the assessment of operational noise. **Section 12.8** provides the assessment of cumulative effects. **Sections 12.7.1.7** and **12.7.2.7** detail the assessment of collision risk with vessels during construction, O&M, respectively. **Sections 12.7.1.5** and **12.7.2.5** and **11.6.4.5** detail the assessment of potential barrier effects from underwater noise, while **Section 12.7.2.10** addresses the potential for barrier effect caused by the physical presence of the Project infrastructure.
Paragraph 2.8.132: "The scope, effort and methods required for marine mammal surveys should be discussed with the relevant SNCB."	Over a two-year period (2021-2023), monthly aerial surveys of marine mammals and seabirds were carried out for the Project. Detailed information about the surveys can be found in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**. SCNBs have been consulted and agreed to the approach for data collection and site-specific surveys, including the methodology for raw data apportioning. Results from the surveys have been presented during (Marine Mammal Ecology Expert Topic Group (ETG) 3 with SNCBs as part of the EPP has been detailed in **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**.

NPS Reference and Requirement	How and Where Considered in the PEIR
Paragraph 2.8.133 -2.8.134: "The applicant should discuss any proposed noisy activities with the relevant statutory body and must reference the joint JNCC and SNCB underwater noise guidance (JNCC *et al.,* 2020) and any successor of this guidance, in relation to noisy activities (alone and in-combination with other plans or projects) within Special Area of Conservation (SACs), SPAs, and Ramsar sites, in addition to the JNCC mitigation guidelines (https://jncc.gov.uk/our-work/marine-mammals-and-noise-mitigation/) for piling, explosive use, and geophysical surveys. Natural Resources Wales (NRW) has a position statement (reference PS 17) on assessing noisy activities which should also be referenced where relevant. 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 2.8.119 above, the applicant must look at possible alternatives or appropriate mitigation."	The Applicant has discussed noisy activities through the EPP (Marine Mammal Ecology ETG3), as outlined in **Section 12.3** and **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**. Reference has been made to the 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 European Sites in the draft HRA. The embedded mitigation measures are outlined in **Section 12.4.3** and the proposed monitoring is outlined in **Section 12.11**. Any required UXO clearance activities would be subject to a separate Marine Licence application, however, an indicative UXO Assessment has been provided for information in **Volume 2, Appendix 12.4 Unexploded Ordnance Assessment**. The **Outline MMMP** (document reference 8.1) includes potential mitigation protocols for UXO clearance.
Paragraph 2.8.135: "The applicant should develop a Site Integrity Plan (SIP) or alternative assessments for projects in English and Welsh waters to allow the cumulative impacts of underwater noise to be reviewed closer to the construction date, when there is more certainty in other plans and projects."	The Project is not situated in or within a 26km radius of any UK SACs designated for marine mammals; thus, a SIP is not required. The potential for additive underwater noise effects however is acknowledged and management methods would be consulted on post-consent. The **RIAA** (document reference 5.3) assesses the effects on the integrity of European designated sites.
Paragraph 2.8.237: "Mitigation Monitoring of the surrounding area before and during the piling procedure can be undertaken by various methods including MMObs and passive acoustic monitoring (PAM). Active displacement of marine mammals outside potential injury zones can be undertaken using equipment, such as ADDs. 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."	The embedded mitigation measures are outlined in **Section 12.4.3** and the proposed monitoring is outlined in **Section 12.11**.
Paragraph 2.8.238: "Where noise impacts cannot be avoided, other mitigation should be considered, including alternative installation methods and noise abatement technology, spatial / temporal restrictions on noisy activities, alternative foundation types."	Mitigation to reduce the impacts from underwater noise are provided in the **Outline MMMP** (document reference 8.1), which is submitted with this PEIR for consultation. As outlined in **Section 12.4.3** and the **Outline MMMP** (document reference 8.1), the required mitigation measures would be further developed in the pre-construction period. This would be based upon the best information and methodologies that are available at that time, in consultation with the relevant SNCBs and the MMO.
Paragraph 2.8.239: "Applicants should undertake a review of up-to-date research and all potential mitigation options presented as part of the application, having consulted the relevant JNCC mitigation guidelines (https://jncc.gov.uk/our-work/marine-mammals-and-noise-mitigation/)."	The relevant JNCC mitigation guidelines are considered throughout the PEIR and **draft HRA** (document reference 5.3).

NPS Reference and Requirement	How and Where Considered in the PEIR
Paragraph 2.8.312 – 2.8.313: “Secretary of State decision making The Secretary of State (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. Unless suitable noise mitigation measures can be imposed by requirements to any development consent the SoS may refuse the application.”	**Section 12.4.4** outlines the selection of the types of foundations, construction methods and mitigation measures that are designed to reasonably minimise significant impacts on marine mammals.
Paragraph 2.8.314: “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 have been considered.”	The conservation status of relevant marine mammal species is detailed in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**. The cumulative and in-combination effects on marine mammals have been assessed in **Section 12.8** of the PEIR and in the **RIAA** (document reference 5.3), respectively. Population modelling has been presented in **Sections 12.7.1.2.2.5** and **12.8.3.1** at a six-year period after the start of construction to reflect the potential impacts on the conservation status.

12.2.2 Other Policy and Legislation

9. Other policy and legislation relevant to the marine mammal assessment is summarised in the following sections.

10. There are a number of pieces of legislation, policy and guidance applicable to the assessment of marine mammals. These include:

- Legislation:
  - The Marine Strategy Regulations 2010 (His Majesty (HM) Government, 2010).
- Policy:
  - The Marine Policy Statement (MPS) (HM Government, 2011);
  - The East Inshore and East Offshore Marine Plans (HM Government, 2014); and
  - North-East Inshore and North-East Offshore Marine Plans (HM Government, June 2021).

12.2.2.1 National & International

11. **Table 12-2**Table 12-2 provides an overview of national and international legislation in relation to marine mammals.

12.2.2.1.1 The Marine Strategy Framework Directive

12. Annex I of the Marine Strategy Framework Directive (MSFD) states that to ensure that good environmental status is met the following must be considered:

- Biological diversity should be maintained;
- The quality and occurrence of habitats, as well as the distribution and abundance of species are in line with prevailing physiographic, geographic, and climatic conditions;
- All elements of the marine food web, to the extent that they are known, occur at normal abundance and diversity levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity;
- Concentrations of contaminants are at levels not giving rise to pollution effects;
- Properties and quantities of marine litter do not cause harm to the coastal and marine environment; and
- Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

12.2.2.1.2 The Marine Policy Statement

13. The MPS (HM Government, 2011) (discussed further in **Chapter 3 Policy and Legislative Context**) provides a high-level approach to marine planning and the general principles for decision making. It sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high-level objective of 'Living within environmental limits' covers the points relevant to marine mammals, this requires that:

- Biodiversity is protected, conserved and where appropriate recovered and loss has been halted;
- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems; and
- Our oceans support viable populations of representative, rare, vulnerable, and valued species.

Table 12-2 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, North-East Atlantic, Irish 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 Bern Convention 1979	International	All cetaceans, grey seal and harbour seal	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	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 *Phocoena phocoena*	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.
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	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.
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	The Habitats Regulations 2017. Provisions of The Habitats Regulations are described further in this chapter and the **RIAA** (document reference 5.3). It should be noted that the Habitats Regulations apply within the territorial seas and to marine areas within UK jurisdiction, beyond 12 nautical miles.
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	The Habitats Regulations 2017.
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.

Legislation	Level of Protection	Species Included	Details
Conservation of Seals Act 1970	International	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.

12.2.2.1.3 The East Inshore and East Offshore Marine Plans

14. Within both the East Inshore and East Offshore Marine Plans (HM Government, 2014), a set of objectives have been set out to ensure biodiversity protections and are of relevance to marine mammals as they cover policies and commitments on the wider ecosystem, as set out within the MPS and the MSFD:

- Objective 6: "*To have a healthy, resilient and adaptable marine ecosystem in the East Marine Plan areas*".
- Objective 7: "*To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas*".

12.2.2.2 European Protected Species and Marine Wildlife Licence Guidance

15. All cetacean species are listed as European Protected Species (EPS) under Annex IV of the European Union (EU) Council Directive 92/43/EEC (Habitats Directive) and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Within the UK, The Habitats Directive is implemented through the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (collectively the 'Habitats Regulations'). Under the Habitats Regulations, it is an offence to:

- Deliberately capture, injure or kill any cetacean species;
- Deliberately disturb them; or
- Damage or destroy a breeding site or resting place.

16. The JNCC, Natural England and the Countryside Council for Wales (CCW) produced a draft guidance concerning the Regulations on the deliberate disturbance of marine EPS (JNCC *et al.,* 2010). This guidance provides interpretations of deliberate injury and disturbance offences under both the Habitats Regulations and Offshore Regulations (now the Habitats Regulations 2017).

17. Grey and harbour seal are also protected under the Habitats Regulations, as well as the Conservation of Seals Act 1970.

18. In English waters, a marine wildlife licence is required if the risk of injury or disturbance to EPS is assessed as likely under the Habitats Regulations 2017. If a licence is required, an application must be submitted, the assessment of which comprises three tests, namely:

- **Test 1**: 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.
- **Test 2**: That there are no satisfactory alternatives to the activity proposed (that would not incur the risk of offence).
- **Test 3**: That the licensing of the activity would not result in a negative impact on the species' / population's Favourable Conservation Status (FCS).

19. A marine wildlife licence would consider all cetacean species at potential risk of injury or disturbance. 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 Marine Management Organisation (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 DBD.

20. 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.

21. If required, the marine wildlife licence application would be submitted post-consent. At that point in time, the project design envelope would have been further refined through detailed design and procurement activities and further detail would be available on the techniques selected for the construction of the wind farm, as well as the mitigation measures that would be in place following the development of the MMMP for piling. A marine wildlife licence application will also be considered as part of the separate UXO clearance Marine Licence process.

12.2.2.3 Conservation Status of Marine Mammals

22. The conservation status of marine mammals occurring in UK and adjacent waters are provided in **Table 12-3**, based on the Article 17 Habitats Directive Report 2019 (on the implementation of the Directive from January 2013 to December 2018) (JNCC, 2019).

Table 12-3 Conservation Status of Marine Mammal Species

Species	Conservation Status Assessment (Population Assessment)
Harbour porpoise	Unknown
Bottlenose dolphin	Unknown
Common dolphin	Unknown
White-beaked dolphin	Unknown
Minke whale	Unknown
Grey seal	Favourable
Harbour seal	Unfavourable-inadequate

23. The conservation status of animals evaluated at a global scale using the International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species Categories and Criteria are shown in **Table 12-4**.

Table 12-4 Conservation Status of Marine Mammal Species Assessed by IUCN

Species	IUCN Red List	Year Assessed
Harbour porpoise	Least Concern	2020
Bottlenose dolphin	Least Concern	2018
Common dolphin	Least Concern	2020
White-beaked dolphin	Least Concern	2023
Minke whale	Least Concern	2018
Grey seal	Least Concern	2016
Harbour seal	Least Concern	2016

12.3 Consultation

24. Topic-specific consultation in relation to marine mammals has been undertaken in line with the process set out in **Chapter 7 Consultation**. A Scoping Opinion from the Planning Inspectorate was received on 2nd August 2024, which has informed the scope of the assessment presented within this chapter (as outlined in **Section 12.4.2**).

25. Feedback received through the ongoing EPP in relation to ETG meetings and wider technical consultation meetings with relevant stakeholders has also been considered in the preparation of this chapter. Details of technical consultation undertaken to date on marine mammals are provided in **Table 12-5**.

26. This chapter will be updated based on refinements made to the Project Design Envelope and to consider where appropriate stakeholder feedback on the PEIR. The updated chapter will form part of the Environmental Statement to be submitted with the DCO Application.

Table 12-5 Technical Consultation Undertaken to Date on Marine Mammals

Meeting	Stakeholder(s)	Date(s) of Meeting / Frequency	Purpose of Meeting
ETG Meetings			
ETG3 (Marine Mammals and Underwater Noise) Meeting 1	• Natural England • MMO • Centre for Environment, Fisheries and Aquaculture (Cefas) • Yorkshire Wildlife Trust	21/11/2023	• Approach to baseline characterisation, impact assessment for Project-alone and cumulatively; and • Discussion of expected mitigation and monitoring requirements.
ETG3 (Marine Mammals and Underwater Noise) Meeting 2	• Natural England • MMO • Cefas	17/10/2024	• Addressing consultation comments on the Scoping Report; • Presentation of final baseline characterisation, including densities and reference populations; • First results from UWN modelling outputs; • Approach to impact assessment, with particular focus on disturbance, vessel collision, barrier effect); and • Approach to Cumulative Effects Assessment (CEA) (presentation of preliminary screening of overlapping plans and projects).

27. **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals** summarises how consultation responses received to date are addressed in this chapter.

28. This chapter will be updated based on refinements made to the Project Design Envelope and to consider, where appropriate, stakeholder feedback on the PEIR. The updated chapter will form part of the Environmental Statement to be submitted with the DCO Application.

12.4 Basis of the Assessment

29. The following sections establish the basis of the assessment of likely significant effects, which is defined by the Study Area(s), assessment scope, and realistic worst-case scenarios. This section should be read in conjunction with **Volume 2, Appendix 1.2 Guide to PEIR, Volume 2, Appendix 6.2 Impacts Register** and **Volume 2, Appendix 6.3 Commitments Register**.

12.4.1 Study Area

30. The marine mammals Study Area(s) has been defined on the basis of marine mammals being highly mobile and transitory in nature. Therefore, it is necessary to examine species occurrence not only within the Offshore Development Area, but also over the wider area. Based on extensive reviews and site-specific digital aerial surveys (as detailed in **Volume 2, Appendix 12.2 Marine Mammals Technical Report** and summarised in **Section 12.6**), the following seven species were identified. For each species of marine mammal, the following study areas have been defined based on the relevant Management Units (MUs) (see **Figure 12.2-1** in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**), as well as the current knowledge and understanding of the biology of each species:

- Harbour porpoise: North Sea (NS) MU;
- Bottlenose dolphin *Tursiops truncatus*: Coastal East Scotland (CES) MU and Greater North Sea (GNS) MU;
- Minke whale *Balaenoptera acutorostrata*: Celtic and Greater North Seas (CGNS) MU;
- Common dolphin *Delphinus delphis* and white-beaked dolphin *Lagenorhynchus albirostris*: CGNS MU; and
- Grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*: south-east (SE) and north-east (NE) England MUs.

31. The marine mammal study areas have been agreed with stakeholders through the EPP (see **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**).

12.4.2 Scope of the Assessment

32. A number of impacts have been scoped out of the marine mammals assessment, in line with the Scoping Opinion (discussed in **Section 12.3**). These impacts are outlined in **Volume 2, Appendix 6.2 Impacts Register**, along with supporting justification.

33. Impacts scoped into the assessment relating to marine mammals are outlined in **Table 12-6**, with a full assessment provided in **Section 12.7**.

Table 12-6 Marine Mammals – Impacts Scoped into the Assessment

Impact ID	Impact and Project Activity	Rationale
Construction		
MM-C-01	Underwater noise: physical and auditory injury – from impact piling during construction	Underwater noise generated by pile driving may result in physical and auditory injury to marine mammals and has the potential to affect their hearing needed to primarily forage, navigate and socialise.
MM-C-02	Underwater noise: behavioural impacts – from impact piling during construction	Underwater noise generated by pile driving may result in behavioural reactions of marine mammals which can include disturbance or displacement.
MM-C-05	Underwater noise: physical and auditory injury resulting from noise associated with other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	Underwater noise generated from construction activities and vessels may result in physical and auditory injury to marine mammals and has the potential to affect their hearing needed to primarily forage, navigate and socialise.
MM-C-06	Underwater noise: behavioural impacts resulting from other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	Underwater noise generated by construction activities and vessels may result in behavioural reactions of marine mammals which can include disturbance or displacement.
MM-C-07	Barrier effects due to underwater noise – from piling activities and other construction activities, and presence of vessels offshore	Underwater noise might prevent marine mammals from moving between key feeding and breeding areas, or increases their swimming distances to avoid the noise, expending more energy.
MM-C-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	Noise from construction activities or the presence of vessels in the vicinity of seal haul-out sites has the potential to disturb seals and have effects on important stages of their life cycle (i.e. moulting, nursing, resting, mating).
MM-C-09	Vessel interaction (increase in risk of collision) – from vessel movement relating to all aspects of construction of the project	An increase in vessels during the construction phase of the Project has the potential to raise the risk for marine mammals to be struck. A collision can be fatal or cause serious permanent injuries.
MM-C-10	Changes to prey resource – from construction of wind turbines, cables and foundations	Any impacts from construction activities causing changes to the habitat (e.g. water quality and sediment processes, etc.) or from fishing pressure have the potential to impact fish species. This in turn would have an indirect effect to marine mammals, whereby a lack or reduced amounts of prey could result in marine mammals having to search longer for their prey or move to alternative feeding grounds.
MM-C-12	Changes to water quality (sediment bound contaminants in the offshore ECC – from installation of cables and foundations	Construction activities causing increased suspended sediment concentrations and associated sediment settlement have the potential to cause indirect effects to marine mammals as the effects are likely to only impact fish species (see **Chapter 11 Fish and Shellfish Ecology**).
Operation and Maintenance		
MM-O-03	Underwater noise: physical and auditory injury – from operational and maintenance noise, operation of wind turbines	Underwater noise generated by operational turbine noise may result in physical and auditory injury to marine mammals, and has the potential to affect their hearing needed to primarily forage, navigate and socialise.
MM-O-04	Underwater noise: behavioural impacts – from operation of wind turbines	Underwater noise generated from operational turbines may result in behavioural reactions of marine mammals, which can include disturbance or displacement.
MM-O-05	Underwater noise: physical and auditory injury from noise associated with maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	Underwater noise generated from maintenance activities and vessels may result in physical and auditory injury to marine mammals, and has the potential to affect their hearing needed to primarily forage, navigate and socialise.
MM-O-06	Underwater noise: behavioural impacts from maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	Underwater noise generated by maintenance activities and vessels may result in behavioural reactions of marine mammals which can include disturbance or displacement.
MM-O-07	Barrier effects due to underwater noise – from underwater noise due to the operation of the wind turbines, as well as disturbance associated with underwater noise from O&M activities along with the presence of vessels offshore	Underwater noise might prevent marine mammals from moving between key feeding and breeding areas, or increases their swimming distances to avoid the noise, expending more energy.

Impact ID	Impact and Project Activity	Rationale
MM-O-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	Noise from maintenance activities or the presence of vessels in the vicinity of seal haul-out sites have the potential to disturb seals and have effects on important stages of their life cycle (i.e. moulting, nursing, resting, mating).
MM-O-09	Vessel interaction (increase in risk of collision) – from all vessel movements relating to operation and maintenance activities	An increase in vessels during the O&M phase of the Project has the potential to raise the risk for marine mammals to be struck. A collision can be fatal or cause serious permanent injuries.
MM-O-10	Changes to prey resource – from presence of wind turbines, cables and foundations	Any impacts from maintenance activities causing changes to the habitat (e.g. water quality and sediment processes, etc.) or from fishing pressure have the potential to impact fish species. This in turn would have an indirect effect to marine mammals, whereby a lack or reduced amounts of prey could result in marine mammals having to search longer for their prey or move to alternative feeding grounds.
MM-O-12	Changes to water quality (sediment bound contaminants in the offshore ECC) – from presence of cables and foundations	Construction activities causing increased suspended sediment concentrations and associated sediment settlement have the potential to cause indirect effects to marine mammals as the effects are likely to only impact fish species (see **Chapter 11 Fish and Shellfish Ecology**).
MM-O-13	Physical Barrier Effect – from presence of wind farm infrastructure	The presence of wind farm infrastructure might prevent marine mammals from moving between key feeding and breeding areas, or increases their swimming distances to avoid infrastructure, expending more energy.
Decommissioning		
MM-D-05	Underwater noise: physical and auditory injury – decommissioning activities not yet defined.	In this assessment, it is assumed that most decommissioning activities would be the reverse of their construction counterparts, and that their impacts would be of similar nature to, and no worse than, those identified during the construction phase.
MM-D-06	Underwater noise: behavioural impacts – decommissioning activities not yet defined.	
MM-D-07	Underwater noise: barrier effects – decommissioning activities not yet defined.	
MM-D-08	Disturbance at seal haul-out sites – decommissioning activities not yet defined.	
MM-D-09	Vessel interaction (increase in risk of collision) – decommissioning activities not yet defined.	
MM-D-10	Changes to prey resource – decommissioning activities not yet defined.	
MM-D-12	Changes to water quality (Sediment bound contaminants in the offshore ECC) – decommissioning activities not yet defined.	

34. A description of how the Impacts Register should be used alongside the PEIR chapter is provided in **Chapter 6 Environmental Impact Assessment Methodology**.

12.4.3 Embedded Mitigation Measures

35. The Commitments Register is provided at PEIR stage to provide stakeholders with an early opportunity to review and comment on the proposed commitments. Proposed commitments may evolve during the pre-application phase as the EIA progresses and in response to refinements to the Project's design envelope and stakeholder feedback. The final commitments will be confirmed in the Commitments Register submitted along with the DCO application.

36. The Project has made several commitments to avoid, prevent, reduce or, if possible, offset potential adverse environmental effects through mitigation measures embedded into the evolution of the Project's design envelope. These embedded mitigation measures include actions that will be undertaken to meet other existing legislative requirements and those considered to be standard or best practice to manage commonly occurring environmental effects. The assessment of likely significant effects has therefore been undertaken on the assumption that these measures are adopted during the construction, operational and decommissioning phases. **Table 12-7** identifies proposed embedded mitigation measures that are relevant to the marine mammal assessment.

37. Full details of all commitments made by the Project are provided within the Commitments Register in **Volume 2, Appendix 6.3 Commitments Register**. A description of how the Commitments Register should be used alongside the PEIR chapter is provided in **Volume 2, Appendix 1.2 Guide to PEIR** and **Chapter 6 Environmental Impact Assessment Methodology**. In addition, a list of draft outline management plans which are submitted with the PEIR for consultation is provided in **Section 1.10** of **Chapter 1 Introduction.** These documents will be further refined and submitted along with the DCO application. See **Volume 2, Appendix 1.2 Guide to PEIR** for a list of all PEIR documents.

38. The Commitments Register is provided at PEIR stage to provide stakeholders with an early opportunity to review and comment on the proposed commitments. Proposed commitments may evolve during the pre-application phase as the EIA progresses and in response to refinements to the Project Design Envelope and stakeholder feedback. The final commitments will be confirmed in the Commitments Register submitted with the DCO application.

39. An **Outline MMMP** (document reference 8.1) for piling is submitted with the PEIR, which details indicative measures relevant to marine mammals that will be secured in the MMMP agreed post-consent. A summary of the embedded mitigation measures which are proposed in the **Outline MMMP** (document reference 8.1 is set out **Table 12-7**.

*Table 12-7 Embedded Mitigation Measures Included in the **Outline MMMP** (document reference 8.1) for Piling*

Measures to be Included: Outline MMMP for Piling
The final MMMP would involve the establishment of a monitoring area and MZ around the pile location before each pile driving activity, based on the maximum predicted distance for PTS. The final MMMP for piling would provide details of the maximum predicted impact (PTS) ranges and areas for piling.
The Project would ensure that the mitigation measures are adequate to minimise the risk of marine mammals being present within the monitoring area and MZ prior to piling activity commencing, to reduce the risk of any physical or auditory injury (PTS).
The methods for establishing the monitoring area and MZ and reducing the potential impacts of piling operations would be agreed with the MMO in consultation with the relevant SNCBs and would be secured as commitments within the final MMMP.
The piling mitigation measures could include: • Establishment of a monitoring area with a minimum 500m radius; ○ The observation of the monitoring area conducted by trained, dedicated and experienced MMOb during daylight hours and when conditions allow suitable visibility (visibility of entire monitoring area; sea state 3 or less); and ○ Deployment of PAM devices in the monitoring area in conjunction with MMO and during poor visibility or at night. • The activation of ADD; • Soft-start and ramp-up; and • Procedure for breaks in piling.

12.4.4 Realistic Worst-Case Scenarios

40. To provide a precautionary, but robust, assessment at this stage of the Project's development process, a realistic worst-case scenario has been defined in **Table 12-9** for each impact scoped into the assessment (as outlined in **Section 12.4.2**). The realistic worst-case scenarios are derived from the range of parameters included in the design envelope. They ensure that the assessment of likely significant effects is based on the maximum potential impact on the environment. Should an alternative development scenario be taken forward in the final design of the Project, the resulting effects would not be greater in effect significance. Further details on the design envelope approach are provided in **Chapter 6 Environmental Impact Assessment Methodology**.

41. The realistic worst-case scenarios used to assess impacts on marine mammals are defined in **Table 12-9**. Following the PEIR publication, further design refinements will be made based on ongoing engineering studies and considerations of the EIA and stakeholder feedback. Therefore, realistic worst-case scenarios presented in the PEIR may be updated in the ES. The design envelope will be refined where possible to retain design flexibility only where it is needed.

Table 12-8 Embedded Mitigation Measures Relevant to Marine Mammals

Commitment ID	Proposed Embedded Mitigation	How the Embedded Mitigation Will be Secured	Relevance to Marine Mammal Assessment	Relevance to Impact ID
CO18	A Traffic Vessel Management Plan (VMP) will be provided as part of the Project Environmental Management Plan (PEMP) and will aim to minimise, as far as reasonably practicable, encounters with marine mammals and common scoter and red-throated diver. The Vessel Management Plan will adhere to latest relevant guidelines for reducing risk of collision with relevant marine species.	DML Condition - Project Environmental Management Plan	Reduces the risk of vessel collision	MM-C-06 MM-O-06 MM-C-08 MM-O-08 MM-C-09 MM-O-09
CO20	An Unexploded Ordnance (UXO) specific Marine Mammal Mitigation Protocol (MMMP) for UXO clearances will be provided and will include details on clearance options, and details of the proposed mitigation zone and any additional mitigation measures required in order to minimise potential impacts of any physical injury or Permanent Threshold Shift (PTS), for example, the activation of an Acoustic Deterrent Device (ADD) prior to the clearance, as much as is practicable.	Secured through a separate UXO Marine Licence	Minimises potential impacts of any physical injury or PTS	**N/A – refer to Volume 2, Appendix 12.4 Unexploded Ordnance Assessment**
CO21	An Offshore Decommissioning Programme will be provided prior to the construction of the offshore works and implemented at the time of decommissioning, based on the relevant guidance and legislation.	DCO Requirement - Offshore Decommissioning Programme		MM-D-05 MM-D-06 MM-D-07 MM-D-08 MM-D-09 MM-D-10 MM-D-12
CO22	A piling Marine Mammal Mitigation Protocol (MMMP) will be provided in accordance with the Outline MMMP and will be implemented during construction. The piling MMMP will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the proposed mitigation zone and any additional mitigation measures required in order to minimise potential impacts of any physical injury or permanent threshold shift (PTS), for example, the activation of an Acoustic Deterrent Device (ADD) prior to the soft-start, as much as is practicable.	DML Condition - Marine Mammal Mitigation Protocol	Minimises potential impacts of any physical injury or PTS	MM-C-01

Commitment ID	Proposed Embedded Mitigation	How the Embedded Mitigation Will be Secured	Relevance to Marine Mammal Assessment	Relevance to Impact ID
CO25	A Project Environmental Management Plan (PEMP) will be provided in accordance with the Outline PEMP and will include: • A Marine Pollution Contingency Plan (MPCP), which will include plans to address the risks, methods and procedures to deal with any spills and collision incidents in relation to all activities carried out below Mean High Water Springs (MHWS) to safeguard the marine environment; • Best practice measures for the storage, use and disposal of lubricant and chemicals will be undertaken throughout the construction phase; • A Chemical Risk Assessment (CRA) to ensure any chemicals, substances and materials to be used will be suitable for use in the marine environment and in accordance with the Health and Safety Executive and the Environment Agency Pollution Prevention Control Guidelines or latest relevant available guidelines; • A marine biosecurity plan detailing how the risk of introduction and spread of invasive non-native species will be minimised; and • Details of waste management and disposal arrangements.	DML Condition - Project Environmental Management Plan	Reduces the risk to changes in water quality affecting prey resources and subsequently marine mammals	MM-C-10 MM-O-10 MM-C-12 MM-O-12
CO28	An Offshore Operations and Maintenance Plan (O&M) will be provided prior to commencement of operation and will outline the reasonably foreseeable O&M offshore activities.	DML Condition - Offshore Operations and Maintenance Plan		MM-C-06 MM-O-06 MM-C-08 MM-O-08 MM-C-09 MM-O-09

Table 12-9 Realistic Worst-Case Scenarios for Impacts on Marine Mammals

Impact ID	Impact and Project Activity	Realistic Worst-Case Scenario	Rationale
Construction			
MM-C-01 MM-C-02	Underwater noise: physical and auditory injury – from impact piling during construction Underwater noise: behavioural impacts – from impact piling during construction	**Number of piles for max. 113 wind turbine foundations**: • Up to 113 monopiles (14MW turbines); and • Up to 904 jacket pin piles (eight pin piles per foundation). **Number of piles for two offshore platform (OP) foundations**: • Up to 12 monopiles; and • Up to 60 pin piles. **Total number of piles for wind turbine and OP foundations**: • Up to 125 monopiles; and • Up to 964 pin piles.	The spatial worst-case scenario is based on the largest hammer energy which is required for monopile foundations. The temporal worst-case scenario is based on the largest number of piling events which is required for pin pile foundations. Full hammer energy is unlikely to be required on all piles, but is assessed for all piles as a worst-case scenario. Suction bucket foundations as an alternative foundation type are an option, but do not represent the worst-case scenario for underwater noise.
		Maximum hammer energy for monopiles: • Up to 8,000kJ. **Maximum hammer energy for jacket pin piles**: • Up to 5,000kJ.	
		Maximum pile diameter for monopiles: • Up to 18m. **Maximum pile diameter for jacket piles**: • Up to 5m.	
		Duration of wind turbine / OP foundation installation: • Approximately 18 months for wind turbine foundation installation; and • Approximately one year for OP installation.	

		Maximum active piling time for wind turbine foundations:
		• **Monopiles** (including soft-start and ramp-up):
		  ○ 5 hours & 20 minutes per wind turbine foundation; and
		  ○ Up to 603 hours (25.1 days) for 113 wind turbines.
		• **Jacket pin piles** (including soft-start and ramp-up):
		  ○ 5 hours & 20 minutes hours per pin pile; and
		  ○ Up to 4,822 hours (200.9 days) for 113 wind turbines (904 total pin piles).	

		Maximum active piling time for two OP foundation: • **Monopiles** (including soft-start and ramp-up): ○ 5 hours & 20 minutes hours per monopile; and	

Impact ID	Impact and Project Activity	Realistic Worst-Case Scenario	Rationale
		○ Up to 64 hours (2.7 days) for two OPs. • **Jacket pin piles** (including soft-start and ramp-up): ○ 5 hours & 20 minutes hours per pin pile; and ○ Up to 320 hours for two OPs (60 total pin piles).	
		Maximum total active piling time for wind turbine & OP foundations (including soft-start and ramp-up): • **Monopiles** for wind turbines and OP: ○ 667 hours (27.8 days). • **Monopiles** for wind turbines and **pin piles** for OP: ○ 986 hours (41.1 days). • **Pin piles** for wind turbines and OP: ○ 5,138 hours (214.1 days).	
		Activation of ADD: • 80 minutes per monopile; and • 65 minutes per pin pile.	Activation of ADD is indicative only and the details will be confirmed during the post-consent phase, through the finalisation of the MMMP.
		Concurrent piling for: • Monopiles.	Cumulative sound exposure levels (SEL_{cum}) have been modelled for a concurrent piling scenario by which two sequential monopiles are installed at the north-west (NW) location and two sequential monopiles are installed at the south-east (SE) location at the same time.
		Potential for sequential piling: • Up to two monopiles or four pin piles could be installed sequentially in same 24-hour period.	Cumulative sound exposure levels (SEL_{cum}) have been modelled for each piling event under consideration: two monopiles piled sequentially and four pin piles piled sequentially.
MM-C-05 MM-O-06	Underwater noise: physical and auditory injury resulting from noise associated with other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic Underwater noise: behavioural impacts resulting from other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	**Seabed clearance methods could include:** • Boulder and sandwave clearance and dredging. **Cable and cable protection installation methods**: • Trenching (e.g. jetting or mechanical cutting); • Dredging; • Ploughing; • Cable laying; and • Rock placement.	The exact processes used to prepare the site will depend on the foundation type chosen for the Project. Underwater noise modelling is available for the following activities: • Dredging (backhoe and suction), drilling, rock placement, suction bucket installation, vessels (</> 100m), cable laying, and trenching. Suction bucket installation, followed by suction dredging, is considered to be the loudest activity in terms of underwater noise levels.
		DBD Array Area: 262km^2.	DBD Array Area
		Duration of offshore construction: Five years.	Offshore construction works could require up to five years but is more likely to be between three to four years.
		For detailed information on construction vessel presence see below for MM-C-09.	

Impact ID	Impact and Project Activity	Realistic Worst-Case Scenario	Rationale
MM-C-07	Barrier effects due to underwater noise – from piling activities and other construction activities, and presence of vessels offshore	Maximum impact range for all potential noise sources from underwater noise assessments (worst-case parameters described above). **Closest distance to shore from DBD Array Area**: 210km.	The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier effect for underwater noise.
MM-C-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	Distance from landfall area and DBD Array Area to seal haul-out sites see **Volume 2, Appendix 12.2 Marine Mammals Technical Report Table 12.2-13** and **Table 12.2-15**. The closest haul-out site to landfall area is 14km (Flamborough Head); the DBD Array Area is 210km from the nearest point to in the coast. Number of vessel trips as outlined below. For detailed information on construction vessel presence see below for MM-C-09.	Construction port(s) would be confirmed prior to the start of construction. However, the assessment considers the potential for in-transit vessels in proximity to the seal haul out sites in the marine mammal Study Area. Movements of construction vessels could occur throughout the year.
MM-C-09	Vessel interaction (increase in risk of collision) – from vessel movement relating to all aspects of construction of the project	**Maximum total number of construction vessels in the offshore ECC at any one time** = up to 55 vessels. **Maximum total number of construction vessels in the DBD Array Area at any one time** = up to 35 vessels. **Maximum total number of construction vessels on site at any one time** = up to 90 vessels. **Maximum total number of round trips over construction period** = 7,527 (or an average of 1,506 annual round trips over five-year construction period). **Vessel types:** • Jack-up vessel; • Heavy lift vessel; • Construction support vessels / service operation vessel; • Rock placement vessels; • Boulder clearance; • Dredgers; • Cable lay vessel; • Pre-lay grapnel run vessel; • Heavy transport vessel; • RO-RO & LO-LO vessels; • Cargo vessels; • Offshore supply vessel; • Anchor handlers; • Support vessel; • Tugs & barges; • Guard vessels; and • Survey & dive vessels.	Due to construction sequencing, not all vessel types will be on site at the same time. The number of vessels would vary depending on activities taking place within wind farm site. Assessments are based on the worst-case scenario for the maximum number of vessels on site at any one time during the construction period. Construction port(s) would be confirmed prior to the start of construction.

Impact ID	Impact and Project Activity	Realistic Worst-Case Scenario	Rationale
MM-C-10	Changes to prey resource – from construction of wind turbines, cables and foundations	Prey impacts from temporary habitat loss / physical disturbance within the DBD Array Area is 17,248,642m^2 and 16,637,100m^2 in the offshore ECC (which also covers part of the Array Area). Suspended sediment / re-deposition volume within the Project Area is 113,525,955m^3 (drilling and seabed preparation for foundations combined). See **Chapter 8 Marine Physical Processes**. Contaminated sediments: see surveys in in **Chapter 9 Marine Water and Sediment Quality**. Prey impacts from underwater noise as outlined for Impacts MM-C-03 and MM-C-05 and **Volume 2, Appendix 12.3 Underwater Noise Modelling.** Changes in fishing pressure outlined in **Chapter 14 Commercial Fisheries**.	The worst-case scenario for marine mammals is based on the worst-case table (**Table 11.5**) and conclusions of the assessments presented in **Chapter 11 Fish and Shellfish Ecology**: • Temporary habitat loss / physical disturbance (FSE-C-02); • Increased suspended sediment and sediment re-deposition (FSE-C-04); • Remobilisation of contaminated sediments if present (offshore ECC) (FSE-C-06); • Underwater noise and vibration (FSE-C-07); and • Changes in fishing pressure (FSE-C-08).
MM-C-12	Changes to water quality (sediment bound contaminants in the offshore ECC – from installation of cables and foundations	Changes to water quality: as assessed in **Chapter 9 Marine Water and Sediment Quality**.	Worst-case scenario for any potential changes to water quality that could affect marine mammals directly.
Operation and Maintenance			
MM-O-03 MM-O-04	Underwater noise: physical and auditory injury – from operational and maintenance noise, operation of wind turbines Underwater noise: behavioural impacts – from operation of wind turbines	Wind turbine parameters (e.g. size and number) as outlined in MM-C-01. Underwater noise modelling parameters in **Volume 2, Appendix 12.3 Underwater Noise Modelling.** Operational lifetime of DBD = 35 years.	Assessment (and underwater noise modelling) based on the largest diameter wind turbines and MW, and largest potential number of wind turbines.
MM-O-05 MM-O-06	Underwater noise: physical and auditory injury from noise associated with other operational and maintenance activities - from maintenance of infrastructure, presence of vessels and vessel traffic Underwater noise: behavioural impacts from other operational and maintenance activities - from maintenance of infrastructure, presence of vessels and vessel traffic	**Cable repair and replacement could include:** • Trenching; • Dredging; • Ploughing; • Cable laying; and • Rock placement. Operational lifetime of DBD = 35 years. Other maintenance activities would require vessels. See MM-O-09 below for more details on vessel presence.	Underwater noise modelling undertaken for these activities as part of a cable-reburial method (**Volume 2, Appendix 12.3 Underwater Noise Modelling**).

Impact ID	Impact and Project Activity	Realistic Worst-Case Scenario	Rationale
MM-O-07	Barrier effects due to underwater noise – from underwater noise due to the operation of the wind turbines, as well as disturbance associated with underwater noise from O&M activities along with the presence of vessels offshore	Maximum impact range for all potential noise sources from underwater noise assessments (MM-O-03 and MM-O-05) during O&M phase. **Closest distance to shore from DBD Array Area**: 210km.	The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier effect for underwater noise.
MM-O-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	• Vessel movements: see MM-O-9. • Location of works: ○ Distance to DBD Array Area: 210km; and ○ O&M port in North-East England.	O&M activities could happen at any time of year and throughout the lifetime of the Project.
MM-O-09	Vessel interaction (increase in risk of collision) – from all vessel movements relating to operation and maintenance activities	**Maximum of O&M vessels at site at any one time:** 16. **Maximum total number of return trips per year** = 96. **Vessel types:** • Three SOVs; • One platform supply vessel; • Six USVs for surveys; • One Jack-up vessel; • Three cable lay / cable support vessels; • One offshore support vessel; and • One fall pipe vessel.	Assessments are based on the worst-case scenario for the maximum number of vessels on site at any one time during O&M.
MM-O-10	Changes to prey resource – from presence of wind turbines, cables and foundations	See details in impact MM-C-10 above. The worst-case scenario for marine mammals is based on the conclusions of the assessments presented in **Chapter 11 Fish and Shellfish Ecology** for all possible effects on prey: • Temporary habitat loss / physical disturbance (FSE-O-02); • Habitat loss / alteration (FSE-O-03); • Increased suspended sediment and sediment redeposition (FSE-O-04); • Remobilisation of contaminated sediments if present - offshore ECC (FSE-O-06); • Underwater noise and vibration (FSE-O-07); • Changes in fishing pressure (FSE-O-08); • Electromagnetic field (EMF) effects (FSE-O-09); • Sediment heating from export cables (FSE-O-10); and • Introduction of hard substrate (FSE-O-11).	
MM-O-12	Changes to water quality (sediment bound contaminants in the offshore ECC) – from presence of cables and foundations	Most recent sediment chemical composition in the offshore ECC showed **negligible** results. This effect was assessed as minor adverse significance in all subsequent chapters.	The worst-case scenario for marine mammals is based on the conclusions of the assessments presented in **Chapter 9 Marine Water and Sediment Quality.**

Impact ID	Impact and Project Activity	Realistic Worst-Case Scenario	Rationale
MM-O-13	Physical Barrier Effect – from presence of wind farm infrastructure	• Wind turbine spacing: 862m (centre to centre). • Distance to shore: 210km.	
Decommissioning			
MM-D-05	Underwater noise: physical and auditory injury – decommissioning activities not yet defined.	The final decommissioning strategy of the Project's offshore infrastructure has not yet been decided. For a description of potential offshore decommissioning works, refer to **Chapter 4 Project Description**. It is recognised that regulatory requirements and industry best practice change over time. Therefore, the details and scope of offshore decommissioning works will be determined by the relevant regulations and guidance at the time of decommissioning. Specific arrangements will be detailed in an Offshore Decommissioning Plan (see Commitment ID CO21 in **Volume 2, Appendix 6.3 Commitments Register**), which will be submitted and agreed with the relevant authorities prior to the commencement of offshore decommissioning works. For this assessment, it is assumed that decommissioning is likely to operate within the parameters identified for construction (i.e. any activities are likely to occur within the temporary construction working areas and require no greater amount or duration of activity than assessed for construction). The decommissioning sequence will generally be the reverse of the construction sequence. It is therefore assumed that decommissioning impacts would likely be of similar nature to, and no worse than, those identified during the construction phase.	
MM-D-06	Underwater noise: behavioural impacts – decommissioning activities not yet defined.		
MM-D-07	Underwater noise: barrier effects – decommissioning activities not yet defined.		
MM-D-08	Disturbance at seal haul-out sites – decommissioning activities not yet defined.		
MM-D-09	Vessel interaction (increase in risk of collision) – decommissioning activities not yet defined.		
MM-D-10	Changes to prey resource – decommissioning activities not yet defined.		
MM-D-12	Changes to water quality (Sediment bound contaminants in the offshore ECC) – decommissioning activities not yet defined.		

12.5 Assessment Methodology

12.5.1 Guidance Documents

42. The following guidance documents have been used to inform the baseline characterisation, assessment methodology and mitigation design for marine mammals:

- Natural England Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards Phase I-V (Parker *et al.,* 2022);
- The Protection of Marine 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);
- EIA for offshore renewable energy projects – guide (British Standards Institution (BSI) 2015);
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy (MRE) 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 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 NAS for OWF 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);
- Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC, 2010);
- JNCC guidance for the use of PAM in UK waters for minimising the risk of injury to marine mammals from offshore activities (JNCC, 2023a);
- UK Marine Noise Registry Disturbance Tool: Description and Output Generation. September 2023 (JNCC, 2023b);
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2025b);
- JNCC guidelines for minimising the risk of injury to marine mammals from unexploded ordnance (UXO) clearance in the marine environment (JNCC, 2025);
- Joint Position Statement by all UK Regulators and SNCBs on the use of UXO (UK Government *et al.,* 2025); and
- Department for Environment, Food and Rural Affairs' (Defra) Policy paper on Reducing Marine Noise (UK Government & Defra, 2025).

12.5.2 Data and Information Sources

12.5.2.1 Desk Study

43. A desk study has been undertaken to compile baseline information in the previously defined marine mammals Study Area(s) (see **Section 29**) using the sources of information set out inTable 12-10 **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

12.5.2.2 Site-Specific Surveys

44. In addition to desk-based sources, site-specific surveys were undertaken to provide detailed baseline information on marine mammals. Further detail of the survey method is provided in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.Table 12-10 **Table 12-10** summarises surveys that have been completed to inform the PEIR which are relevant to the marine mammal baseline characterisation.

45. The survey methodology used by APEM Ltd. is considered standard and has been presented at the ETG3 Meeting 1 (see **Table 12-5**).

46. More information regarding consultation on the site-specific surveys can be found in **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**.

Table 12-10 Site-Specific Survey Data for Marine Mammals

Survey	Spatial Coverage	Year(s)	Summary of Survey Data
APEM Digital Aerial survey	DBD Array Area plus 4km buffer	October 2021 to September 2023	Monthly digital aerial surveys for marine mammals and seabirds at sea

12.5.3 Impact Assessment Methodology

47. The methodology to assess impacts for Project-alone and cumulatively has been presented at the ETG3 Meetings 1 and 2 (see **Table 12-5**).

48. **Chapter 6 Environmental Impact Assessment Methodology** sets out the overarching approach to the impact assessment methodology. The topic-specific methodology for the marine mammal assessment is described further in this section.

12.5.3.1 Impact Assessment Criteria

12.5.3.1.1 Receptor Sensitivity

49. The sensitivity of a receptor is determined through its ability to accommodate change and on its ability to recover if it is affected (**Table 12-11**). The sensitivity level of marine mammals 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 impact;
- **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 impact; and
- **Value** – A measure of the receptor importance, rarity and worth.

Table 12-11 Definition of Sensitivity for A Marine Mammal Receptor

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

12.5.3.1.2 Receptor Value

50. In addition, for some assessments the ‘value’ of a receptor may also be an element to add to the assessment where relevant – for instance if the receptor is designated or has an economic value.

51. The ‘value’ of the receptor forms an important element within the assessment, for instance, if the receptor is a protected species or habitat it is considered to be of higher value than a habitat or species that is not protected. It is important to understand that high value and high sensitivity are not necessarily linked within a particular effect. A receptor could be of high value 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.

52. Most species of marine mammals are protected by a number of international legislations, as well as European and UK law and policy. All cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin, grey seal and harbour seals are also afforded international protection through the designation of protected sites. As such, all species of marine mammal can be considered to be of high value.

53. **Table 12-12** provides definitions for the value afforded to a receptor based on its legislative importance. The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement.

Table 12-12 Definition of Value for A Marine Mammal Receptor

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 marine mammal 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.

12.5.3.1.3 Impact Magnitude

54. The thresholds for defining the potential magnitude of impact that could occur from a particular impact will be determined using expert judgement, current scientific understanding of marine mammal population biology, and the draft guidance on disturbance to EPS species by JNCC *et al (*2010). This draft guidance suggests definitions for a 'significant group' of individuals or proportion of the population for EPS species. Consequently, this guidance has been considered in defining the thresholds for magnitude of impact (**Table 12-13**).

55. 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 FCS. It also provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement.

Table 12-13 Definition of Magnitude of Impacts

Severity	Definition	Approximate duration of effect	% of ref pop exposed to the effect	Reversibility
High	Impact has an irreversible adverse effect on the population or the environment. These impacts threaten the long-term viability, health and functioning of the affected population or environment and typically difficult to mitigate.	Permanent	> 1%	No, very difficult.
		Long-term[1]	>5%	
		Temporary[2]	>10%	
Medium	Impacts are noticeable and measurable but do not exceed the limits in which a population can recover or threaten the overall integrity or functioning of the affected environment or population.	Permanent	0.01% - 1%	Typically, yes with appropriate mitigation.
		Long-term	1% - 5%	
		Temporary	5% - 10%	
Low	Impacts are detectable, but do not cause significant adverse changes to a population or the habitat the receptors live in. The effects of these impacts are localised and short term in nature without long-term consequences.	Permanent	0.001% - 0.01%	Yes
		Long-term	0.01% - 1%	
		Temporary	1% - 5%	
Negligible	Impacts are so minor that they do not cause any significant changes to the environment or population. These impacts are often undetectable of fall within the natural variability of the system	Permanent	< 0.001%	Yes
		Long-term	< 0.01%	
		Temporary	< 1%	

56. 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 impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

[1] 10 years or more, but not permanent (e.g. limited to O&M phase of the Projects).

[2] 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.

57. 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 ASCOBANS and 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 impact to <1% of the population (Defra 2003; ASCOBANS 2015).

58. To determine the magnitude of an impact for any quantitative impact assessments, the number of individuals that could be impacted is put into the context of the relevant reference population (based on the definitions of magnitude shown in **Table 12-13**). For all assessments where the results show that more than one individual is at risk, the number has been rounded up to a whole number to ensure the result of the assessment is biologically relevant.

12.5.3.1.4 Effect Significance

59. The assessment of significance of an effect is informed by the sensitivity of the receptor and the magnitude of the impact. The determination of significance is guided by the use of an impact significance matrix presented in **Table 12-14**. Definitions of each level of significance are provided in **Table 12-15**. Impacts and effects may be deemed as being either positive (beneficial) or negative (adverse). Any effect that has a significance of **minor** or **negligible** is not significant.

Table 12-14 Effect Significance Matrix

		Adverse Impact				Beneficial Impact			
		Magnitude							
		High	**Medium**	**Low**	**Negligible**	**Negligible**	**Low**	**Medium**	**High**
Receptor 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
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 12-15 Definition of Effect Significance

Significance	Definition
Major	Large changes to the receptor condition which may be adverse or beneficial. This is likely to be at a national or population level and consideration to national and statutory objectives should be noted.
Moderate	Intermediate changes to the receptor condition which may be regionally important.
Minor	Small changes to the receptor condition which may be locally important.
Negligible	No changes to the receptor condition.

12.5.4 Cumulative Effects Assessment Methodology

60. The cumulative effects assessment (CEA) considers other plans and projects that may act collectively with the Project to give rise to cumulative effects on marine mammal receptors. The general approach to the CEA for marine mammals involves screening for potential cumulative effects, identifying a short list of plans and projects for consideration and evaluating the significance of cumulative effects. **Chapter 6 Environmental Impact Assessment Methodology** and **Volume 2, Appendix 6.4 Cumulative Effects Screening Report - Offshore** provides further details on the general framework and approach to the CEA.

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

- Other OWFs (including construction, O&M, and decommissioning);
- MRE developments (wave and tidal);
- Aggregate extraction and dredging;
- Licenced disposal sites;
- Planned construction of sub-sea cables and pipelines;
- Coastal developments, such as port or harbour developments;
- Oil and gas development, operation and decommissioning;
- Other industries (including gas storage, offshore mining, and carbon capture);
- UXO clearance; and
- Geophysical and seismic surveys.

62. Commercial fishing activity and shipping (noise and vessel collision) are not considered in the CEA. Further information and justification for this decision is provided in the CEA project screening, which is set out in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**.

63. The CEA is a two-part process where firstly, an initial long list of potential projects and activities is identified. The potential to interact with the Project is determined based on the mechanism of interaction and the spatial extent of the reference population for each marine mammal species, as well as the potential for a temporal overlap in activities. The long list of projects and activities is then refined based on the potential for cumulative effects and the level of information available to enable further assessment.

64. 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);
- Offshore projects and activities, where there is the potential for cumulative effects during the construction, O&M, or decommissioning of the Project; and
- OWFs, if the construction and / or piling period of the OWFs could overlap with the proposed construction and / or piling period of the Project, based on best available information on when the OWFs are likely to be constructed and indicative piling schedules.

65. The CEA considers projects, plans and activities which have sufficient information publicly available to undertake the assessment. Insufficient information would preclude a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances. Accordingly, projects which do not have sufficient publicly available information have not been cumulatively assessed. **Volume 2, Appendix 12.5 Cumulative Assessment Screening** sets out the screening for projects, plans and activities considered in the CEA.

12.5.5 Transboundary Effects Assessment Methodology

66. The transboundary effect assessment considers the potential for effects to occur as a result of the Project on marine mammal receptors within the Exclusive Economic Zone (EEZ) of other European Economic Area (EEA) member states or other interests of EEA member states. **Chapter 6 Environmental Impact Assessment Methodology** provides further details on the general framework and approach to the transboundary effect assessment.

67. For marine mammals, the potential for transboundary effects has been considered by taking into account the reference MUs and potential linkages to other countries (for example, as identified through seal telemetry studies). Further information on transboundary effects is outlined in **Section 12.9**.

68. The assessment of effects on transboundary designated sites is presented in the **RIAA** (document reference 5.3).

12.5.6 Assumptions and Limitations

69. There is a good understanding of the baseline environment 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.

70. There are some limitations to the data collected by marine mammal surveys. Primarily limitations are due to the highly mobile nature of marine mammals and, therefore, the potential variability in usage of the wind farm site. Each survey provides only a 'snapshot'. The majority of the surveys, such as the Small Cetaceans of the Atlantic and the North Sea (SCANS), are typically carried out in summer months, which can result in seasonal gaps. However, the site-specific aerial surveys are conducted every month during a two-year survey period, with both years' worth of data analysed (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**). Therefore, taking into account the site-specific survey, and given the number of 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 be present at the wind farm site and surrounding areas.

71. There are acknowledged limitations in the detectability of marine mammals from aerial surveys, including the inability to detect submerged individuals and those not available to count. To address these limitations, a correction factor is used.

72. For harbour porpoise, these correction factors are based on Teilmann *et al (*2013), with different correction factors applied for different months, times of day, and for whether individuals would be at the surface or within the top 2m of the water column. This methodology determines the absolute density estimates from the site-specific aerial surveys (details in **Section 12.2.4.1** of **Volume 2, Appendix 12.2 Marine Mammals Technical Report)**.

73. For grey and harbour seal, a correction factor (derived by Special Committee on Seals (SCOS)-BP 21/02 in SCOS, 2021) is applied to the haul-out counts from SCOS (2022), to take account of the number of seals that were not available to count during the surveys (**Section 12.2.5.6** and **12.2.5.7** of **Volume 2, Appendix 12.2 Marine Mammals Technical Report)**.

74. Limitations of the use of distribution maps developed by Waggitt *et al (*2019) emphasise that their use should only illustrate the general, broad-scale distributions of species. Using these densities for fine-scale distributions should be avoided due to the following caveats:

- Small and isolated sub-populations have very little influence on models, such as white-beaked dolphins in SW England and Risso's dolphins in North Wales / Isle of Man;
- Substantial changes in harbour porpoise movements from north to south in the North Sea took place across the study period;
- Seasonal movements were detected by the modelling but have not produced changes in seasonal changes in densities; and
- The densities for bottlenose dolphins represent the offshore ecotype only, excluding regionally important inshore populations (e.g. Moray Firth, Cardigan Bay).

75. While the Waggitt *et al (*2019) data has been used, to allow a more accurate comparison of the species densities across the different data sets, the average for seasonal and annual periods across the area of the SCANS block where the Project is located have been calculated for each species (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**). As a precautionary approach, density estimates for each marine mammal species used in the assessments are based on the highest density for the area, based on available data sources. These densities were agreed through the EPP process, at ETG3 1 and 2 (**Table 12-5**).

76. Further assumptions and limitations with regards to population modelling and the application of dose-response curves (DRC) in assessments are detailed in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**. Throughout **Volume 2, Appendix 12.3 Underwater Noise Modelling Report,** any assumptions and limitations with regards to underwater noise modelling have been detailed.

12.6 Baseline Environment

12.6.1 Existing Baseline

77. As outlined in **Section 12.4.1**, the key marine mammal species relevant to the marine mammals Study Area are:

- Harbour porpoise;
- Bottlenose dolphin;
- Common dolphin;
- White-beaked dolphin;
- Minke whale;
- Grey seal; and
- Harbour seal.

78. **Volume 2, Appendix 12.2 Marine Mammals Technical Report** provides further information that is relevant for the assessments for each of the species, including details from the site-specific surveys, density estimates, abundance estimates, distribution, diet, and seal haul-out sites.

12.6.2 Harbour Porpoise

79. Harbour porpoise is the most abundant cetacean in UK waters, particularly the NS MU (Gilles *et al.,* 2023; Department for Business, Energy and Industrial Strategy[3] (BEIS), 2022a, b; Hammond *et al.,* 2021; Waggitt *et al.,* 2019).

80. The most recent abundance estimate for harbour porpoise within the NS MU was published in the SCANS-IV survey report, which reported 338,918 harbour porpoise in the North Sea Assessment Unit (AU) (Gilles *et al.,* 2023).

81. Data from the two-year (October 2021 to September 2023) site-specific aerial surveys conducted for the Project have been used to generate initial abundance and density estimates for harbour porpoise across the full survey area (encompassing the DBD Array Area and a 4km buffer). Further information on the survey area and buffers applied is provided in **Section 12.2.3.1** in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

[3] The DECC was merged with the BEIS in 2016. As of February 2023, BEIS is known as the Department for Energy Security and Net Zero (DESNZ).

82. Harbour porpoise was the most commonly sighted marine mammal species during the site-specific surveys. They were consistently present throughout each month and widespread across the survey area. Overall, 795 individuals were recorded in the 24-month survey.

83. The first winter in 2021 had an overall higher average maximum density (0.57 animals/km^2) than the following summer in 2022 (0.49 animals/km^2), possibly due to a spike in densities in November 2021 with 1.66 animals/km^2. On the contrary, the second winter surveys had a much lower density in harbour porpoise (0.44 animals/km^2) than the following summer in 2023 (0.68 animals/km^2), possibly due to a spike in densities in May 2023 with 1.44 animals/km^2. As noted in **Section 12.5.6**, the digital aerial surveys provide only a monthly snapshot. Therefore, any conclusions regarding seasonal abundance should be approached with caution. Overall, the average maximum densities for the summer or winter seasons over the two years are quite similar (**Table 12.2-5** of **Volume 2, Appendix 12.2 Marine Mammals Technical Report**).

84. Using aerial and vessel survey sightings data (between 1980 – 2018), the distribution maps by Waggitt *et al (*2019) show high harbour porpoise densities in the southern North Sea year-round, with calculated densities of 0.836/km^2 for the DBD Array Area and 0.574/km^2 for the offshore ECC. There is little seasonal variation in the calculated Waggitt *et al (*2019) densities.

85. Greater abundance in the southern North Sea (compared to the northern North Sea) was highlighted in both SCANS-III (Hammond *et al.,* 2021) and SCANS-IV (Gilles *et al.,* 2023) surveys. A southward shift within the harbour porpoise range was suggested by several researchers, hypothesising that the shift could be attributed to a change in distribution of principal prey species ((International Fund for Animal Welfare (IFAW) and Marine Conservation Research International (MCRI), 2012; Hammond *et al.,* 2013, 2021; JIsseldijk *et al.,* 2020) (see also **Section 12.5.6**).

86. During the summer 2022 surveys (SCANS-IV, Gilles *et al.,* 2023), the estimated abundance in block NS-H (in which DBD Array Area is located) was 55,691 harbour porpoise (95% Confidence Limit (CL) = 33,836 – 87,685); a slight decrease from the 2017 survey where the population was at 58,066 (95% CL = 32,372 - 91,372). The SCANS-IV density estimate is 0.8034 animals/km^2 (Coefficient of Variation (CV) = 0.241) (in block NS-H).

87. The offshore ECC lies within SCANS-IV block NS-C, where the density (0.6027 animals/km^2; CV = 0.228) and population abundance (36,286; 95% CL = 23,346 – 56,118) is lower than in the DBD Array Area block NS-H.

88. The worst-case density and reference population as shown in **Table 12-16** are taken forward to the assessment. A comparison of densities from other available sources is presented in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

Table 12-16 Density (Worst-Case) and Abundance for Harbour Porpoise

Density		**Source**
DBD Array Area	**0.842** harbour porpoise/km^2	Site-specific +4km buffer APEM survey
Offshore ECC	**0.6027** harbour porpoise/km^2	SCANS-IV; block NS-H
Reference population and Management Unit		
338,918 (NS AU)		Gilles *et al.,* 2023

12.6.3 Bottlenose Dolphin

89. In the UK, bottlenose dolphin occur in coastal habitats such as shallow bays and in offshore habitats near the continental shelf edge. This separates them into two ecotypes – inshore and offshore bottlenose dolphin (Louis *et al.,* 2014b; Oudejans *et al.,* 2015; BEIS, 2022a). Primarily, bottlenose dolphins are an inshore species (within 10km of land), often associated with river estuaries, headlands, and strong tidal currents (Ingram & Roger, 2002; Moreno & Mathews, 2018).

90. The Moray Firth is home to a resident population of bottlenose dolphin, with 226 individuals (95% Confidence Interval (CI): 214 – 239; Cheney *et al.,* 2024). It is the only known resident population of coastal bottlenose dolphins in wider Study Area. For the last few years, these dolphins have been reported swimming outside of their normal range, venturing along the coastline of north-east England (Aynsley, 2017; Hacket, 2022). Along the NE coast of England, the majority of land-based observations from public sightings were of bottlenose dolphins. Within a single year, 72 sightings were recorded, totalling 570 dolphins were made (SeaWatch Foundation (SWF), 2024).

91. The Project is located within the GNS MU, with an estimated reference population of 2,022 (CV = 0.75) individuals (IAMMWG, 2023).

92. As mentioned above, observations were made that bottlenose dolphin from the Moray Firth are traveling as far south as Flamborough Head. As such, there is the possibility that individuals from this resident population, which is part of the CES MU, may be affected from DBD. This PEIR will consider both the North Sea population (GNS MU), as well as the CES population for any identified effects within the inshore region only.

93. No bottlenose dolphins were recorded during the site-specific surveys (October 2021 – September 2023).

94. The SCANS-III survey conducted during the summer of 2016 recorded no bottlenose dolphin in either survey block N or O, which are the areas where the Project is located (Hammond *et al.,* 2021; see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**).

95. Few bottlenose dolphins were recorded during SCANS-IV (Gilles *et al.,* 2023), resulting in an estimated density of at 0.0014 animals/km^2 (CV = 0.700) and an abundance of 96 (95% CL = 1 – 344) individuals within survey block NS-H (relevant for the array area), and a density of 0.0419 animals/km^2 and abundance of 2,520 (95% CL = 57 – 6,616) within block NS-C (relevant for the ECC).

96. To provide a comparison of densities across a wider area, the Waggitt *et al (*2019) data was applied across the area of the SCANS-IV block NS-C and NS-H (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report** for results), with the results showing lower densities (when compared to SCANS-IV) of 0.0005/km^2 (for block NS-H) and 0.0009/km^2 (for block NS-C).

97. The density and reference population as shown in **Table 12-17** are taken forward to the assessment. A comparison of densities from other available sources is presented in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

Table 12-17 Density (Worst-Case) and Abundance for Bottlenose Dolphin

Density		**Source**
DBD Array Area	**0.0014** bottlenose dolphin/km^2	SCANS-IV; block NS-H
Offshore ECC	**0.0419** bottlenose dolphin /km^2	SCANS-IV; block NS-C
Reference population and Management Unit		
2,022 (GNS MU) and **226** (CES MU)		Inter-Agency Marine Mammal Working Group (IAMMWG), 2023; Cheney *et al.,* 2024

12.6.4 Common Dolphin

98. Throughout its range, the common dolphin is primarily distributed in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland (BEIS 2022b; Hammond *et al.,* 2021; Waggitt *et al.,* 2019) and is recorded as rare in the North Sea (Reid *et al.,* 2003; Camphuysen & Peet, 2006; Evans, *et al.,* 2003; Kinze *et al.,* 2010; Murphy *et al.,* 2013; Murphy *et al.,* 2021). There is very little literature on common dolphins in the North Sea, however it is documented that they have a seasonal occurrence in the North Sea in the summer months (Waggitt *et al.,* 2019).

99. The reference population for common dolphin is based on the CGNS MU which is estimated to be 102,656 (CV = 0.29) animals (IAMMWG, 2023).

100. During the SCANS-IV (Gilles *et al.,* 2023) surveys, common dolphin was recorded for the first time in the North Sea. In block NS-C (location of the offshore ECC), the abundance was estimated to be 192 (95% CL: 6 – 724) with a density of 0.0032 common dolphin per km^2 (CV=0.966). Within survey block (NS-H) in which the DBD Array Area is located, no common dolphin was sighted during SCANS-IV surveys.

101. Four common dolphins were sighted over two separate sightings during the site-specific surveys (October 2021 – September 2023).

102. Furthermore, several public sightings of common dolphins were confirmed between October 2023 and 2024, mainly along the eastern coast of England (SWF, 2024).

103. To provide a comparison of densities across a wider area, the Waggitt *et al (*2019) data was applied across the area of the SCANS-IV block NS-C and NS-H, with a resultant density of 0.012 animals/km^2 for the NS-H block, and 0.017 animals/km^2 for the NS-C block (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report** for results). A slight seasonal variation is evident, with higher densities in the summer months.

104. The worst-case density and reference population as shown in **Table 12-18** are taken forward to the assessment. A comparison of densities from other available sources is presented in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

Table 12-18 Density (Worst-Case) and Abundance for Common Dolphin

Density		**Source**
DBD Array Area	**0.012** common dolphin/km^2	Waggitt *et al (*2019) over SCANS-IV block NS-H
Offshore ECC	**0.017** common dolphin /km^2	Waggitt *et al (*2019) over SCANS-IV block NS-C
Reference population and Management Unit		
102,656 (GNS MU)		IAMMWG, 2023

12.6.5 White-Beaked Dolphin

105. White-beaked dolphin was the second most commonly occurring cetacean in UK shelf waters and is regularly encountered in coastal and offshore waters (BEIS, 2022b); usually found in waters of 50-100m depth (Reid *et al.,* 2003) in the northern half of UK waters. However, the occurrence of white-beaked dolphin in the southern North Sea is relatively low (Reid *et al.,* 2003; Hammond *et al.,* 2013; 2021).

106. The reference population for white-beaked dolphins is based on the CGNS MU, which is estimated to be 43,951 individuals (CV = 0.22) (IAMMWG, 2023).

107. The long-term sightings data collation by Waggitt *et al (*2019) provide insight via density distribution maps for white-beaked dolphin, indicating higher densities in the northern North Sea. Densities decreases south of Scotland and highlighted seasonal differences, where summer densities peaked in the northern range of the species.

108. To provide a comparison of densities across a wider area, the Waggitt *et al (*2019) data was applied across the area of the SCANS-IV block NS-C and NS-H, with a resultant density of 0.0104 animals/km^2 for the NS-H block, and 0.034 animals/km^2 for the NS-C block (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report** for results).

109. The SCANS-IV surveys (Gilles *et al.,* 2023) indicate an increase in white-beaked dolphin numbers in the southern North Sea since SCANS-III (Hammond *et al.,* 2021). In survey block NS-H, where the DBD Array Area is located, the estimated abundance of white-beaked dolphins is 157 (95% CI: 3 – 484), with a density of 0.0023 animals/km^2 (CV = 0.992). In survey block NS-C, where the offshore ECC is situated, the estimated abundance is 894 dolphins (95% CI: 12 – 2,387), with a density of 0.0149 animals/km^2 (CV = 0.758).

110. Whilst no white-beaked dolphins were seen in the site-specific surveys (October 2021 – September 2023), a relatively large number (68 individuals) were identified from public sightings data through SWF between October 2023 and 2024 (SWF, 2024).

111. The worst-case density and reference population as shown in **Table 12-19** are taken forward to the assessment. A comparison of densities from other available sources is presented in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

Table 12-19 Density (Worst-Case) and Abundance for White-Beaked Dolphin

Density		**Source**
DBD Array Area	**0.0104** white-beaked dolphin/km^2	Waggitt *et al (*2019) over SCANS-IV block NS-H
Offshore ECC	**0.034** white-beaked dolphin /km^2	Waggitt *et al (*2019) over SCANS-IV block NS-C
Reference population and Management Unit		
43,951 (CGNS MU)		IAMMWG, 2023

12.6.6 Minke Whale

112. Minke whale are widely distributed along the Atlantic seaboard of Britain and Ireland and throughout the North Sea. The JNCC Cetacean Atlas (Reid *et al.,* 2003) indicates that minke whale occur regularly in the North Sea to the north of Humberside but are comparatively scarce in the southern North Sea. Animals are present throughout the year, but most sightings are between May and September (Reid *et al.,* 2003).

113. Sightings rarely extend south of Dogger Bank, but occasional sightings of minke whale are made as far south as Flamborough Head and the north Humberside coastlines between July and October (Department of Energy and Climate Change[3] (DECC) 2016).

114. The minke whale reference population is the CGNS MU, with an estimated population of 20,118 individuals (CV = 0.18) (IAMMWG, 2023).

115. Sightings data collected during the two-year aerial surveys indicated that only two minke whale were present in the DBD Array Area and 4km buffer. However, eight minke whale were identified by public surveys through the SWF between October 2023 and 2024 on the eastern coastline of England (SWF, 2024).

116. The density maps by Waggitt *et al* (2019) show a 'corridor' of higher minke whale density stretching from north of Orkney, around the north and west coasts of the UK, to Northern Ireland (NI). In the Project area, minke whale density is nearly absent in January but sees a slight increase in July, though overall densities remain relatively low.

117. In SCANS-IV (Gilles *et al.,* 2023), fewer minke whales were observed than during SCANS-III, resulting in a density of 0.0153 animals/km^2 (CV = 0.552) and an estimated abundance of 1,061 whales (95% CL: 231 – 2,771) in block NS-H (location of DBD Array Area). In block NS-C (location of offshore ECC), the density was 0.0068 animals/km^2 (CV = 0.881) with an estimated abundance of 412 whales (95% CL: 4 – 1,392).

118. To provide a comparison of densities across a wider area, the Waggitt *et al (*2019) data was applied across the area of the SCANS-IV block NS-C and NS-H, with a resultant density of 0.0014 animals/km^2 for the NS-H block, and 0.0048 animals/km^2 for the NS-C block (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report** for results). A slight seasonal variation is evident, with higher densities in the summer months.

119. The worst-case density and reference population as shown in **Table 12-20** are taken forward to the assessment. A comparison of densities from other available sources is presented in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

Table 12-20 Density (Worst-Case) and Abundance for Minke Whale

Density		**Source**
DBD Array Area	**0.0153** minke whale/km^2	SCANS-IV; block NS-H
Offshore ECC	**0.0068** minke whale/km^2	SCANS-IV, block NS-C
Reference population and Management Unit		
20,118 (CGNS MU)		IAMMWG, 2023

12.6.7 Grey Seal

120. Grey seals are found in the North Atlantic, Barents, and Baltic Seas, with major populations on the east coast of Canada, the USA, and north-west Europe. About 35% of the global grey seal population breeds in the UK, with 80% of these breeding in Scotland, particularly in the Outer Hebrides and Orkney. There are also breeding colonies in Shetland, mainland Britain's north and east coasts, and SW England and Wales (SCOS, 2022). The main haul-out sites in the north-east England are listedTable 12-13 in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

121. Over the two-year monthly aerial surveys (October 2021 to September 2023), only 19 grey seals were identified and an additional 15 unidentified seal species that could be grey seals.

122. The grey seal density estimates for the Project were calculated using the latest seal at sea maps, produced by Carter *et al (*2022), based on the 5km-by-5km grids that overlap with the DBD Array Area and the offshore ECC (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**). The mean at-sea density estimates were used in the assessment, as the worst-case and presented in **Table 12-21**.

123. SCOS (2022) carried out surveys in August 2022 to estimate the current status of British grey seals (SCOS, 2022). The reference population extent for grey seal incorporated the NE England MU (SCOS, 2022) and the SE England MU (SCOS, 2022; Carter *et al.,* 2022). To account for the grey seals that were not available for counting during these surveys, a population scalar was added to provide a more accurate population estimate. The population scalar was based on the proportion of seals estimated to be available to count during the August surveys ((0.2515 taken from SCOS, 2021 (BP 21/02)). This resulted in the below adjusted population estimates for the relevant MUs for harbour seal **Table 12-21**.

Table 12-21 Density (Worst-Case) and Abundance for Grey Seal

Density		**Source**
DBD Array Area	**0.080** grey seal/km^2	Carter *et al.,* 2022; SCOS, 2022
Offshore ECC	**0.274** grey seal/km^2	
Reference population and Management Unit		
56,505 = 30,592 (SE England) and 25,913 (NE England MU)		SCOS, 2022

12.6.8 Harbour Seal

124. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina* (SCOS, 2022).

125. On the east coast of Britain harbour seal distribution is generally restricted, with concentrations in the major estuaries of the Thames, The Wash and the Moray Firth (SCOS, 2022).

126. No harbour seal was recorded during the site-specific survey (October 2021 – September 2023).

127. The harbour seal density estimates for the Project were calculated using the latest seal at sea maps, produced by Carter *et al (*2022), based on the 5km-by-5km grids that overlap with the DBD Array Area and the offshore ECC (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**). The mean at-sea density estimates were used in the assessment, as the worst-case and presented in **Table 12-22**.

128. SCOS (2022) carried out surveys in August 2022 to estimate the current status of British harbour seals (SCOS, 2022). The reference population extent for harbour seal incorporated the NE England MU (SCOS, 2022) and the SE England MU (SCOS, 2022; Carter *et al.,* 2022). To account for the harbour seals that were not available for counting during these surveys, a population scalar was added to provide a more accurate population estimate. The population scalar was based on the proportion of seals estimated to be available to count during the August surveys (0.72 taken from Lonergan *et al.,* 2013). This resulted in the below adjusted population estimates for the relevant MUs for harbour seal **Table 12-22**.

Table 12-22 Density (Worst-Case) and Abundance for Harbour Seal

Density		**Source**
DBD Array Area	**0.000011** harbour seal/km^2	Carter *et al.*, 2022; SCOS, 2022
Offshore ECC	**0.00080** harbour seal/km^2	
Reference population and Management Unit		
4,992 = 4,868 (SE England) and 124 (NE England MU)		SCOS, 2022

12.6.9 Summary of Marine Mammal Densities and Reference Populations for Assessments

129. **Table 12-23** provides a summary of the reference populations and the density estimates for marine mammal species used in the impact assessments described in the chapter.

130. To determine the magnitude of an impact, the number of individuals that could be impacted by the Project were put into the context of the relevant reference population (see **Table 12-13** for definitions of magnitude).

Table 12-23 Summary of Marine Mammal Densities and Reference Populations Used in The Assessments

Species	Offshore component	Density (animals/km^2)	Source	Reference population	MU	Source
Harbour porpoise	DBD Array Area	**0.842**	Site-specific +4km buffer APEM survey	**338,918**	NS MU	Gilles *et al.*, 2023
	Offshore ECC	**0.6027**	SCANS-IV; block NS-C			
Bottlenose dolphin	DBD Array Area	**0.0014**	SCANS-IV; block NS-H	**2,022**	GNS	IAMMWG, 2023
	Offshore ECC	**0.0419**	SCANS-IV; block NS-C	**226**	CES	Cheney *et al.*, 2024
Common dolphin	DBD Array Area	**0.012**	Waggitt *et al* (2019) over SCANS-IV block NS-H	**102,656**	CGNS	IAMMWG, 2023
	Offshore ECC	**0.017**	Waggitt *et al* (2019) over SCANS-IV block NS-C			
White-beaked dolphin	DBD Array Area	**0.0104**	Waggitt *et al* (2019) over SCANS-IV block NS-H	**43,951**	CGNS	IAMMWG (2023)
	Offshore ECC	**0.034**	Waggitt *et al* (2019) over SCANS-IV block NS-C			
Minke whale	DBD Array Area	**0.0153**	SCANS-IV; block NS-H	**20,118**	CGNS	IAMMWG (2023)
	Offshore ECC	**0.0068**	SCANS-IV, block NS-C			
Grey seal	DBD Array Area	**0.080**	Carter *et al* (2022)	30,592 + 25,913 = **56,505**	NE & SE England	SCOS (2022)
	Offshore ECC	**0.274**				
Harbour seal	DBD Array Area	**0.000011**	Carter *et al* (2022)	4,868 + 124 = **4,992**	NE & SE England	SCOS (2022)
	Offshore ECC	**0.00080**				

12.6.10 Predicted Future Baseline

131. Marine mammals in the North Sea are increasingly vulnerable to the effects of climate change and other anthropogenic pressures, as it is one of the most intensively used seas in the world (Matthijsen *et al.,* 2018). OSPAR's Quality Status Report (QSR) from 2023 reported that the status of seals and small toothed cetaceans (for example dolphins, and harbour porpoise) is not good while the status of other marine mammals remains unknown (OSPAR, 2023). The assessment in the report have noticed limited improvements as compared to previous assessments. Significant change has been documented in many aspects of the UK marine environment in BEIS (2022b). These changes include rising sea temperatures, biogeographical shifts in many zooplankton assemblages, with a northward extension of warm-water species and changes in the distribution and abundance of fish species, with southern species becoming more prominent. This is likely due to a variety of factors, including climatic influences, nutrient inputs and anthropogenic factors, such as fishing. These observations are in line with the those of the OSPAR QSR 2023, whereby the state of marine food webs was deemed to be of great concern.

132. Warming sea surface temperatures, driven by global climate change, are projected to rise by 1.5–3°C by the end of the 21st century, depending on future greenhouse gas emissions OSPAR 2017; Intergovernmental Panel on Climate Change (IPCC) 2023). These temperature increases, combined with shifts in oceanographic conditions, will likely disrupt the abundance and distribution of key prey species such as sandeels and small pelagic fish, which are critical for species like harbour porpoises (MacLeod *et al.,* 2007; OSPAR 2017). As prey availability declines or shifts to cooler, northern waters, marine mammals may experience distributional shifts, with range contractions likely in southern parts of the North Sea where conditions become less favourable.

133. This trend has already been observed in other regions where prey stress has impacted marine mammal populations, reducing reproductive success and survival rates (Evans & Waggitt. 2020) and affects distribution, abundance and migration patterns, community structure, and susceptibility to disease and contaminants (Learmonth *et al.,* 2006; Evans & Waggitt, 2020. The changing climate will also impact critical habitats for seals, particularly low-lying haul-out sites and breeding grounds in coastal areas such as the Wadden Sea. Submergence of haul-out sites and habitat degradation may force seals to relocate to alternative areas, although their ability to establish new colonies will be limited in a region characterised by intense human activity and coastal development.

134. Changes in ocean temperatures could also affect species that require a specific range of water temperatures in which they can physically survive (Learmonth *et al.,* 2006; MacLeod *et al.,* 2007; Evans & Waggitt, 2020). Species of marine mammal with a narrow range of temperature tolerance, such as species of the Phocidae (earless seals such as grey and harbour seal), have been shown to be more susceptible to the effects of climate change (Orgeret *et al.,* 2021).

135. At the same time, the North Sea is undergoing rapid industrialisation, driven by the expansion of offshore renewable energy in the last twenty years and the emergence of carbon capture and storage projects. While oil and gas activities were prospering in the past, they are now experiencing declines in oil production with the lowest production measured since its beginning in 1970 (Taylor *et al.,* 2024). Gas production peaked in the early 2000s and due to resource depletion, production has been in a steady decline since then (University of Aberdeen (no date). Shipping, already at high levels in the North Sea, is projected to increase further (OSPAR, 2023; Robbins *et al.,* 2022a), exacerbating underwater noise pollution and increasing the risk of ship strikes. In addition, fisheries interactions remain a persistent threat, particularly through bycatch. As fish distributions shift due to climate change, fishing practices may also intensify in new areas, further increasing bycatch risks unless effective mitigation strategies are widely adopted (Ojea *et al.,* 2020).

12.6.10.1 Harbour Porpoise

136. The observed distribution of harbour porpoises from the SCANS-III survey in the summer of 2016 was similar to that observed in SCANS-II in 2005 (Hammond *et al.,* 2013). Although, one notable difference was that more sightings were made throughout the English Channel (block C) in 2016 and in block NS-A in 2022 (Gilles *et al.,* 2023) compared to previous surveys (Hammond *et al.,* 2021). The progressive spread of sightings into most of the Channel over the past three decades indicates that harbour porpoise distribution has expanded, probably from the North Sea and the Celtic Sea, and now encompasses the entire Channel, at least in summer (Gilles *et al.,* 2023). To mitigate the seasonal bias in data collection, conducting surveys outside of the summer SCANS period would enhance our understanding of changes in harbour porpoise distribution.

137. The effects of climate change on harbour porpoise populations are still relatively unknown, however, it is expected that there will be impacts to the population through prey depletion and range shifts. Harbour porpoise habitat and population range is determined from their preferred prey availability. 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). Although harbour porpoise feed on a range of prey, sandeels are their preferred item due to their high nutritional value. A decline in sandeel populations was thought to have impacted the distribution of harbour porpoise in the Scottish North Sea (MacLeod *et al.,* 2007). With the recent ban of the sandeel fishing in the UK (European Commission, 2024), this closure might have cascading effects on the marine food web (Marine Directorate, 2023). Consequently, it could enhance food availability for harbour porpoise, reducing starvation and potentially stabilising their population.

138. National monitoring in the southern North Sea showed that the seasonal pattern of occurrence has changed. For example, harbour porpoise in the southern part of the North Sea show a higher abundance in winter and spring and lower abundances in summer (Camphuysen, 2011; Scheidat *et al.,* 2012). Recently, this pattern has changed (2012–2017); harbour porpoise abundance increased in summer and abundance and density are now comparable to spring (Geelhoed and Scheidat, 2018, Nachtsheim *et al.,* 2021).

139. In the German sector of the North Sea, harbour porpoise abundance has been in decline in summer between 2002 and 2019, as well as local and seasonal differences in trends. (Nachtsheim *et al.,* 2021). The underlying causes for the observed trends are unknown but it is suggested that cumulative effects of a number of stressors could be the cause. However, it is acknowledged that there is a lack of data on population trends that could be driven by anthropogenic activities (Nachtsheim *et al.,* 2021). Therefore, more research is required to look at harbour porpoise population trends in the wider North Sea as there is little documentation on porpoise population trends in the area of interest.

12.6.10.2 Bottlenose Dolphin

140. The observed distribution of bottlenose dolphins in SCANS-III in 2016 was similar to that observed in SCANS-II and Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) in 2005/07 (Hammond *et al.,* 2013, 2021; Hammond *et al.,* 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; Working Group on Marine Mammal Ecology (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).

141. In SCANS-III there was an increase in predicted densities of bottlenose dolphin off the south-west coast of Britain and north-west coast of Spain since 2005, indicating that the species may be increasing its range northwards over time in response to climate change, warming seas and prey availability. There has been an increasing range expansion of the bottlenose dolphin from the Moray Firth. With an increase in the number of dolphins using areas along the east coast of Scotland, such as St Andrews Bay and the Tay estuary, 300km south of the Moray Firth SAC (Arso Civil *et al.,* 2019). There has also been a recent increase in bottlenose dolphins in the north-east of England (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands.

142. In the SCANS-IV summer survey in 2022, the population in the east coast Scotland are continuing to show signs of an increase and range expansion (Geelhoed *et al.,* 2022, Gilles *et al.,* 2023).

143. The Moray Firth population is a regular visitor to the east coast of England during the summer months; and potentially could be evidence of a new population becoming residents in the area, perhaps an expansion of the Moray Firth dolphins ranges (Hackett, 2022). This shift in bottlenose dolphin distribution is most likely due to a change a prey distribution (Hackett, 2022).

12.6.10.3 Common Dolphin

144. SCANS- III predicted high densities of common dolphin in the Celtic Sea in 2016, focused on shelf waters off the south-west of England and north-west 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 (Hammond *et al.,* 2013, 2021).

145. 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).

146. Common dolphins prefer a warm temperate or tropical environment (thermophilic) and are noted as having a flexible diet (Marçalo *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).

147. In the SCANS-IV survey in the summer of 2022, common dolphin was encountered in the North Sea, therefore showing a more northly distribution compared to previous SCANS surveys (Gilles *et al.,* 2023).

12.6.10.4 White-Beaked Dolphin

148. Studies have found colder-water adapted species, such as white-beaked dolphin, have been seen less frequently in British waters, potentially due to climate change effects (IAMMWG, 2023; Williamson *et al.,* 2021; Evans & Waggitt, 2020). However, the observed distribution of white-beaked dolphin in 2022 (SCANS-IV) was similar to that observed in SCANS-III in 2016, SCANS-II in 2005 and in SCANS-I in 1994 (Gilles *et al.,* 2023; Hammond *et al.,* 2002, 2013, 2021). The estimate of abundance of white-beaked dolphin in 2022 of 67,138 (CV = 0.33) was higher than previous estimates, with SCANS-III being 36,287 (CV = 0.29) in 2016, SCANS-II was 37,689 (CV = 0.36) in 2005 and SCANS was 23,716 (CV = 0.30) in 1994.

149. SCANS-IV found no evidence of a trend in abundance of white-beaked dolphin in the North Sea since the mid-1990s (Hammond *et al.,* 2021, Gilles *et al.,* 2023). A review of the strandings data of white-beaked dolphin in the North Sea were collated and assessed by ASCOBANS (IJsseldijk *et al.,* 2018) in order to determine temporal and spatial trends in the distributions of white-beaked dolphin in the SW North Sea. Strandings data used within the review were from Belgium, Germany, the Netherlands and the UK, from 1991 to 2017. This review indicates that there has been a reduction in the abundance of white-beaked dolphin in the south-east coasts of the UK, with an increase in the north-east area (IJsseldijk *et al.,* 2018). These changes probably reflect changes in prey distribution as a result of climate change.

150. Around north-west Scotland in the period 1992 to 2003, the relative frequency of strandings of white-beaked dolphin (a colder water species) declined, while strandings of common dolphin (a warmer water species) increased. Similarly, sightings surveys in the area also showed that the relative occurrence and abundance of white-beaked dolphins had declined, and common dolphins increased, in comparison to previous studies. These observations were consistent with changes in the local cetacean community, being driven by increases in local water temperature (MacLeod *et al.,* 2005). This study demonstrates that climatic changes have been driving the expansion of species distribution ranges. Although the study focused on north-west Scotland and no equivalent research is known for the North Sea, it can be inferred that future shifts in species distributions may occur.

12.6.10.5 Minke Whale

151. The abundance estimate of minke whale from SCANS-IV is slightly lower compared to SCANS-III survey, however a trend analysis has shown no support for change in abundance in the North Sea since 1989 (Gilles *et al.,* 2023). However, 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).

152. A study by Sun *et al* (2022), using predictive distribution modelling for the North Atlantic minke whale, has identified a reduction in future suitable habitats and a poleward shift in response to warming climates, depending on the climate scenarios used in the models. For instance, under the worst-case climate scenario, the North Sea region has been predicted to be a loss of minke whale habitat in the year 2100 (Figure 8 in Sun *et al*., 2022).

153. Similar results for other baleen species blue whale *Balaenoptera musculus* and sperm whale *Physeter macrocephalus* were highlighted in Peters *et al (*2022) that also modelled future suitable habitat these species in New Zealand waters. In line with Sun *et al (*2022), the research by Peters *et al* (2022) revealed a shift towards higher latitudes (i.e. polewards) in response to several climate scenarios. Peters *et al (*2022) highlighted that this higher latitude shift was likely to be driven through changes in prey composition and sea surface temperatures. Similar observations were made by McLeod *et al (*2005) in the UK, in which changes in local cetacean communities were observed driven by increases in local water temperature (minke whale was not investigated in this study). Changes as described by Sun *et al* (2022), Peters *et al (*2022) and McLeod *et al (*2005) are expected to have significant impacts on the local ecosystem.

12.6.10.6 Grey Seal

154. Grey seals were exploited in large scale culls in the 1960s and 1970s in the North Sea, Orkney and Hebrides as population control measure and since the 1960s regular surveys began (SCOS, 2022), which have shown that there has been a continual increase in the total UK grey seal pup production (SCOS, 2022). Grey seal pup production at colonies in the North Sea increased rapidly with an average 7% annual increase (SCOS, 2022). The majority of the increase in the North Sea has been due to the continued rapid expansion of newer colonies on the mainland coasts in Berwickshire, Lincolnshire, Norfolk and Suffolk. Interestingly, these colonies are all at easily accessible sites on the mainland, where grey seals have probably not bred in significant numbers since before the last ice age (SCOS, 2020).

155. In the southern North Sea, pup production increased by an average of 22% per year from 2010 to 2014, suggesting that there is likely immigration from colonies further north (SCOS, 2019). The colonies in the southern North Sea are still increasing in population size, but the rate of increase has slowed significantly in the last three years, giving an early indication that they may be reaching their carrying capacity (SCOS, 2022), similar to what has been recorded in grey seal populations in other areas such as Orkney (SCOS, 2022).

12.6.10.7 Harbour Seal

156. Overall, the UK population of harbour seal has increased since the late 2000s and is close to the previous high observed during the 1990s (SCOS, 2021). However, there are significant differences in the population dynamics between seal MUs, with general declines in counts of harbour seals in several regions around Scotland and more recently in the south-east of England. Recent trends, i.e. those that incorporate the last ten years, show significant growth in both MUs on the east coast of England up to 2018, but the 2019 count was approximately 27.6% lower than the mean of the previous five years in the SE England MU (SCOS, 2021).

157. The 2019 decrease follows a period when growth rates had decreased to zero, possibly indicating that the population in the SE England MU was approaching its carrying capacity. This could represent the first indication of a population decline. Additional surveys in 2020, 2021 and 2022 confirmed this continued decrease (SCOS, 2022).

158. In The Wash between 2006 and 2012 the counts of harbour seal approximately doubled and increased by 50% for East Anglia as a whole. Since 2012 the counts in these areas have been almost constant. The 2018 count was the second highest ever recorded in The Wash and was consistent with the pattern of relatively stable population since 2010. However, the 2019 count was 27% lower than the 2012 to 2018 mean count (SCOS, 2021). Along the east Anglian coast, the 2018 count was 17% higher than the 2017 count and similar to the average for the preceding five years.

159. This continues the pattern of high inter annual variability (SCOS, 2021). As outlined in SCOS (2021), these wide fluctuations are not unusual in the long-term time series and despite the apparently wide inter-annual variation, the pup production has increased at around 5.6% per year since surveys began in 2001, although the rate of increase may have slowed and may be reaching an asymptote (SCOS, 2021). The count for The Wash and North Norfolk SAC has decreased by approximately 19% over the same time periods, while Donna Nook and Scroby Sands showed a 38% decrease (SCOS, 2022). The harbour seal decline is evident at all sites and appears to have affected all sub-sections of The Wash and North Norfolk SAC (SCOS, 2022).

160. Harbour seal counts in 2019 to 2022 that were carried out during the harbour seal moult, when the highest numbers are hauled out, over all were much lower, indicating a decline of 20 to 30%.

161. The factors driving the population decline remain uncertain, but the most likely main drivers could be increased competition with grey seals, anthropogenic activities, disease, toxins or interactions therein (SCOS, 2022). This decline is a clear cause for concern and emergency funding for additional surveys has been provided by Defra. A proposed research programme is currently being developed to investigate the causes behind this decline (SCOS, 2022).

12.6.10.8 Summary

162. For marine mammals, there have been some changes evident as a result of climate change and anthropogenic pressures, and it is reasonable to expect further such changes in the future and over the lifetime of the Project. However, the latest changes in population distribution and abundance have been taken into account in the impact assessment.

12.7 Assessment of Effects

163. The potential significant effects to marine mammal receptors that may occur during construction, operation and decommissioning of the Project are assessed in the following sections. The assessment follows the methodology set out in **Section 12.5** and is based on the realistic worst-case scenarios defined in **Section 12.4.4**, with consideration of embedded mitigation measures identified in **Section 12.4.3**.

12.7.1 Potential Effects during Construction

12.7.1.1 Underwater Noise: Physical and Auditory Injury (MM-C-01)

12.7.1.1.1 Underwater Noise Modelling

164. Underwater noise modelling was carried out by Subacoustech Environmental Ltd to predict the noise levels likely to arise during impact piling and other activities. The modelled impact ranges were used to determine the potential effects on marine mammals.

165. The underwater noise modelling was undertaken using the Impulsive Noise Propagation and Impact Estimator (INSPIRE) v5.2 sub-sea noise propagation model. 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 **Volume 2, Appendix 12.3 Underwater Noise Modelling Report** for further details).

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

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

167. A detailed review of the modelling confidence is provided in **Section 3.1** of **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**.

12.7.1.1.1.1 Methodology

12.7.1.1.1.1.1 Piling locations

168. Modelling was undertaken at four representative locations covering the extents of the DBD Array Area. This included the deeper location of the site which is typically the worst-case location (i.e. the deepest location where piling can take place tends to give the greatest noise propagation) (**Volume 2, Appendix 12.2 Marine Mammals Technical Report**):

- NE location with a water depth of 26.6m;
- NW location with a water depth of 23.8m;
- SE location with a water depth of 21.5m; and
- Centre OP location with a water depth of 26.2m.

169. The worst-case scenario for monopiles was derived from the maximum impact range modelled for all four locations, while for jacket pin piles the worst-case was derived from the maximum impact range modelled for three locations (NE, NW, SE) at which jacket pin piles were considered an option. These were used to inform the assessment of the maximum potential effect on receptor groups in order to provide a conservative assessment. Note that the worst-case locations for each species group, or each piling scenario, was not always the same.

12.7.1.1.1.1.2 Hammer Energy, Soft-Start and Ramp-Up

170. The underwater noise modelling was based on the following piling scenarios for monopiles and jacket pin piles:

- Two sequential monopiles, with maximum diameter of up to 18m, maximum hammer energy of up to 8,000 kilojoule (kJ) and maximum starting energy of 800kJ; and
- Four sequential jacket pin piles, with diameter of up to 5m, maximum hammer energy of up to 5,000kJ and maximum starting hammer energy of 500kJ.

171. The piling duration (for either one monopile or one pin pile) was estimated to take five hours 20 minutes.

172. To determine the potential for PTS or TTS from SEL_{cum}, the soft-start, ramp-up, hammer energy, total duration and strike rate were all taken into account.

173. **Table 12-24** summarises the soft-start, ramp-up and piling duration used to assess SEL_{cum} for monopiles and jacket pin piles.

174. As a worst-case scenario, it was assumed that the maximum hammer energy would be required and applied for the remaining duration of the pile installation. However, in practice, the maximum hammer energy is only likely to be required for a small proportion of the piling installations and for shorter periods of time. Therefore, the modelling and assessments are considered conservative and precautionary.

Table 12-24 Summary of Hammer Energy, Soft-Start and Ramp-Up Used for Piling Modelling

	Starting hammer energy	Ramp-up	Maximum hammer energy
Monopile			
Monopile hammer energy (%)	800kJ (10%)	Gradual ramp-up	8,000kJ (100%)
Number of strikes	600	1,800	7,200
Strikes per minute	30	30	30
Duration	20 minutes	1 hour	4 hours
Maximum piling in 24 hours	Up to two monopiles (10 hours and 40 minutes maximum of active piling, with each pile installed as per the parameters above)		
Pin pile			
Pin pile hammer energy (%)	500 (10%)	Gradual ramp-up	5,000 (100%)
Number of strikes	600	1,800	7,200
Strikes per minute	30	30	30
Duration	20 minutes	1 hour	4 hours
Maximum piling in 24 hours	Up to four pin piles (21 hours and 20 minutes maximum of active piling, with each pile installed as per the parameters above)		

12.7.1.1.1.1.3 Concurrent Piling

175. Underwater noise modelling has also been undertaken to cover the possible option for two sequentially installed monopiles (in the same 24-hour period) to be piled at the NW and SE location concurrently (equating to a maximum of four monopiles installed in a 24-hour period). The modelling was based on the worst-case of these two locations having the largest separation distance from one another (i.e. NW and SE) (**Volume 2, Appendix 12.3 Underwater Noise Modelling Report**).

12.7.1.1.1.1.4 Noise Source Levels

176. Underwater noise modelling requires knowledge of the source level, which is the theoretical noise level at 1m from the noise source. The INSPIRE noise propagation model assumes that the noise acts as a single point source. The source level is estimated based on the pile diameter and the hammer energy imparted on the pile by the hammer. This is then adjusted, depending on the water depth at the modelling location, to allow for the length of pile in contact with the water, which can affect the amount of noise that is transmitted from the pile into its surroundings (see **Volume 2, Appendix 12.3 Underwater Noise Modelling Report** for further information).

177. The unweighted peak sound pressure level (SPL_{peak}) and single strike sound exposure level (SEL_{ss}) source levels estimated for this assessment are summarised in Table 12-25. All decibel (dB) SPL values are referenced to 1µPa and all SEL values are referenced to $1\mu Pa^2s$. Predicted noise levels at 750m from the piling locations are also provided in **Table 3-5** of **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**.

Table 12-25 Unweighted Source Levels Used in Underwater Noise Modelling for Monopiles and Jacket Pin Piles

Source level	Monopile (8,000kJ)	Pin pile (5,000kJ)
SPL_{peak} (dB re 1 μPa @ 1m)	243.3 dB re 1 μPa @ 1m	242.6 dB re 1 μPa @ 1m
SEL_{ss} (dB re 1 μPa²s @ 1m)	224.6 dB re 1 μPa²s @ 1m	223.7 dB re 1 μPa²s @ 1m

12.7.1.1.1.1.5 Environmental Conditions

178. The inclusion of measured data for similar offshore piling operations in UK waters allows the INSPIRE noise propagation 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 wind farm site. Data from the British Geological Survey show that the seabed surrounding in and around DBD is generally made up of various combinations of sand and gravelly sand. The in-situ geophysical surveys in 2021 and the benthic sediment samples taken during a site-specific survey in 2022 support the above findings (**Volume 2, Appendix 8.2 Marine Geophysical Survey Report** and **Volume 2, Appendix 10.3 Benthic Ecology Baseline Characterisation Report**). For the modelling, digital bathymetry, from the European Marine Observation and Data Network (EMODnet) (data can be found on their website https://emodnet.ec.europa.eu/en) has also been used. Mean tidal depth has been used throughout.

12.7.1.1.1.1.6 Thresholds and Criteria

179. Sound measurements underwater are usually expressed using the dB scale, which is a logarithmic measure of sound. For example, equal increments of sound levels do not have an equal increase in the perceived sound. Instead, each doubling of sound level will cause a roughly equal increase of loudness (further details are provided in **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**).

180. 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.

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

182. The SEL is the constant sound level acting for one second. It sums up 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 **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**).

183. SEL_{ss} is the sound exposure level from a single strike of the hammer, i.e. one hammer strike at the starting hammer energy or maximum hammer energy applied.

184. SEL_{cum} is the cumulative sound exposure level throughout the duration of piling, including the soft-start, ramp-up and time required to complete the installation of the pile (**Table 12-25**). 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 would swim away from the noise source. For this, a constant swimming speed of 3.25m/second (s) has been assumed for minke whale (Blix & 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 and calf pairs (Otani *et al.,* 2000). This is considered a worst-case scenario, as marine mammals are expected to be able to swim faster. When reviewing the underwater noise modelling results for SEL_{cum} exposures, it is important to keep in mind that any individual is at risk of injury if they are within the identified range at the onset of the noise. Further details on how SEL_{cum} is modelled is provided in **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**.

185. At the time of writing, the metrics and criteria that have been used to assess the potential effect of underwater noise on marine mammals are based on the most up to date publications, recommended guidance, and discussions during Marine Mammal Ecology ETG3 meetings (see consultation in **Volume 2, Appendix 12.1 Consultation Responses for Marine Mammals**).

186. Southall *et al (*2019) categorised marine mammal species into hearing groups and applied filters to the unweighted noise in order to approximate the hearing sensitivities of the species. This allowed the specific hearing abilities and sensitivities of each group to be approximated. This provides the weighted SEL criteria, which corrects the sound level based on the sensitivity of the receiver; for example, harbour porpoise is less sensitive to low frequency (LF) sound than minke whales. Marine mammals hearing group ranges are summarised in **Table 12-26**.

Table 12-26 Southall et al (2019) Marine Mammals Hearing Ranges

Species hearing group	Generalised hearing range
Harbour porpoise [Very high-frequency cetaceans (VHF)]	275Hz to 160kHz
Bottlenose dolphin, common dolphin, white-beaked 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

187. Southall *et al (*2019) presented 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.

188. Southall *et al (*2019) also included 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, should not be compared directly. Assessments have been based on the criteria with the greatest predicted impact ranges.

189. It should be noted that the Marine Mammal Noise Exposure Criteria for unweighted SEL_{peak}, as outlined by Southall *et al (*2019), are identical to those of the National Marine and Fisheries Service (NMFS) (2018).

190. The Southall *et al (*2019) thresholds and criteria for PTS and TTS impacts to the species groups used in the assessments are summarised in **Table 12-27**.

Table 12-27 Southall et al (2019) Thresholds and Criteria Used in the Underwater Noise Modelling and Assessments

Species	Species group	Impact	Unweighted SPL_{peak} (dB re 1 μPa) impulsive	Weighted SEL_{ss} and SEL_{cum} (dB re 1 $\mu Pa^2 s$)	
				Impulsive	Non-impulsive
Harbour porpoise	VHF	PTS	202	155	173
		TTS	196	140	153
Dolphin species	HF	PTS	230	185	198
		TTS	224	170	178
Minke whale	LF	PTS	219	183	199
		TTS	213	168	179
Grey seal and harbour seal	PCW	PTS	218	185	201
		TTS	212	170	181

191. The PTS thresholds are extrapolated from TTS thresholds. These PTS thresholds are ultimately used to indicate the potential number of animals that could be at risk (e.g. experience permanent hearing sensitivity loss, even after the exposure to sound ceases, or in-between successive sound exposures), as 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).

192. The likelihood of individual animals experiencing PTS and TTS is dependent on both the intensity of the sound and also time of the exposure, as PTS and / or TTS can occur as a result of prolonged exposure to increased noise levels, for example as for the duration of pile installation (SEL_{cum}).

12.7.1.1.1.1.7 Impulsive and Non- Impulsive Noise

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

- Impulsive (single or multiple pulse): 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; and

- Non-impulsive (or 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.

194. 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 **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**). Both impulsive and non-impulsive criteria from Southall *et al (*2019) have been included in the underwater noise modelling, however, assessments presented in this chapter have been based on the criteria with the greatest predicted impact range.

12.7.1.1.1.1.8 Assumptions and Considerations

195. It should be noted, and considered, that the underwater noise modelling and assessment is based on worst-case scenarios and precautionary approaches. This includes assumptions for both the noise source, and the marine mammal themselves.

196. In terms of the noise source, the maximum hammer energy to be applied and maximum piling duration for each scenario was assumed for all piling locations; however, it is unlikely that applying maximum hammer energy throughout the maximum duration would be required at the majority of piling locations. In addition, the maximum predicted impact ranges were based on the location with the greatest potential noise propagation range and this was assumed as the worst-case for each piling location.

197. In terms of the marine mammal themselves, the assumption that fleeing marine animals (such as harbour porpoise, dolphin species, grey seal and harbour seal) are swimming at a constant speed of 1.5m/s is based on the slow swimming speed of harbour porpoise mothers and their calves (Otani *et al.,* 2000). Normally, marine mammals are expected to swim faster, for example harbour porpoise have been recorded swimming at speeds of up to 4.3m/s (Otani *et al.,* 2000). During playbacks of pile driving sounds (SPL of 154 dB re 1μPa) the swimming speed was measured as 1.97m/s (7.1km/h), whereas, during quiet baseline periods, the mean swimming speed was 1.2m/s (4.3km/h; Kastelein *et al.,* 2018).

198. The assumption that animals are submerged 100% of the time does not account for any time that an individual may spend at the surface. Compared to SELs in the water column, noise levels near the surface are lower, so when cetaceans surface to breathe, or when seals have their head out of the water, the animal would not be exposed to such high levels.

199. Underwater noise modelling assumed that marine mammals would travel in the mid-water column, where SPLs are greatest. However, in reality, animals would not be subjected to these high SPL at all times, since they are likely to move up and down through the water column. In order to breathe, the animals would have to regularly surface, where the sound pressure would be lower near the surface than in the mid-water column. A study by Teilmann *et al (*2007) on diving behaviour of harbour porpoise in Danish waters suggested 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.

200. The swimming patterns of harbour porpoise undertaking direct travel are typically characterised by short submergence periods, compared to feeding animals (Watson & 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).

201. Noise impact assessments assume that all animals within the noise contour may be affected to the same degree for the maximum worst-case scenario. For example, all animals exposed to noise levels that induce behavioural avoidance would be displaced, or all animals exposed to noise levels that are predicted as inducing PTS or TTS would 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, suggested 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 DRC, such that the probability of inducing TTS would decrease moving further away from the SEL threshold required to induce TTS. Further work by Thompson *et al (*2013) has adopted this DRC to produce a theoretical dose-response for PTS in harbour seal, by scaling up Finneran *et al (*2005) DRC for changes in levels of TTS at different SEL. This showed the probability of seals experiencing PTS increases from an SEL of 186, up to 240 dB re 1 μPa^{2}s; the point at which all animals are predicted to have PTS.

202. Soft-start and ramp-up periods are included as embedded mitigation (**Section 12.4.3**). The soft-start begins with a lower hammer energy, before ramping-up to the maximum hammer energy, with the assumption that marine mammals would 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 noise levels at any given distance were highest at low hammer energies (Thompson *et al.,* 2020). Modelling highlighted that there was a strong negative relationship between noise from pin pile installations and pile penetration depth, whereas hammer energy only had a weak positive relationship between received noise and hammer energy. The study further found that strong responses of porpoises to ADDs resulted in far-field disturbance beyond that required to mitigate injury.

12.7.1.1.1.2 Modelling Results

203. The modelling results showed that, among all modelled locations, the impact ranges at the Centre (OSP) location were worst-case. However, the area over which the sound would be received by marine mammals was modelled to be larger in the NE location. This was the case for LF and VHF cetaceans, while for PCW and HF the ranges and areas were either the same or higher for the NE location. Therefore, the PTS and TTS assessments will be based on the NE location as the larger area would account for the worst-case over which animals could be at risk to PTS or TTS. However, any mitigation requirements will be based on the largest impact ranges rather than areas.

204. **Table 12-28** presents the underwater noise modelling results for the predicted PTS impact ranges and areas at the wind farm site (for the worst-case NE location) from:

- A single strike from the maximum hammer energy;
- Cumulative SEL (over a 24-hour period) for:
  - Two sequential monopiles per 24 hours; and
  - Four sequential Jacket pin piles.
- Two sequentially installed monopiles at NW location and two sequentially installed monopiles at SE location.

205. **Table 12-29**Table 12-29 presents the underwater noise modelling results for the predicted TTS impact ranges and areas at the wind farm site (worst-case location of NE) from:

- A single strike from the maximum hammer energy;
- Cumulative SEL (over a 24-hour period) for:
  - Two sequential monopiles per 24 hours;
  - Four sequential Jacket pin piles; and
  - Two sequentially installed monopiles at NW location and two sequentially installed monopiles at SE location

12.7.1.1.2 Receptor Sensitivity

206. All species of cetaceans rely on sonar for navigation, finding prey and communication, and are therefore highly sensitive to permanent hearing damage (Southall *et al.,* 2007). Any PTS would be permanent and marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects and considered unable to recover from the effects.

207. 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 echolocate. PTS would not result in an individual being unable to hear but could result in some permanent change to hearing sensitivity.

208. Pinnipeds use sound in both air and water for social and reproductive interactions (Southall *et al.,* 2007), but not for finding prey. Therefore, Thompson *et al (*2012) suggested 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 seal and grey seal is expected to be lower than in 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.,* 2016).

209. 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 effect.

210. The sensitivity for all marine mammal receptors to PTS is considered to be **high** as a precautionary approach.

211. The sensitivity for all marine mammal receptors to TTS is considered to be **medium**.

Table 12-28 Predicted PTS Impact Ranges (And Areas) At the DBD Array Area from A Single Strike and From Cumulative Exposure for Maximum Hammer Energy

Species	**Impact**	**Criteria and threshold (Southall *et al.*, 2019)**	**Maximum impact range and area**		**Maximum impact area**
			2x monopile (sequential piling) Maximum hammer energy (8,000kJ)	**4x pin pile (sequential piling) Maximum hammer energy (5,000kJ)**	**2x monopiles at NW and 2x monopiles at SE (sequential and concurrent piling) Maximum hammer energy (8,000kJ)**
Harbour porpoise (VHF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (202 dB re 1µPa) Impulsive	0.69km ($1.5km^2$)	0.63km ($1.2km^2$)	*N/A*
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (155 dB re 1µPa2s) Impulsive	7.0km ($140km^2$)	5.8km ($91km^2$)	$600km^2$
Dolphin species (HF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (230 dB re 1µPa) Impulsive	<0.05km (<$0.01km^2$)		*N/A*
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (185 dB re 1µPa2s) Impulsive	<0.1km (<$0.1km^2$)		*There is no cumulative effect between the two locations*
Minke whale (LF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (219 dB re 1µPa) Impulsive	<0.05km ($0.01km^2$)		*N/A*
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (183 dB re 1µPa2s) Impulsive	9.1km ($220km^2$)	7.0km ($130km^2$)	$900km^2$
Grey and harbour seal (PCW)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (218 dB re 1µPa) Impulsive	0.06km ($0.01km^2$)	0.05km ($0.01km^2$)	*N/A*
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (185 dB re 1µPa2s) Impulsive	0.73km ($1.6km^2$)	0.43km ($0.53km^2$)	$110km^2$

Table 12-29 Predicted TTS Impact Ranges (and Areas) at the DBD Array Area from a Single Strike and from Cumulative Exposure for Maximum Hammer Energy

Species	**Impact**	**Criteria and threshold (Southall *et al.*, 2019)**	**Maximum impact range and area**		**Maximum impact area**
			2x monopile (sequential piling) Maximum hammer energy (8,000kJ)	**4x pin pile (sequential piling) Maximum hammer energy (5,000kJ)**	**2x monopiles at NW and 2x monopiles at SE (sequential and concurrent piling) Maximum hammer energy (8,000kJ)**
Harbour porpoise (VHF)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (196 dB re 1µPa) Impulsive	1.7km ($9.1km^2$)	1.6km ($7.4km^2$)	*N/A*
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (140 dB re 1µPa2s) Impulsive	35.0km ($2,900km^2$)	33.0km ($2,600km^2$)	$5,100km^2$
Dolphin species (HF)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (224 dB re 1µPa) Impulsive	<0.05km (<$0.01km^2$)		*N/A*
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (170 dB re 1µPa2s) Impulsive	0.58km ($0.92km^2$)	0.3km ($0.24km^2$)	$110km^2$
Minke whale (LF)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (213 dB re 1µPa) Impulsive	0.13km ($0.05km^2$)	0.11km ($0.04km^2$)	*N/A*
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (168 dB re 1µPa2s) Impulsive	45.0km ($4,500km^2$)	42.0km ($3,800km^2$)	$7,600km^2$
Grey and harbour seal (PCW)	TTS from single strike (without mitigation)	SPL_{peak} Unweighted (212 dB re 1µPa) Impulsive	0.15km ($0.07km^2$)	0.13km ($0.05km^2$)	*N/A*
	TTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (170 dB re 1µPa2s) Impulsive	19.0km ($900km^2$)	18.0km ($800km^2$)	$2,000km^2$

12.7.1.1.3 Impact Magnitude

12.7.1.1.3.1 Permanent Threshold Shift

12.7.1.1.3.1.1 Permanent Threshold Shift from Single Strike at Maximum Hammer Energy

212. The maximum predicted impact range for instantaneous PTS, from a single strike of monopile or pin pile, with maximum hammer energy without any mitigation, is up to 0.69km for harbour porpoise for monopiles with a maximum hammer energy of 8,000kJ (**Table 12-28**).

213. An assessment of the maximum number of marine mammals that could be at risk of instantaneous PTS from a single strike of monopile or jacket pin pile (at the maximum hammer energy) is presented in Table 12-30. This assessment assumed the maximum hammer energy without any mitigation, based on the worst-case NE location, whereby less than 0.001% of the reference populations are exposed to a permanent effect (**Table 12-30**). The magnitude is therefore considered to be **negligible** for all marine mammal species.

Table 12-30 Maximum Number Of Individuals (and % of Reference Population) That Could Be at Risk of PTS From a Single Strike of Monopile or Jacket Pin Pile At the Maximum Hammer Energy Without Mitigation, Based on The Worst-Case Location at the DBD Array Area

Species	**Criteria and threshold (Southall *et al.*, 2019)**	**Monopile with maximum hammer energy of 8,000kJ**		**Pin pile with maximum hammer energy of 5,000kJ**	
		Maximum number of individuals (% of reference population)	**Magnitude (permanent effect)**	**Maximum number of individuals (% of reference population)**	**Magnitude (permanent effect)**
Harbour porpoise	SPL$_{peak}$ Unweighted (202 dB re 1µPa) Impulsive	2 (0.0006% of NS MU)	**Negligible**	1 (0.0003% of NS MU)	**Negligible**
Bottlenose dolphin	SPL$_{peak}$ Unweighted (230 dB re 1µPa) Impulsive	0.00001 (0.0000007% of GNS MU)	**Negligible**	0.00001 (0.0000007% of GNS MU)	**Negligible**
Common dolphin		0.0001 (0.0000001% of CGNS MU)	**Negligible**	0.0001 (0.0000001% of CGNS MU)	**Negligible**
White-beaked dolphin		0.0001 (0.0000002% of CGNS MU)	**Negligible**	0.0001 (0.0000002% of CGNS MU)	**Negligible**
Minke whale	SPL$_{peak}$ Unweighted (219 dB re 1µPa) Impulsive	0.0002 (0.0000008% of CGNS MU)	**Negligible**	0.0002 (0.0000008% of CGNS MU)	**Negligible**
Grey seal	SPL$_{peak}$Unweighted (218 dB re 1µPa) Impulsive	0.0008 (0.000001% of NE & SE MU)	**Negligible**	0.0008 (0.000001% of NE & SE MU)	**Negligible**
Harbour seal		0.0000001 (0.000000002% of NE & SE MU)	**Negligible**	0.0000001 (0.000000002% of NE & SE MU)	**Negligible**

12.7.1.1.3.1.2 Permanent Threshold Shift from Cumulative Exposure for Sequential Pile Installation

214. The two largest maximum predicted impact ranges for PTS from cumulative exposure (SEL$_{cum}$) during the installation of two monopiles, with a maximum hammer energy of 8,000kJ, in the absence of any additional mitigation, is up to 7.0km for harbour porpoise and 9.1km for minke whale (**Table 12-28**).

215. The maximum predicted impact range for PTS from cumulative exposure (SEL$_{cum}$) during sequential piling of four jacket pin piles, with maximum hammer energy of 5,000kJ, is up to 5.8km for harbour porpoise and 7.0km for minke whale, without any additional mitigation (**Table 12-28**).

216. The SEL_{cum} is a measure of the total received noise over the whole piling operation and the SEL_{cum} range indicates the distance from the piling location an individual would need to be at the onset of piling to avoid exposure to PTS. 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 could receive a noise exposure in excess of the criteria threshold. 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 (see **Volume 2, Appendix 12.3 Underwater Noise Modelling Report** for further details).

217. An assessment of the maximum number of individuals that could be at risk of PTS from cumulative exposure during sequential installation of either two monopiles or four jacket pin piles is presented in **Table 12-31**.

Table 12-31 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of PTS From Cumulative SEL of the Sequential Installation of Two Monopiles or Four Jacket Pin Piles at Maximum Hammer Energy Without Mitigation, Based on the Worst-Case Location at the DBD Array Area

Species	Criteria and threshold (Southall *et al.*, 2019)	Monopile with maximum hammer energy of 8,000kJ		Pin pile with maximum hammer energy of 5,000kJ	
		Maximum number of individuals (% of reference population)	Magnitude (permanent effect)	Maximum number of individuals (% of reference population)	Magnitude (permanent effect)
Harbour porpoise	SEL_{cum} Weighted (155 dB re $1\mu Pa^2s$) Impulsive	118 (0.035% of NS MU)	**Medium**	77 (0.023% of NS MU)	**Medium**
Bottlenose dolphin	SEL_{cum} Weighted (185 dB re $1\mu Pa^2s$) Impulsive	0.0001 (0.000007% of GNS MU)	**Negligible**	0.0001 (0.000007% of GNS MU)	**Negligible**
Common dolphin		0.001 (0.000001% of CGNS MU)	**Negligible**	0.001 (0.000001% of CGNS MU)	**Negligible**
White-beaked dolphin		0.001 (0.000002% of CGNS MU)	**Negligible**	0.001 (0.000002% of CGNS MU)	**Negligible**
Minke whale	SEL_{cum} Weighted (183 dB re $1\mu Pa^2s$) Impulsive	4 (0.020% of CGNS MU)	**Medium**	2 (0.0099% of CGNS MU)	**Medium**
Grey seal	SEL_{cum} Weighted (185 dB re $1\mu Pa^2s$) Impulsive	0.13 (0.0002% of NE & SE MU)	**Negligible**	0.04 (0.00008% of NE & SE MU)	**Negligible**
Harbour seal		0.00002 (0.0000004% of NE & SE MU)	**Negligible**	0.000006 (0.0000001% of NE & SE MU)	**Negligible**

218. This assessment assumes a maximum hammer energy of 8,000kJ for monopile and 5,000kJ for pin piles, without any additional mitigation, and is based on the worst-case NE location for the maximum impact area (as set out in **Table 12-25**).

219. The magnitude of impact for two monopiles is therefore considered to be **medium** for harbour porpoise and minke whale; and **negligible** for all other species (**Table 12-31).**

220. The magnitude of impact for four jacket pin piles is therefore considered to be **medium** for harbour porpoise and minke whale; and **negligible** for all other species.

221. It is important to note that the assessment for PTS from cumulative exposure is highly precautionary. There is some variation in the potential impact ranges for SEL_{cum} at each location and between locations, therefore in many cases less individuals would be at risk of exposure than presented here (as the assessments are based on the worst-case location). It is also unlikely that the maximum hammer energy would be required at all piling locations for the entire duration of the piling activity.

12.7.1.1.3.1.3 Permanent Threshold Shift from the Cumulative Exposure for Concurrent and Sequential Pile Installation

222. The maximum predicted impact area for PTS from the cumulative exposure (SEL_{cum}) during the installation of two monopiles at the NW location and two monopiles at the SE location at the same time (i.e. concurrently), in the absence of any additional mitigation, is up to 600km² for harbour porpoise, and up to 900km² for minke whale (**Table 12-28**).

223. An assessment of the maximum number of individuals that could be at risk of PTS from cumulative exposure during the sequential and concurrent piling scenario at the NW and SE locations is presented in **Table 12-32**. The potential impact is assessed based on concurrent piling of two sequential monopile installations at both the NW and SE locations as the worst-case locations (up to a maximum of four piling events in 24 hours), with a maximum hammer energy of 8,000kJ, in the absence of any additional mitigation.

Table 12-32 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of PTS from Cumulative SEL of the Concurrent and Sequential Installation of two Monopiles at the NW and SE Locations at Maximum Hammer Energy without Mitigation

Species	Criteria and threshold (Southall *et al.*, 2019)	2x monopiles at NW and 2x monopiles at SE (sequential and concurrent piling)	
		Maximum number of individuals (% of reference population)	Magnitude (permanent effect)
Harbour porpoise	SEL_{cum} Weighted (155 dB re 1µPa²s) Impulsive	505 (0.15% of NS MU)	**Medium**
Bottlenose dolphin	SEL_{cum} Weighted (185 dB re 1µPa²s) Impulsive	0.0001 (0.000007% of GNS MU)	**Negligible**
Common dolphin		0.001 (0.000001% of CGNS MU)	**Negligible**
White-beaked dolphin		0.001 (0.000002% of CGNS MU)	**Negligible**
Minke whale	SEL_{cum} Weighted (183 dB re 1µPa²s) Impulsive	14 (0.070% of CGNS MU)	**Medium**
Grey seal	SEL_{cum} Weighted (185 dB re 1µPa²s)	9 (0.016% of NE & SE MU)	**Medium**
Harbour seal	Impulsive	0.001 (0.00002% of NE & SE MU)	**Negligible**

224. For dolphin species, there is no concurrent area of effect as the potential PTS onset areas of the two areas do not overlap. Therefore, for dolphin species, the assessment is based on the sum of both the NE and SE sequential PTS onset areas. This equates to an area of 0.2km² (0.1km² at both the NE and SE locations).

225. The magnitude of impact is therefore considered to be **medium** for harbour porpoise, minke whale and grey seal, and **negligible** for all other species.

12.7.1.1.3.2 Temporary Threshold Shift

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

227. The underwater noise modelling results for the maximum predicted ranges (and areas) for TTS in marine mammals are presented in **Table 12-29**.

228. The maximum predicted impact range for TTS from a single strike of a monopile, with maximum hammer energy, without any mitigation, is up to 1.7km for harbour porpoise (**Table 12-29**).

229. The maximum predicted impact range for TTS from a single strike of a jacket pin pile, with maximum hammer energy, without any mitigation, is up to 1.6km for harbour porpoise (**Table 12-29**).

230. An assessment of the maximum number of marine mammals that could be at risk of TTS from a single strike of a monopile or jacket pin pile is presented in **Table 12-33**. This assessment assumes the maximum hammer energy without any mitigation, based on the worst-case location and found that 1% or less of the relevant reference populations anticipated to be exposed to any temporary effect.

231. The magnitude of the potential impact, without any mitigation, is therefore considered to be **negligible** for all marine mammal species (**Table 12-33**).

Table 12-33 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk Of TTS From Single Strike of Monopile or Jacket Pin Pile at Maximum Hammer Energy Without Mitigation, Based on Worst-Case Location at the DBD Array Area

Species	**Criteria and threshold (Southall *et al.*, 2019)**	**Monopile with maximum hammer energy of 8,000kJ**		**Pin pile with maximum hammer energy of 5,000kJ**	
		Maximum number of individuals (% of reference population)	**Magnitude (permanent effect)**	**Maximum number of individuals (% of reference population)**	**Magnitude (permanent effect)**
Harbour porpoise	SPL_{peak} Unweighted (196 dB re 1µPa) Impulsive	8 (0.002% of NS MU)	**Negligible**	7 (0.002% of NS MU)	**Negligible**
Bottlenose dolphin	SPL_{peak} Unweighted (224 dB re 1µPa) Impulsive	0.00001 (0.0000007% of GNS MU)	**Negligible**	0.00001 (0.0000007% of GNS MU)	**Negligible**
Common dolphin		0.0001 (0.0000001% of CGNS MU)	**Negligible**	0.0001 (0.0000001% of CGNS MU)	**Negligible**
White-beaked dolphin		0.0001 (0.0000002% of CGNS MU)	**Negligible**	0.0001 (0.0000002% of CGNS MU)	**Negligible**
Minke whale	SPL_{peak} Unweighted (213 dB re 1µPa) Impulsive	0.0008 (0.000004% of CGNS MU)	**Negligible**	0.0006 (0.000003% of CGNS MU)	**Negligible**
Grey seal	SPL_{peak} Unweighted (212 dB re 1µPa) Impulsive	0.006 (0.00001% of NE & SE MU)	**Negligible**	0.004 (0.000007% of NE & SE MU)	**Negligible**
Harbour seal		0.0000008 (0.00000002% of NE & SE MU)	**Negligible**	0.0000006 (0.000000011% of NE & SE MU)	**Negligible**

232. The maximum predicted impact range for TTS from cumulative exposure (SEL_{cum}) during the sequential installation of two monopiles, with maximum hammer energy of 8,000kJ, is up to 35km for harbour porpoise and 45km for minke whale, based on the worst-case location and in the absence of any additional mitigation (**Table 12-29**).

233. The maximum predicted impact range for TTS from cumulative exposure (SEL_{cum}), during sequential piling of four pin piles, is up to 33km for harbour porpoise and 42km for minke whale, for a maximum hammer energy of 5,000kJ and without any additional mitigation (**Table 12-29**).

234. The maximum number of marine mammals that could be at risk of TTS from cumulative exposure during the installation of either two sequential monopiles or four sequential jacket pin piles is presented in **Table 12-34.** This assessment assumes a maximum hammer energy, without any additional mitigation, and is based on the worst-case location for the maximum impact area.

235. The magnitude of the potential impact is considered to be **negligible** for all species (see **Table 12-34**).

Table 12-34 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS from Cumulative Exposure (SEL_{cum}) During Installation of Two Sequential Monopiles or Four Sequential Pin Piles Without Additional Mitigation, Based on the Worst-Case Location at DBD Array Area

Species	**Criteria and threshold (Southall *et al.*, 2019)**	**Monopile with maximum hammer energy of 8,000kJ**		**Pin pile with maximum hammer energy of 5,000kJ**	
		Maximum number of individuals (% of reference population)	Magnitude (temporary effect)	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)
Harbour porpoise	SEL_{cum} Weighted (140 dB re 1 µPa²s) Impulsive	2,442 (0.72% of NS MU)	**Negligible**	2,190 (0.65% of NS MU)	**Negligible**
Bottlenose dolphin	SEL_{cum} Weighted (170 dB re 1 µPa²s) Impulsive	0.001 (0.00006% of GNS MU)	**Negligible**	0.0003 (0.00002% of GNS MU)	**Negligible**
Common dolphin		0.011 (0.00001% of CGNS MU)	**Negligible**	0.003 (0.000003% of CGNS MU)	**Negligible**
White-beaked dolphin		0.01 (0.00002% of CGNS MU)	**Negligible**	0.002 (0.000006% of CGNS MU)	**Negligible**
Minke whale	SEL_{cum} Weighted (168 dB re 1 µPa²s) Impulsive	69 (0.34% of CGNS MU)	**Negligible**	59 (0.29% of CGNS MU)	**Negligible**
Grey seal	SEL_{cum} Weighted (170 dB re 1 µPa²s) Impulsive	72 (0.13% of NE & SE MU)	**Negligible**	64 (0.11% of NE & SE MU)	**Negligible**
Harbour seal		0.01 (0.0002% of NE & SE MU)	**Negligible**	0.009 (0.0002% of NE & SE MU)	**Negligible**

12.7.1.1.3.2.1 Temporary Threshold Shift from the Cumulative Exposure for Concurrent and Sequential Pile Installation

236. The maximum predicted impact area for TTS from cumulative exposure (SEL_{cum}) during the installation of two monopiles at the NW location and two monopiles at the SE location, in the absence of any additional mitigation, was up to 5,100km^2 for harbour porpoise and up to 7,600km^2 for minke whale (**Table 12-29**).

237. An assessment of the maximum number of individuals for each species that could be at risk of TTS from cumulative exposure during the sequential and concurrent piling scenario at the NW and SE location (as the worst-case locations) is presented in **Table 12-35**. This assessment assumes a maximum hammer energy (of up to 8,000kJ), in the absence of any additional mitigation, for piling at two locations concurrently (up to a maximum of four pile installations in a 24-hour period).

238. The magnitude of impact is therefore considered to be **low** for harbour porpoise, and **negligible** for all other species.

Table 12-35 Maximum Number of Individuals (and % Of Reference Population) That Could Be at Risk of TTS from Cumulative SEL of the Concurrent and Sequential Installation of Two Monopiles at Each the NW and SE Location at Maximum Hammer Energy without Mitigation

Species	Criteria and threshold (Southall *et al.*, 2019)	2x monopiles at NW and 2x monopiles at SE (sequential and concurrent piling)	
		Maximum number of individuals (% of reference population)	Magnitude (temporary effect)
Harbour porpoise	SELcum Weighted (140 dB re 1µPa2s) Impulsive	4,295 (1.27% of NS MU)	**Low**
Bottlenose dolphin	SELcum Weighted (168 dB re 1µPa2s) Impulsive	0.15 (0.008% of GNS MU)	**Negligible**
Common dolphin		2 (0.002% of CGNS MU)	**Negligible**
White-beaked dolphin		2 (0.005% of CGNS MU)	**Negligible**
Minke whale	SELcum Weighted (168 dB re 1µPa2s) Impulsive	117 (0.58% of CGNS MU)	**Negligible**
Grey seal	SELcum Weighted (170 dB re 1µPa2s) Impulsive	160 (0.28% of NE & SE MU)	**Negligible**
Harbour seal		0.02 (0.0004% of NE & SE MU)	**Negligible**

12.7.1.1.4 Effect Significance

239. For PTS from a single strike of the maximum hammer energy for monopiles or jacket pin piles, the effect significance for any permanent changes in hearing sensitivity (PTS) has taken into account the high marine mammal sensitivity and the potential magnitude of the impact. The latter was based on the number of individuals as a percentage of the reference population, as set out in **Table 12-30** and **Table 12-31**.

240. The PTS from a single strike of the maximum hammer energy for monopiles or jacket pin piles, in the absence of any additional mitigation, has been assessed as:

- **Minor adverse** for all species, which is **not significant** in EIA terms (**Table 12-36**).

241. For PTS from cumulative exposure for the sequential piling of either two monopiles or four pin piles, in the absence of any additional mitigation, the effect significance has been assessed in **Table 12-36** as:

- **Major adverse** for harbour porpoise and minke whale, which is **significant** in EIA terms; and
- **Minor adverse** for all dolphin species and both seal species, which is **not significant** in EIA terms.

242. For PTS from cumulative exposure for the concurrent piling of two monopiles both at the SE and NW location, in the absence of any additional mitigation, the effect significance has been assessed in **Table 12-36** as:

- **Major adverse** for harbour porpoise, minke whale and grey seal, which is **significant** in EIA terms; and
- **Minor adverse** for all dolphin species and harbour seal, which is **not significant** in EIA terms.

Table 12-36 Assessment of Significances of Effect for PTS and TTS in Marine Mammals from Underwater Noise During Piling

Species / receptor	Potential impact		Sensitivity	Magnitude	Effect significance	Additional mitigation measures proposed	Residual effect
Harbour porpoise	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**	**Outline MMMP** (document reference 8.1)	**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from sequential piling at max hammer energy – monopile or pin pile	PTS	**High**	**Medium**	**Significant (Major adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from concurrent piling at max hammer energy – monopiles only	PTS	**High**	**Medium**	**Significant (Major adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Low**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
Bottlenose dolphin	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from sequential piling at max hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from concurrent piling at max hammer energy – monopiles only	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
Common dolphin	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from single or sequential piling at max hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from concurrent piling at max hammer energy – monopiles only	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
White-beaked dolphin	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from single or sequential piling at max hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**

Species / receptor	Potential impact		Sensitivity	Magnitude	Effect significance	Additional mitigation measures proposed	Residual effect
	Cumulative exposure from concurrent piling at max hammer energy – monopiles only	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
Minke whale	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from single or sequential piling at max hammer energy	PTS	**High**	Monopile: **Medium** Pin pile: **Low**	Monopile: **Significant (Major adverse)** Pin pile: **Significant (Moderate adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from concurrent piling at max hammer energy – monopiles only	PTS	**High**	**Medium**	**Significant (Major adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
Grey seal	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from single or sequential piling at max hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from concurrent piling at max hammer energy – monopiles only	PTS	**High**	**Medium**	**Significant (Major adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
Harbour seal	Single strike of maximum hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from single or sequential piling at max hammer energy – monopile or pin pile	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**
	Cumulative exposure from concurrent piling at max hammer energy	PTS	**High**	**Negligible**	**Not significant (Minor adverse)**		**Not significant (Minor adverse)**
		TTS	**Medium**	**Negligible**	**Not significant (Negligible adverse)**		**Not significant (Negligible adverse)**

243. For TTS, from a single strike of the maximum hammer energy for monopiles or jacket pin piles, the effect significance for any temporary changes in hearing sensitivity has taken into account the medium marine mammal sensitivity and the potential magnitude of the impact as set out in **Table 12-32** and **Table 12-33**.

244. From a single strike of the maximum hammer energy for monopiles or jacket pin piles, in the absence of any additional mitigation, TTS effects have been assessed as:

- **Negligible adverse** for all species, which is **not significant** in EIA terms (**Table 12-36**).

245. For TTS from cumulative exposure, the effect significance has also been assessed as:

- **Negligible adverse** for all species, which is **not significant** in EIA terms (**Table 12-36**).

246. For TTS from cumulative exposure for the concurrent piling of two monopiles both at the SE and NW location, in the absence of any additional mitigation, the effect significance has been assessed in **Table 12-36** as:

- **Minor adverse** for harbour porpoise, which is **not significant** in EIA terms; and
- **Negligible adverse** for all dolphin species, minke whale, grey seal and harbour seal, which is **not significant** in EIA terms.

12.7.1.1.5 Additional Mitigation and Residual Effects

247. The development and implementation of an MMMP (Commitment ID 22) for piling (as described in **Section 12.4.3**) would reduce the risk of PTS from the first strike of the soft-start, from a single strike of the maximum hammer energy and from the cumulative exposure of each monopile and each jacket pin pile foundation.

248. The MMMP for piling would be developed post-consent, in consultation with the MMO and other relevant organisations, and would be based on the latest information, scientific understanding and guidance, and detailed Project design. The MMMP for piling would be based on the **Outline MMMP** (document reference 8.1), a draft of which has been included with the PEIR. The **Outline MMMP** (document reference 8.1) includes further details of the embedded mitigations and the potential additional mitigation measures to be adopted by the Project.

249. The UK Government and Defra (2025) have released a policy paper in January 2025 on marine noise and "*expect that all offshore wind pile driving activity across all English waters will be required to demonstrate that they have utilised best endeavours to deliver noise reductions through the use of primary and/or secondary noise reduction methods in the first instance*". With respect to this policy paper and the effect it will have on commitments to NAS, the Project will investigate and consider the requirement for the use of NAS prior to DCO submission.

250. Potential additional mitigation to reduce the risk of PTS would include establishing a monitoring zone and ADD activation prior to the soft-start commencing (for details refer to the **Outline MMMP** (document reference 8.1)).

251. ADDs have proven to be effective mitigation for harbour porpoise, dolphin species, minke whale, grey and harbour seal (Sparling *et al.,* 2015; McGarry *et al.,* 2017, 2020) and have been widely used as mitigation to deter marine mammals during OWF piling.

252. Brandt *et al (*2018) observed that at seven German OWF, and Benhemma-Le Gall *et al (*2023) found that at two Scottish OWFs, harbour porpoise detections decreased several hours before the start of piling as a result of increased construction-related activities and vessel presence. Similarly, studies in the Moray Firth during the Beatrice OWF piling indicated that higher vessel activity within 1km of the area was linked to an increased probability of harbour porpoise response (Graham *et al.,* 2019). This disturbance of marine mammals around the construction site prior to piling could potentially lower the risk of PTS.

253. The Offshore Renewables Joint Industry Programme (ORJIP) published their findings on the latest range dependent nature of impulsive noise (RaDIN) in a report, which analysed field acoustic recordings and hammer logs from several impact real pile driving activities. Using the real-world hammer logs in comparison to the modelled (simulated) PTS ranges, showed that the majority of PTS ranges were markedly smaller. The minimum percentage reduction in impacted area was a 16% reduction and the median was a 57% reduction. It should however be noted that in two scenarios had very high blow rates following the first pile strike, thus the impact areas where larger than initially anticipated.

254. The mitigation measures set out in the **Outline MMMP** (document reference 8.1) to reduce the risk of PTS would also reduce the number of marine mammals at risk of TTS.

255. Taking into account the additional mitigation, the residual effect significance of the potential risk of PTS to marine mammals due to underwater noise during piling, would be, at worst, **minor adverse**, which is **not significant** in EIA terms for all species (**Table 12-36**).

256. The additional mitigation adopted 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 due to underwater noise during piling, would also, at worst, be **minor adverse**, which is not significant in EIA terms for all species (**Table 12-36**).

12.7.1.2 Underwater Noise: Behavioural Impacts (MM-C-02)

257. There is currently no common agreement on noise thresholds, or criteria, for the behavioural response and disturbance of marine mammals, and as such it is not possible to conduct underwater noise modelling to predict impact ranges.

258. A review of current information in relation to the potential disturbance and impact ranges of marine mammals from underwater noise during piling has been included to provide an understanding of the associated potential effects and support the marine mammal assessment (**Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**).

259. To assess the potential for disturbance, it is necessary to consider the likelihood that exposure of the animal(s) elicits a response which is likely to generate a significant population-level effect. Assessment of population-level effects from a temporary disturbance is made complicated by the highly variable nature of the introduced disturbance (e.g. the complex nature of sound and its propagation in the marine environment), and the variability of behavioural response in different species and individuals.

260. The JNCC *et al (*2010) guidance proposes that "*any action that is likely to increase the risk of long-term decline of the population(s) of (a) species could be regarded as disturbance under the Regulations*." The JNCC *et al (*2010) guidance indicates that a score of 5 or more on the Southall *et al (*2007) behavioural response severity scale could be significant (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, **Table 12.6-6**). The more severe the response on the scale, the less time animals will likely tolerate the disturbance, before there could be significant negative effects on life functions, which would constitute a disturbance.

261. 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).

262. It should be noted that a behavioural response does not mean that the individuals would avoid the area. Additionally, the modelled maximum predicted ranges for behavioural response from piling are based on the maximum hammer energy at the worst-case location for noise propagation. In reality, the duration of any piling at maximum energy would be less (if this energy is reached at all) and noise propagation would vary considerably with location (i.e. be less than the worst-case modelled).

12.7.1.2.1 Receptor Sensitivity

263. See **Section 12.1.1.1.1** for more information on marine mammal receptor sensitivity to underwater noise.

264. Harbour porpoise have been shown to be more sensitive to construction activities and there is an increased potential for disturbance. Due to the broadband frequencies emitted during construction and the LF hearing spectrum of minke whales there is also an increased probability of disturbance. Marine mammals within the potential disturbance area are considered to have the 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.

265. Marine mammals may exhibit varying intensities of behavioural response at different noise levels. These responses 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, and 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).

266. The response of individuals to a noise stimulus would vary, and not all individuals would respond. However, for the purpose of some of the following assessment approaches, it has been assumed that at the disturbance range, 100% of the individuals exposed to the noise stimulus would respond and be displaced from the area. This is a highly precautionary approach given that it is unlikely that all individuals would be displaced from the potential disturbance area.

267. The sensitivity of marine mammals is therefore considered to be **medium** for all marine mammal species.

12.7.1.2.2 Impact Magnitude

268. Potential disturbance of marine mammals from underwater noise during piling has been assessed using different methods for each species (see **Table 12-37**).

Table 12-37 Overview of Available and Applied Disturbance Methods for Marine Mammal Species Considered for the Disturbance Assessment

Method	Harbour porpoise	Dolphin species	Minke whale	Seal species
Effective Deterrence Range (EDR)	26km / 15km (JNCC, 2023b)	-	-	-
Known disturbance ranges	-	26km / 15km (using harbour porpoise EDRs as a proxy) (JNCC, 2023b)	30km (Richardson *et al.*, 1999)	25km (Russell *et al.*, 2016)
DRC	✓	✓ (using the harbour porpoise DRC as a proxy)	-	✓
Interims population consequences of disturbance (iPCoD)	✓	✓ (bottlenose dolphin only)	✓	✓
ADD	✓	✓	✓	✓

269. For population modelling (iPCoD), available for harbour porpoise, bottlenose dolphin, minke whale, grey seal and harbour seal, the worst-case numbers of animals disturbed will be taken forward. These numbers are derived from EDRs, known disturbance impact ranges or DRCs (see final model parameters in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**).

12.7.1.2.2.1 Disturbance / Displacement Based on Effective Deterrence Range or Known Disturbance Ranges for Marine Mammals

12.7.1.2.2.1.1 Harbour Porpoise

270. The Statutory Nature Conservation Bodies (SNCBs) recommend using a 26km EDR for monopiles (equating to an area of effect of 2,124km^2) and 15km EDR for pin piles (equating to an area of effect of 707km^2), both without noise abatement, to assess potential disturbance areas for harbour porpoise within designated SACs in England, Wales, and NI (JNCC, 2023b). While the Project is not situated within any harbour porpoise SAC, this precautionary approach has been applied for assessing disturbance from piling at the Project.

271. Brown *et al* (2023) highlights the approach used to produce the current 26km EDR likely overestimates the response because it does not account for underlying seasonal variation during baseline and piling periods. In addition, findings in the latest PrePared report looking at harbour porpoise response to piling at Ocean Winds Moray West OWF found evidence of an EDR of 10km, providing a strong case for reducing the current 26km EDR for unabated impact piling of monopiles (Benhemma-Le Gall *et al.*, 2024)

272. Not all harbour porpoise within these potential EDR disturbance areas would be disturbed. However, a worst-case scenario of 100% disturbance of harbour porpoise in the areas has been assumed in the assessment.

273. The estimated number of harbour porpoise, and corresponding percentage of the NS MU reference population, that could be disturbed as a result of underwater noise during piling at the Project, is presented in **Table 12-38.**

274. The magnitude of the potential impact is assessed as **negligible** for the 26km and 15km EDR, with <1% of NS MU anticipated to be temporarily disturbed (**Table 12-38**).

Table 12-38 Maximum Number of Harbour Porpoise (and % of Reference Population) That Could Be Disturbed During Piling at the Project Based on the EDR Approach

Species	26km EDR (2,124km^2) for monopile		15km EDR (707km^2) for pin pile	
	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)
Harbour porpoise	1,789 (0.53% of NS MU)	**Negligible**	596 (0.18% of NS MU)	**Negligible**

12.7.1.2.2.1.2 Dolphin Species

275. Based on the literature described in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, there is no agreed disturbance range for dolphin species for piling noise impacts. During the EPP process with stakeholders (ETG3, Meeting 2; see Table 12-5), it was agreed to apply proxy disturbance ranges until such ranges were agreed upon within the industry. Following this, the estimated number of bottlenose dolphin, common dolphin, and white-beaked dolphin, and the corresponding percentage of the MU reference population, that could be disturbed as a result of underwater noise during Project piling, has been estimated by using the harbour porpoise EDR of 26km for monopiles and 15km for pin piles (**Table 12-39**). This approach presents a highly precautionary assessment of disturbance as harbour porpoise have much more sensitive hearing (see **Table 12-26**) and are generally much more skittish (Whale & Dolphin Conservation, 2025) as opposed to dolphin species.

276. The magnitude of the potential impact was assessed as **negligible** for all dolphin species across the relevant MUs, with <1% of the populations anticipated to be temporarily disturbed (**Table 12-39**).

Table 12-39 Maximum Number of Dolphin Species (and % of Reference Population) That Could Be Disturbed During Piling at the Project Based on the Harbour Porpoise EDR Approach

Species	26km EDR (2,124km^2) for monopile		15km EDR (707km^2) for pin pile	
	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)
Bottlenose dolphin	3 (0.15% of GNS MU)	**Negligible**	1 0.049% of GNS MU)	**Negligible**
Common dolphin	26 (0.025% of CGNS MU)	**Negligible**	9 (0.009% of CGNS MU)	**Negligible**
White-beaked dolphin	23 (0.052% of CGNS MU)	**Negligible**	8 (0.018% of CGNS MU)	**Negligible**

12.7.1.2.2.1.3 Minke Whale

277. Based on the literature review in **Section 12.6.3** of **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, a precautionary disturbance range of 30km (2,827.43km^2) (Richardson *et al.,* 1999) has been applied to minke whale. The estimated number of minke whale, and corresponding percentage of the CGNS MU reference population, that could be disturbed as a result of underwater noise during piling at the Project is presented in **Table 12-40**.

278. The magnitude of the potential impact is considered to be **negligible** with <1% of the CGNS MU anticipated to be temporarily disturbed (**Table 12-40**).

Table 12-40 Maximum Number of Minke Whale (and % of Reference Population) That Could Be at Disturbed During Piling at the Project Based on a Disturbance Range of 30km

Species	30km disturbance range (2,827.43km^2) for monopiles	
	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)
Minke whale	44 (0.22% of CGNS MU)	**Negligible**

12.7.1.2.2.1.4 Seal Species

279. Based on the literature review in **Section 12.6.3** of **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, a precautionary disturbance range of 25km (Russell *et al.,* 2016) has been applied to both seal species. The estimated number of grey and harbour seal, and the corresponding percentage of the reference population, that could be disturbed as a result of underwater noise during piling at the Project, is presented in **Table 12-41**.

280. The magnitude of the potential impact was assessed as **negligible** for grey seal and harbour seal, with <1% of the NE & SE England MU population anticipated to be temporarily disturbed (**Table 12-41**).

Table 12-41 Maximum Number of Grey and Harbour Seal (and % of Reference Population) That Could Be at Disturbed During Piling at the Project Based on a Disturbance Range of 25km

Species	25km disturbance range (1,963km^2) for monopiles	
	Maximum number of individuals (% of reference population)	Magnitude (temporary effect)
Grey seal	158 (0.28% of NE & SE MU)	**Negligible**
Harbour seal	0.02 (0.0004% of NE & SE MU)	**Negligible**

12.7.1.2.2.2 Dose- Response Curve Assessment

281. The application of a DRC allows for an evidence-based estimate of the number of animals disturbed, which accounts for the fact that the likelihood of an animal exhibiting a response to a stressor, or stimulus, will vary according to the dose of stressor or stimulus received (Dunlop *et al.,* 2017). Therefore, unlike the traditional threshold assessments commonly used, a dose-response analysis assumes that not all animals in an impacted area will respond (with behavioural disturbance response in this case).

282. For the purposes of this assessment, the dose was the received single-strike SEL (SEL_{ss}). The use of SEL_{ss} in a dose-response analysis, where possible, is considered best practice in the latest guidance provided by Southall *et al* (2021). It accounts for the actual behavioural response (i.e. not all individuals would respond to the same level of noise) and is therefore a more realistic approach to assessing the potential for disturbance.

283. The dose-response methodology is outlined in **Section 12.6.4** in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**. The dose-response approach has been undertaken for all piling locations, with the highest resultant number of individuals disturbed presented in this assessment.

284. The estimated numbers of harbour porpoise, dolphin spp., grey seal, and harbour seal, and the corresponding percentage of the relevant MU populations that could be disturbed as a result of underwater noise during piling, based on the worst-case foundation and location, are presented in **Table 12-42**.

Table 12-42 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling of Monopiles Based on the Dose-Response Approach

Species	Number of individuals disturbed (monopiles) (% of reference population)	Number of individuals disturbed (pin-piles) (% of reference population)	Magnitude (temporary effect)
Harbour porpoise	5,015 (1.48% of the NS MU)	4,559 (1.3% of the NS MU)	**Low**
Bottlenose dolphin	67 (3.31% of the GNS MU)	57 (2.8% of the GNS MU)	**Low**
Common dolphin	111 (0.11% of CGNS MU)	98 (0.10% of CGNS MU)	**Negligible**
White-beaked dolphin	184 (0.42% of CGNS MU)	159 (0.36% of CGNS MU)	**Negligible**
Grey seal	184 (0.33% of the NE & SE MU)	165 (0.29% of the NE & SE MU)	**Negligible**
Harbour seal	0.031 (0.0006% of the NE & SE MU)	0.027 (0.00054% of the NE & SE MU)	**Negligible**

285. For harbour porpoise and bottlenose dolphin the potential magnitude of the impact was assessed as **low** (1.5% of the NS MU; and 3.3% of the GNS MU, respectively). For all other species the magnitude was **negligible**, with less than 0.5% of the relevant MU reference population predicted to be disturbed (**Table 12-42**).

286. As outlined in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, the application of DRCs developed for the hearing sensitive harbour porpoise is considered conservative for dolphin species. Dolphins are considered HF cetaceans and therefore have a different hearing range to those of VHF cetaceans. Further, it should be noted that, this dose-response analysis was carried out in relation to pile driving noise only, and, therefore, does not account for the use of ADDs which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

12.7.1.2.2.3 Disturbance During Acoustic Deterrent Device Activation

287. As set out in the **Outline MMMP** (document reference 8.1), to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing.

288. Assessment of the potential disturbance during any ADD activation is indicative only at this time as the final requirements for mitigation would be determined in the MMMP prior to construction and would be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and the MMO.

289. Based on the worst-case maximum predicted PTS impact ranges for cumulative exposure (SEL_{cum}) during sequential installation of two monopiles or four pin piles, including soft-start and ramp-up (see **Table 12-24**), ADD activation would be a necessary mitigation to deter animals out of the ranges. Considering known swimming speeds for minke whale (Blix & Folkow, 1995) and harbour porpoise (Otani *et al.*, 2000) from scientific literature, it was established how far animals would have to swim to flee beyond the modelled PTS (SEL_{cum}) impact ranges.

290. **Table 12-43** provides a summary of the ADD activation durations required to reach the modelled piling PTS SEL_{cum} impact ranges. This identified that a minimum 80 minute ADD activation would be necessary to deter harbour porpoise from the impact area during monopile installation. This activation time would also be sufficient to cover the impact ranges for minke whale, dolphins and seals.

291. However, based on scientific evidence and experiences from other OWF constructions (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance, Section 12.6.5** for more details), an upper boundary has been identified for when ADD activation time appears to become ineffective, thereby becoming an unnecessary additional noise source to the marine environment. This upper limit was identified as approximately 80 minutes, during which harbour porpoise, dolphins and seals would swim at least 7.2km away and minke whale would move 15.6km away (**Table 12-43**). The final Project design would define which hammer energies are likely to be used, and for what duration, and may be below the maximum hammer energy assessed. Thus, the impact ranges could be smaller, and the 80-minute ADD duration would also be reduced accordingly.

Table 12-43 Effect Ranges of ADD Activation for Monopiles and Pin Piles for PTS SEL_{cum} Impact Ranges

	Minke whale (LF)*	Dolphins (HF)**	Harbour porpoise (VHF)**	Seals (PCW)**
Monopiles				
Maximum PTS SEL_{cum} impact range (km)***	9.5	0.1	7.2	0.73
Just ADD effect range (km) (ADD on for 80 min)	15.60	7.2	7.2	7.2
Pin piles				
Maximum PTS SEL_{cum} impact range (km)	7.0	0.1	5.8	0.43
ADD effect range (km) (ADD on for 65 min)	12.68	5.85	5.85	5.85

*based on a swimming speed of 3.25m/s (Blix & Folkow, 1995) for LF
**based on a precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000) for HF, VHF, PCW
*** using the max. PTS ranges from either C (OP) or the NE location

292. While the PTS SEL_{cum} range for sequential piles is shown as 7.0km in **Table 12-28**Table 12-28, this is based on the modelled piling location with the highest effect area (NE), but the highest effect range was modelled for the Centre (OP) location, with 7.2km. Therefore, 7.2km has been used as the maximum PTS SEL_{cum} range for which the ADDs must cover. See **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**.

293. For pin piles, the maximum predicted PTS SEL_{cum} impact ranges for sequential installation of four jacket pin piles is 5.8km for harbour porpoise and 7.0km for minke whale. **Table 12-43** shows that only 65 minutes of ADD activation would be necessary to deter harbour porpoise from the impact area. This activation time would also be sufficient to cover the impact ranges for minke whale, dolphins and seals.

294. Based on the above presented information, the assessments for disturbance effects during ADD activation are based on an 80-minute ADD activation for monopiles and a 65-minute ADD activation for pin piles.

295. The magnitude of the potential impact was assessed as **negligible** for all marine mammal species, with 1% or less of the relevant reference populations anticipated to be temporarily disturbed (**Table 12-44**).

Table 12-44 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed during 80 minute ADD Activation Prior to Piling

Species	Maximum number of individuals (% of reference population) during monopile installation	Maximum number of individuals (% of reference population) during pin-pile installation	Magnitude (temporary effect)
Harbour porpoise	60 (0.02% of NS MU)	49 (0.014% of NS MU)	**Negligible**
Bottlenose dolphin	0.1 (0.005% of GNS MU)	0.1 (0.004% of GNS MU)	**Negligible**
Common dolphin	1 (0.001% of CGNS MU)	1 (0.001% of CGNS MU)	**Negligible**
White-beaked dolphin	1 (0.002% of CGNS MU)	1 (0.002% of CGNS MU)	**Negligible**
Minke whale	2 (0.012% of CGNS MU)	2 (0.01% of CGNS MU)	**Negligible**
Grey seal	6 (0.01% of NE & SE MU)	5 (0.01% of NE & SE MU)	**Negligible**
Harbour seal	0.0008 (0.00002% of NE & SE MU)	0.0006 (0.00001% of NE & SE MU)	**Negligible**

12.7.1.2.2.4 Duration of Piling and Acoustic Deterrent Device activation

296. The foundation installation period for wind turbines and the OSP (or both monopiles and jacket pin piles) is expected to be carried out over a period of up to 18 months (**Table 12-9**). This would include transit of the foundation components in batches to the DBD Array Area, and foundation installation, including any piling.

297. Piling would not be constant during the piling phases and construction periods. There would be gaps between the installation of individual piles and, if installed in groups, there would be time periods when piling is not taking place, accounting for vessel transit to and from the site. There are also likely to be potential breaks for example due to weather.

298. There is also the potential for up to two vessels to be on site at the same time to install piles sequentially and concurrently. This would potentially reduce the duration of the installation phase due to the potential overlap but not the duration of noise produced per pile.

299. **Table 12-45** summarises the worst-case scenarios for the duration of piling (including soft-start, ramp-up and ADD activation), based on:

- Maximum number of wind turbines;
- Maximum design option for the OSP(s); and
- Maximum number of piles.

300. For monopiles for wind turbine foundations, including ADD activation, there will be up to 32 days of active piling within the five-year offshore construction period. For jacket pin piles for the OSP foundations, including ADD activation, there will be up to 16 days of active piling within the offshore construction period. Note that the actual active piling period will be less than this, as piling will not be required for the full 5.33 hours per pile at all locations.

301. The duration of piling identified in **Table 12-45** to inform the assessment is based on a very precautionary approach. As demonstrated through experience at other OWFs, the duration can be considered to be overestimated. For example, for the installation of monopile foundations at Dudgeon OWF, the impact assessment estimated a 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 was 65 hours (approximately three days) with the average time for installation per monopile of 71 minutes (Dudgeon OWF Limited (DOWL), 2016). Therefore, the actual piling duration was approximately 21% of the predicted maximum piling duration.

302. The piling duration to install the individual monopiles at Dudgeon OWF 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. At Dudgeon OWF, the time intervals between the installations of individual monopiles (not including time to collect further piles for installation) was on average of 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).

303. At Dogger Bank A, the expected time to install one monopile, including the soft start and ramp-up, was 5.5 hours. However, the actual installation time was significantly shorter, taking only between 1.3 and 2.1 hours, which represents a 58% - 70% reduction in piling durations (Dogger Bank Offshore Windfarm, 2024).

304. Similar results were also observed for Beatrice OWF, where within the ES it was estimated that each pin pile would require five hours of active piling time. However, during construction, the total piling duration ranged from 19 minutes to two hours and 45 minutes, with an average duration of one hour and 15 minutes per pin pile (Beatrice OWF Limited, 2018).

305. Once piling is completed, exclusion periods for harbour porpoises could last up to three days following a single piling event if the animal is close to the noise source. According to data from Brandt *et al (*2009, 2011), harbour porpoises 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 to 6.0km of the noise source. Waiting times did not return to normal until 22.7 hours after piling. At distances greater than approximately 9.0km from the noise source, the duration of the effect was much shorter, with waiting times returning to normal between one and 2.6 hours after piling ceased. However, at distances of 18 to 25km, there was still a noticeable effect. Porpoise activity was significantly lower within approximately 3km of the noise source for 40 hours after piling.

306. A study on the effects of OWF 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 of construction on acoustic porpoise detections (one – two days in duration), there was 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.

307. The duration of any potential displacement impact would 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, they would continue with their normal behaviour which may involve approaching the wind farm site.

Table 12-45 Maximum Duration of Piling, Based on Worst-Case Scenarios for the Impact Ranges, Including Soft-Start, Ramp-Up and ADD Activation

Parameter	Number of piles	Maximum active piling time per pile	Total piling time	ADD activation	Total active piling duration including indicative ADD activation
Up to 113 wind turbines	113 monopiles	5.33 hours including soft-start and ramp-up	602.66 hours for 113 monopiles	80 minutes ADD activation prior to each monopile installation = 150.66 hours for 113 monopiles	Up to 754 hours (31.4 days)
	904 pin piles for 113 jacket foundations (8 pin piles per foundation)	5.33 hours including soft-start and ramp-up	4,821.33 hours for 904 pin piles	65 minutes ADD activation prior to each pin pile installation = 979.33 hours for 904 pin piles	Up to 5,801 hours (214.7 days)
2x OSP	12 monopiles	5.33 hours including soft-start and ramp-up	64 hours for 12 monopiles	80 minutes ADD activation prior to each monopile installation = 16 hours for 12 monopiles	Up to 144 hours (six days)
	60 pin piles	5.33 hours including soft-start and ramp-up	320 hours for 60 pin piles	65 minutes ADD activation prior to each pin pile installation = 65 hours for 60 pin piles	Up to 385 hours (16 days)
Piling of up to 125 monopiles for 113 wind turbines and two OSPs (including soft-start, ramp-up and ADD activation) = up to 898 hours (37.4 days)					
Piling of up to 113 monopiles for 113 wind turbines and 60 pin piles for two OSPs (including soft-start, ramp-up and ADD activation) = up to 1,202 hours (50.1 days)					
Piling of up to 964 pin piles for 113 wind turbines and two OSPs (including soft-start, ramp-up and ADD activation) = up to 6,182 hours (257.6 days)					

308. Nabe-Nielsen *et al (*2018) developed the Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea (DEPONS) model, to simulate individual animal's movements, energetics and survival, for assessing population consequences of sub-lethal behavioural effects. The model was used to assess the effect of OWF construction noise on the North Sea harbour porpoise population, based on the acoustic monitoring of harbour porpoise during construction of the Dutch Gemini OWF. Local population densities around the Gemini wind farm recovered two – six hours after piling, with similar recovery rates being obtained in the model. The model indicated that, assuming noise influenced porpoise movements as observed at the Gemini wind farm, the North Sea harbour porpoise population was not affected by construction of 65 wind farms, as required to meet the EU renewable energy target (Nabe-Nielsen *et al.,* 2018).

309. The DEPONS model determined that, at the North Sea scale, population dynamics were indistinguishable from those in the noise-free baseline scenario when porpoises reacted to noise up to 8.9km from the construction sites, as at the Gemini wind farm. Underwater noise from OWF construction noise only influenced population dynamics in the North Sea when simulated animals were assumed to respond at distances exceeding 20–50km from the wind farms. Indicating that in these scenarios, the population effect of noise was more strongly related to the distance at which animals reacted to noise (Nabe-Nielsen *et al.,* 2018). The duration of any potential displacement effect would differ, depending on the distance of the individual from the piling activity and the noise level to which the animal is exposed.

12.7.1.2.2.5 Modelled Population Level Consequences due to Disturbance

310. Population modelling has been conducted for harbour porpoise, bottlenose dolphin, minke whale, harbour seal and grey seal. The interim population consequence of disturbance (iPCoD) framework (Harwood *et al.,* 2013, King *et al.,* 2015) was used to predict the potential medium- and long-term population consequences of the predicted amount of disturbance resulting from piling at the Project.

311. The model only has capacity to run simulations for species that have sufficient data on population-specific demographic rates and have undergone the expert elicitation process (Harwood *et al.,* 2013). This is essential in capturing how disturbance modifies the demographic rates and underpins the functioning of the model.

312. The iPCoD modelling methods, including key assumptions and chosen model inputs, are detailed in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance** in **Section 12.6.2**.

313. Regarding interpreting significance through population modelling, there are currently no specific potential biological removal limits in place in English waters, therefore there are currently no specific thresholds to determine whether a population level effect would be significant in EIA terms.

314. Evans and Arvela (2012) advise that an annual population decline of more than 1% on average over a 12-year period represents unfavourable conservation status. Booth *et al.,* 2016 undertook a study into the use of the iPCoD model for assessing population level effects of offshore wind farm piling in the North Sea. The study assumed that the harbour porpoise population could already be experiencing an annual decline of 1% (in reference to the Evans and Arvela (2012) threshold noted above), and therefore a threshold of an additional 1% annual decline could be used to determine whether the construction works of offshore wind would result in a disturbed population, which is **not significant** in EIA terms.

315. If, as a result of PTS, a population shows a continued decline of >1% per year (versus a modelled un-impacted reference population) over a set period of time (e.g. the first six years, based on the former FCS) reporting period), then there is a high likelihood that a significant effect cannot be ruled out (NRW, 2023). In the absence of relevant guidance for English waters, the NRW guidance will be used to determine the potential for a significant population level effect at the Project, and therefore if the population modelling results show a decline of more than 1% (on average) over the initial six year period, it will be concluded that there is a significant impact at the population level (see **Table 12-52**). It should also be noted that the results of the population modelling show the significance of a population level of effect, rather than a magnitude.

316. For context, for each species assessed, the estimated number of animals disturbed or potentially exposed to PTS for each monopile event are set out in **Table 12.6-4** in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**. The number of disturbed animals has been determined based on the worst-case assessment presented in **Section 267**. The worst-case disturbance assessments for harbour porpoise, bottlenose dolphin, grey seal and harbour seal are based on the dose-response assessment, and for minke whale is based on the known disturbance ranges assessment, which is **not significant** in EIA terms.

12.7.1.2.2.5.1 Harbour Porpoise

317. Assuming a worst-case of 5,015 harbour porpoises disturbed (**Table 12-42**) and 118 estimated animals with PTS on every piling day (**Table 12-31**), the iPCoD model estimated there to be only the slightest discernible impact to the harbour porpoise population (**Figure 12-1** and **Table 12-46**).

318. The results from the effects of piling at the Project-alone have been presented as mean and median ratios of impacted: unimpacted population sizes. The results show a less than 1% average annual decline over the first six years and the 25-year period for both the mean and median, with a resultant effect significance of **negligible adverse**, which is **not significant** in EIA terms.

Table 12-46 Results Of The iPCoD Modelling for the Project, Giving the Mean Population Size for the Harbour Porpoise Population (NS MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points
Start 2029	338,918	338,918	100.00%	100.00%	-
End 2030	339,431	339,365	99.98%	99.98%	**<1%**
End 2033	339,503	339,091	99.88%	99.86%	**<1%**
End 2034	339,556	339,075	99.86%	99.87%	**<1%**
End 2054	341,734	340,855	99.74%	99.67%	**<1%**

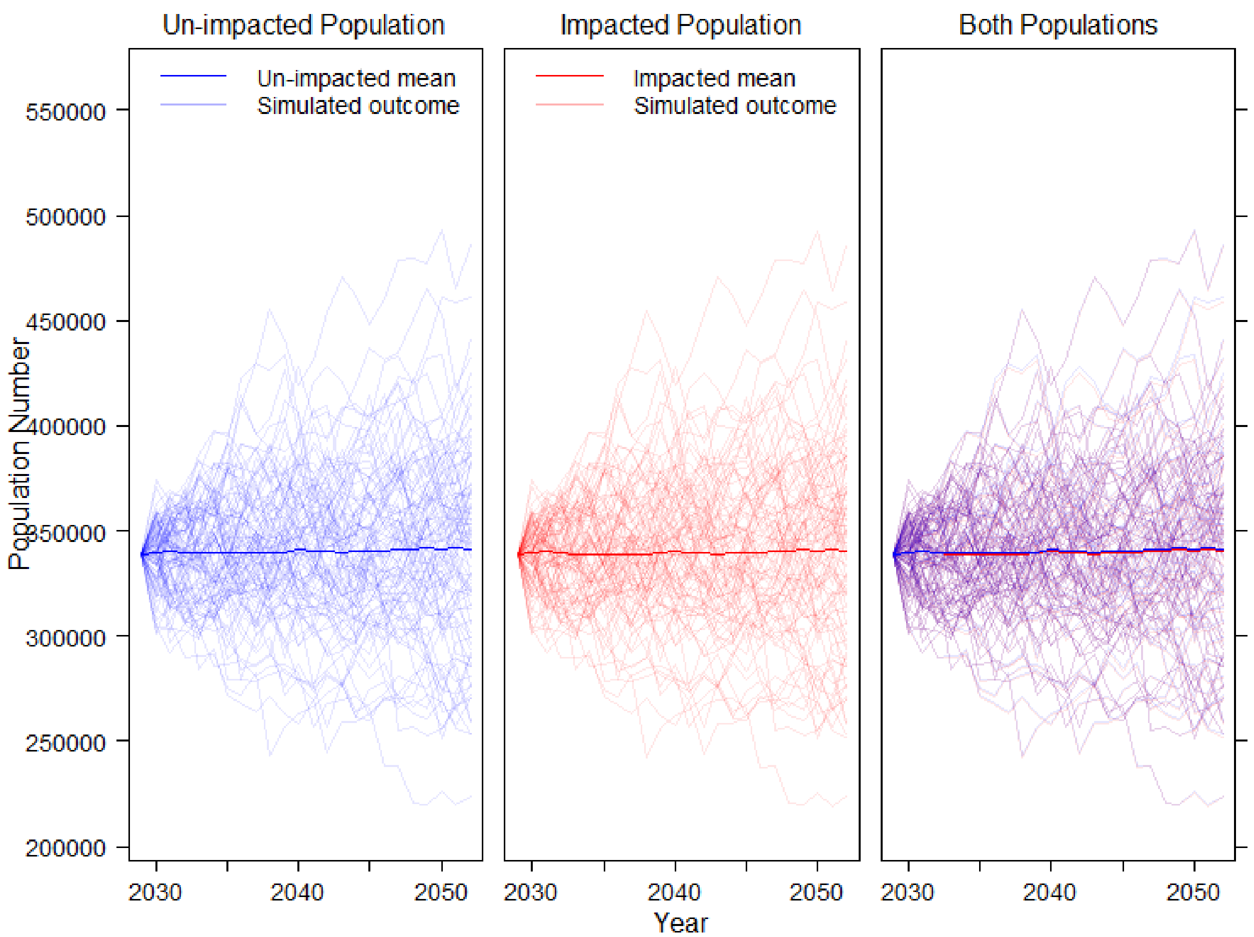

Figure 12-1 Simulated Worst-Case Harbour Porpoise Population Sizes for Both the Un-Impacted and the Impacted Population

12.7.1.2.2.5.2 Bottlenose Dolphin

319. Assuming a worst-case of 67 disturbed bottlenose dolphin (**Table 12-42**) and one estimated animal with PTS on every piling day (**Table 12-31**), the iPCoD model estimated there to be no discernible effect on bottlenose dolphin of the GNS population (**Figure 12-2** and **Table 12-47**).

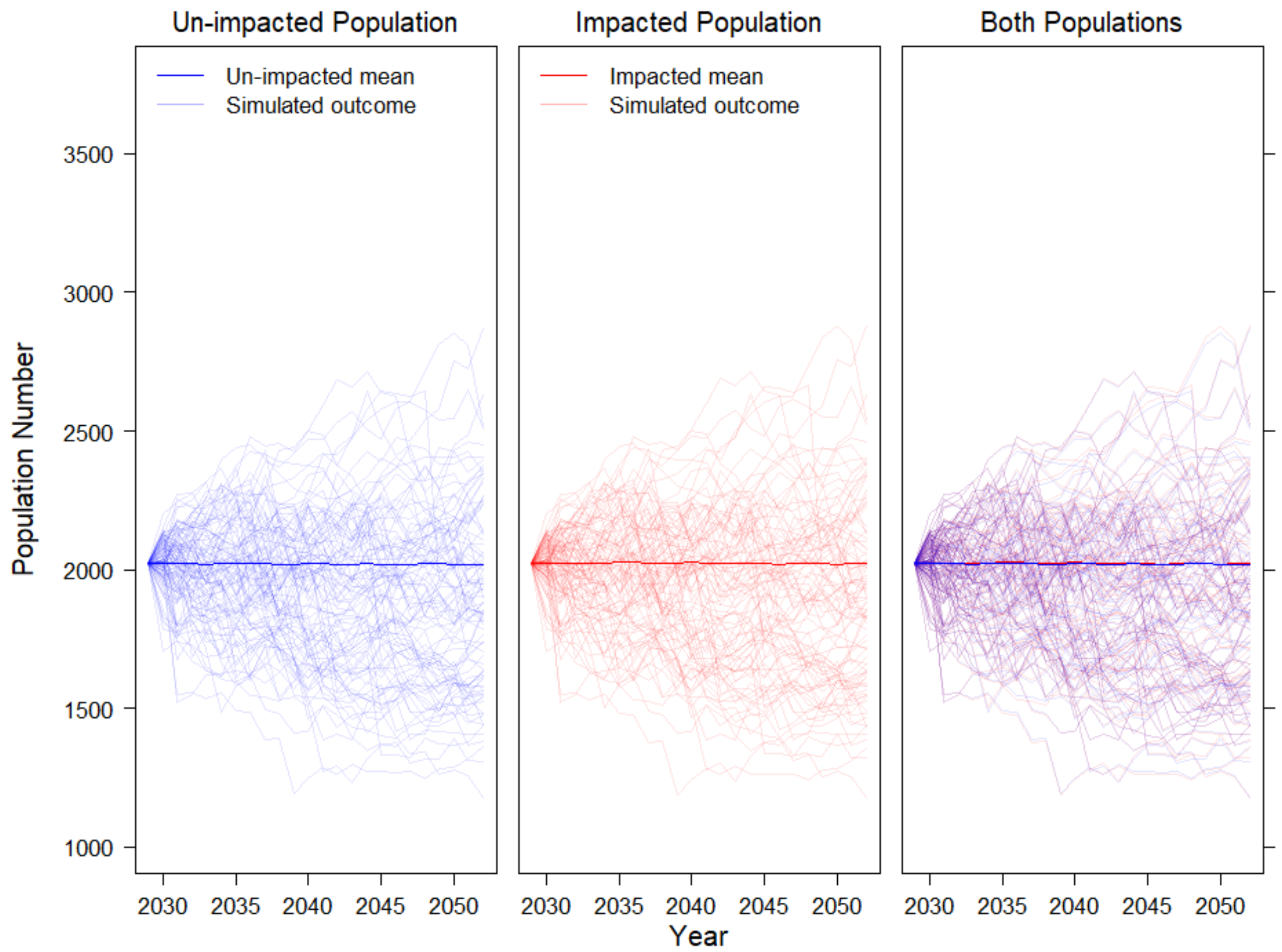

Figure 12-2 Simulated Worst-Case Bottlenose Dolphin (GNS MU) Population Sizes for Both the Un-Impacted and the Impacted Population

320. The results from the effects of piling at the Project-alone have been presented as mean and median ratios of impacted: unimpacted population size (**Table 12-47**). Both the impacted and the un-impacted population maintain a stable trajectory until 2054, which marks the end point of the modelling.

321. The results show a less than 1% average annual decline over the first six years and the 25-year period for both the mean and median, with a resultant effect significance of **negligible adverse**, which is **not significant** in EIA terms.

Table 12-47 Results of the iPCoD Modelling for the Project, Giving the Mean Population Size for the Bottlenose Dolphin Population (GNS MU) for Years up to 2056 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	2,024	2,024	100.00%	**100.00%**	-
End 2030	2,021	2,022	100.05%	**100.00%**	**0%**
End 2033	2,020	2,021	100.05%	**100.25%**	**0%**
End 2034	2,022	2,024	100.10%	**100.10%**	**0%**
End 2054	2,024	2,028	100.20%	**100.10%**	**0%**

12.7.1.2.2.5.3 Minke Whale

322. Assuming a worst-case of 44 disturbed minke whale (**Table 12-40**) and four estimated animals with PTS on every piling day (**Table 12-31**), the iPCoD model estimated there to be a slight impact to the minke whale CGNS population (**Table 12-48** and **Figure 12-3**).

Table 12-48 Results of the iPCoD Modelling for the Project, Giving the Mean Population Size for the Minke Whale Population (CGNS MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	20,120	20,120	100.00%	**100.00%**	-
End 2030	20,122	20,114	99.96%	**99.96%**	**<1%**
End 2033	20,257	20,144	99.44%	**99.46%**	**<1%**
End 2034	20,192	10,030	99.20%	**99.01%**	**<1%**
End 2054	20,210	19,781	97.88%	**98.05%**	**<2%**

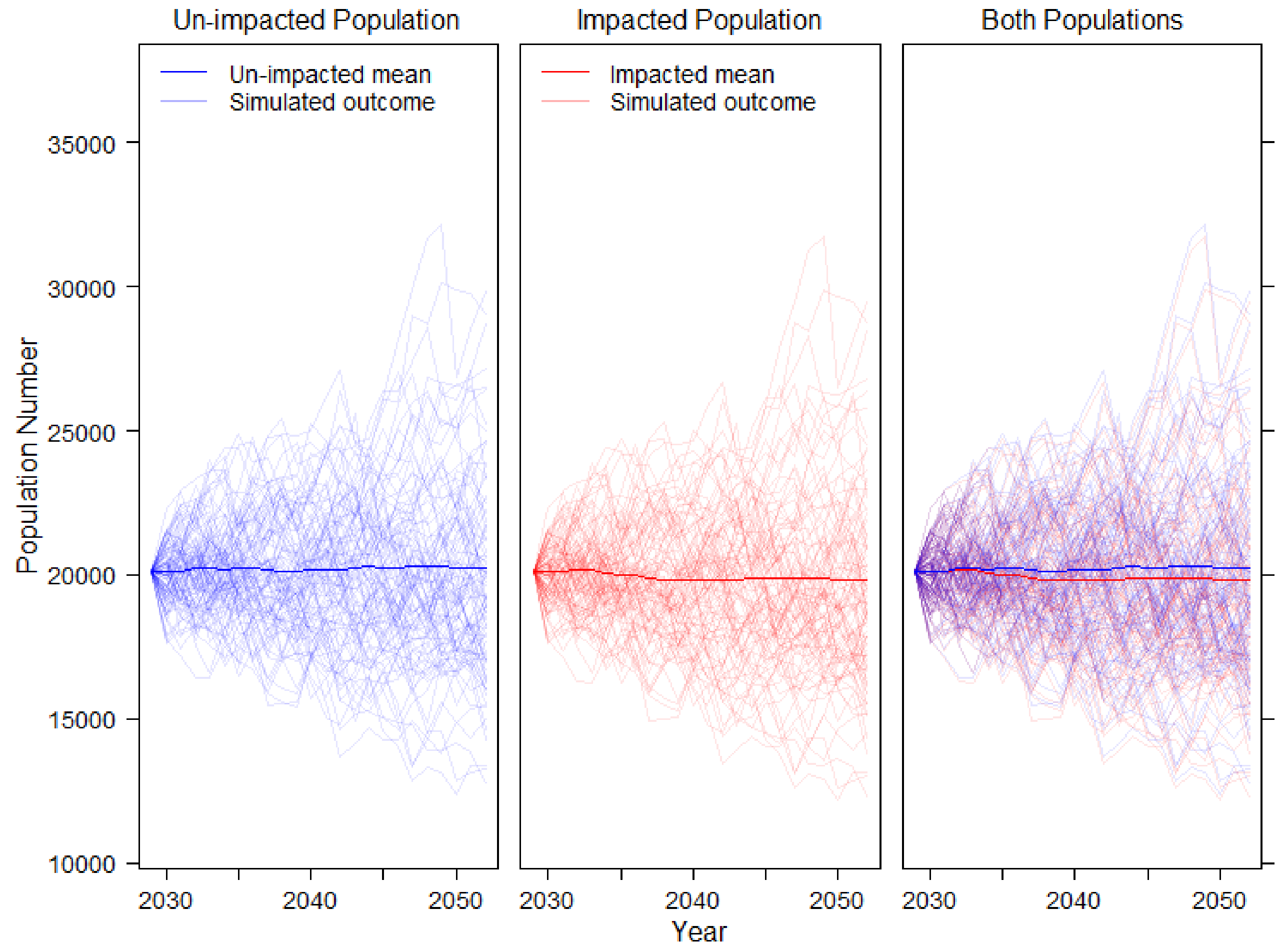

Figure 12-3 Simulated Worst-Case Minke Whale (CGNS MU) Population Sizes for Both the Un-Impacted and the Impacted Population

323. The results from the effects of piling at the Project-alone have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-48**). The mean and median value of the population size is predicted to be 100% of the un-impacted population at the end of 2030 (one year after the piling has commenced). At the end of the five-year piling period, however, there is a decline of the impacted population, whilst the un-impacted population remains relatively stable throughout the modelling period (**Table 12-48**).

324. The results show a less than 1% average annual decline over the first six years and the 25-year period for both the mean and median, with a resultant effect significance of **minor adverse**.

12.7.1.2.2.5.4 Grey Seal

325. Assuming a worst-case of 184 disturbed grey seal (**Table 12-41**) and one estimated animals with PTS on every piling day (**Table 12-31**), the iPCoD model estimated there to be only the slightest discernible impact to the grey seal NE & SE England MU population (**Figure 12-4** and **Table 12-49**).

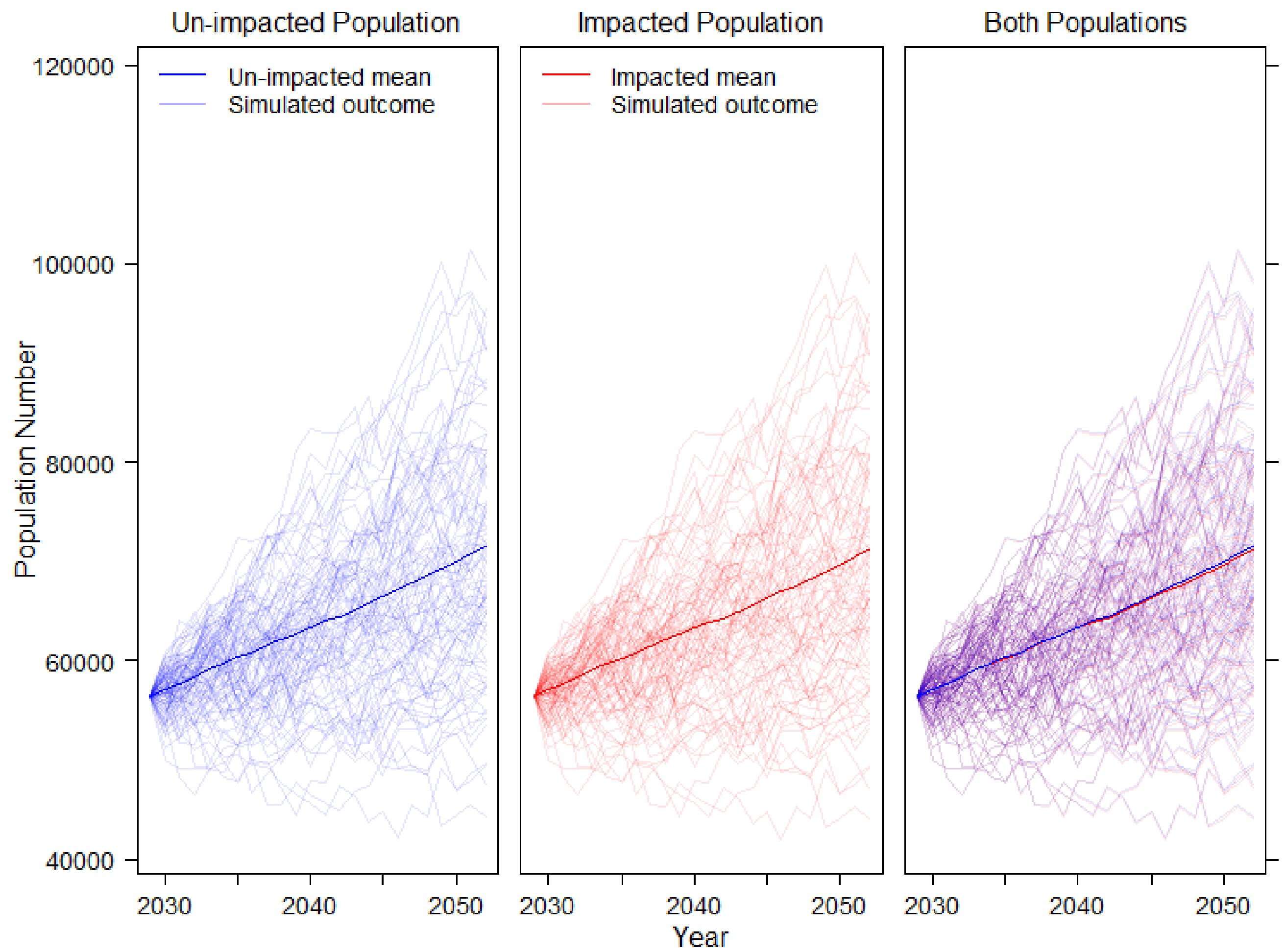

Figure 12-4 Simulated Worst-Case Grey Seal (NE & SE England MU) Population Sizes for Both the Un-Impacted and the Impacted Population

326. The results from the effects of piling at the Project-alone have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-49**). The future trend until the end of the modelling time in 2054, both, the impacted and un-impacted population, experience a significant increase in the population.

327. The results show a less than 1% average annual decline in the first six years and over the 25-year period for both the mean and median, with a resultant effect significance of **negligible adverse**, which is **not significant** in EIA terms.

Table 12-49 Results of the iPCoD Modelling for the Project, Giving the Mean Population Size for the Grey Seal Population (NE and SE England MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	56,502	56,502	100.00%	**100.00%**	-
End 2030	57,142	57,411	99.97%	**99.97%**	<1%
End 2033	59,139	59,321	99.98%	**99.98%**	<1%
End 2034	59,700	59,858	99.98%	**99.98%**	<1%
End 2054	57,142	72,151	99.42%	**99.39%**	<1%

12.7.1.2.2.5.5 Harbour Seal

328. Assuming a worst-case of one disturbed harbour seal (**Table 12-41**) and one estimated animal with PTS on every piling day (**Table 12-31**), the iPCoD model, assuming a stable population (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance** for details and parameters), estimated there to be only a slight impact to the harbour seal NE & SE England MU population over the first six years, followed by a decline there onwards until the end of the modelling period (**Table 12-50** and **Figure 12-5**).

329. The results from the effects of piling at the Project-alone have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-50**). The results show a less than 1% average annual decline over the first six years and over the 25-year period for both the mean and median. The end of the six-year initial period shows a negligible decline, with less than 1% change in total, however, the decline increases to 7.4% by the end of the 25-year reporting period. As the decline is less than 1% in the initial six-year reporting period, the effect significance is assessed as **minor adverse**.

330. Reports on declining populations in the SE England MU (SCOS, 2022) led to the following presentation of population modelling using parameters for a declining population (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance** for details and parameters). It is estimated that there is a significant impact to the harbour seal NE & SE England MU population, regardless whether piling at the Project took place (**Figure 12-6** and **Table 12-51**).

Table 12-50 Results of the iPCoD Modelling for the Project, Giving the Mean Population Size for the Harbour Seal (Stable) Population (NE and SE England MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	4,990	4,990	100.0%	**100.00%**	-
End 2030	4,994	4,977	99.66%	**99.68%**	**<1%**
End 2032	4,990	4,975	99.70%	**99.72%**	**<1%**
End 2034	4,989	4,975	99.72%	**99.80%**	**<1%**
End 2054	4,977	4,604	92.51%	**92.57%**	**7.4%**

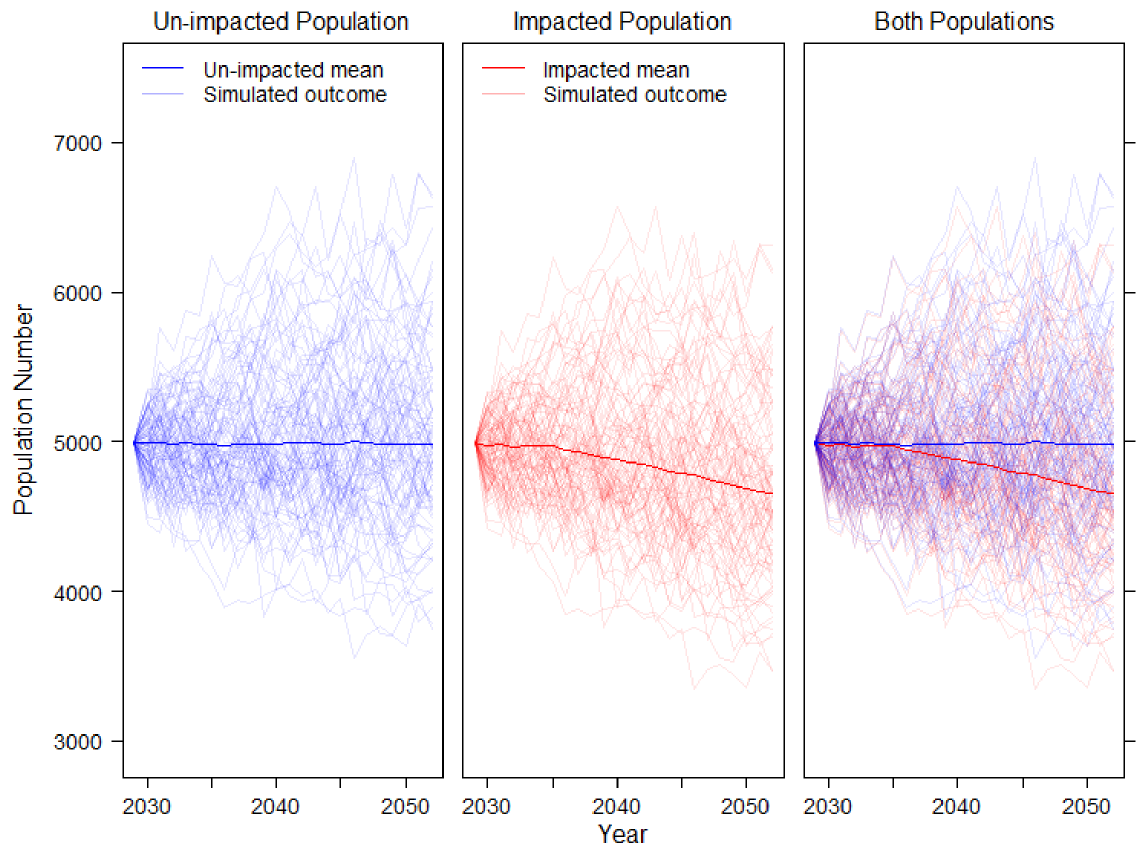

Figure 12-5 Simulated Worst-Case Harbour Seal (Stable) (NE & SE England MU) Population Sizes for Both the Un-Impacted and the Impacted Population

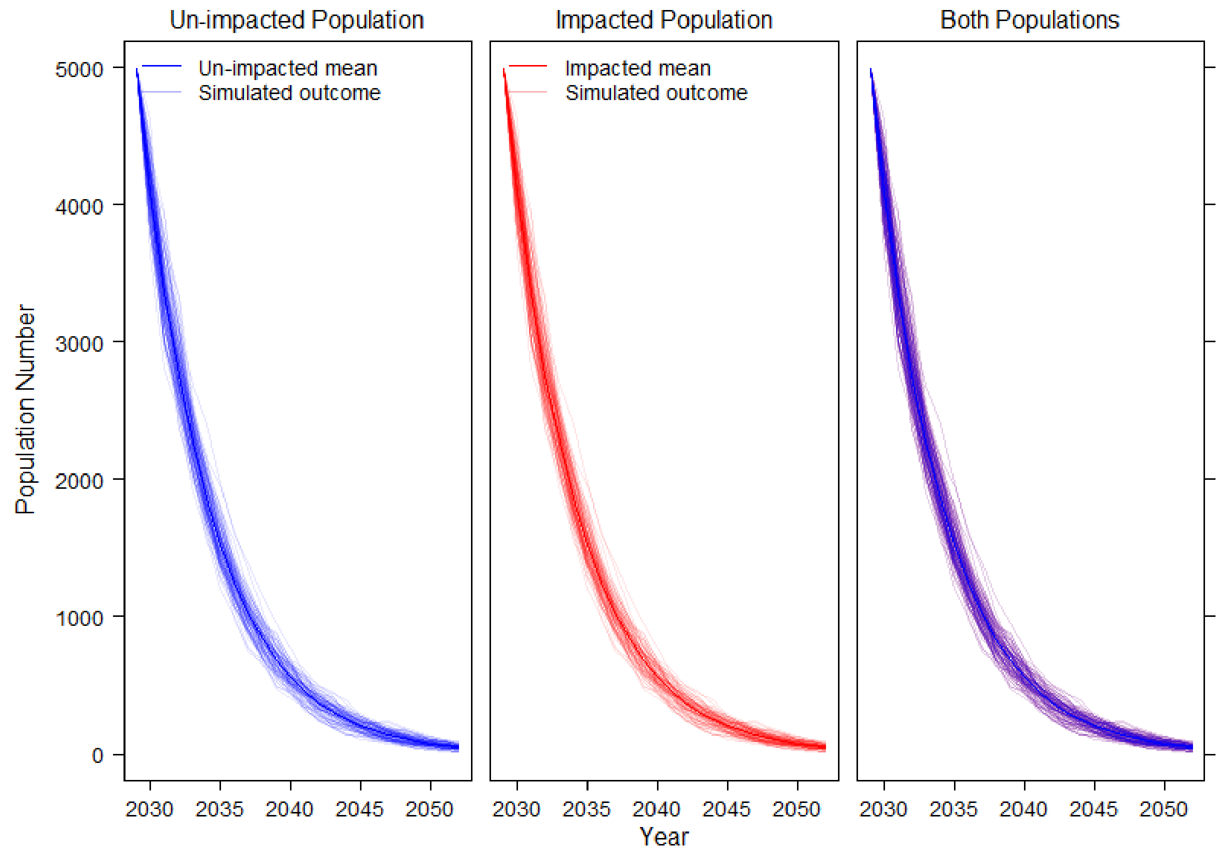

Figure 12-6 Simulated Worst-Case Harbour Seal (Declining) (NE & SE England MU) Population Sizes for Both the Un-Impacted and the Impacted Population

Table 12-51 Results of the iPCoD Modelling for the Project, Giving the Mean Population Size for the Harbour Seal Population (NE and SE England MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change in between time points (impacted vs un-impacted [median])
Start 2029	4,99	4,992	100.0%	**100.0%**	-
End 2030	4,095	4,095	100.0%	**100.0%**	**0%**
End 2032	2,255	2,255	100.0%	**100.0%**	**0%**
End 2034	1,848	1,848	100.0%	**100.0%**	**0%**
End 2054	35	35	100.0%	**100.0%**	**0%**

331. Both populations experience a significant decline in their population under the scenario of a declining population. At the end of the modelling period, less than 1% of the reference population remains alive.

332. Although the decline is steep, the results show that there is no difference in the unimpacted vs the impacted population, with no additional decline as a result of the Project. Therefore, the resultant effect significance is assessed as **negligible adverse**, which is **not significant** in EIA terms.

12.7.1.2.2.5.6 Summary of Magnitude of Population Level Consequences Due to Disturbance

333. For all species assessed, the modelled impact of piling from the Project was modelled to be below the threshold of a 1% average annual decline in population that would be considered significant over the first six years.

334. While for harbour porpoise, bottlenose dolphin and grey seal the results showed no significant changes in the populations, the modelled results for minke whale and harbour seal indicated changes in the population. For minke whale, the greatest impact occurred with a predicted 1.2% decline in population size between six- and 25-years median ratio of impacted:un-impacted population. On average however, there was less than 1% decline for the minke whale population. Similarly, both the stable and declining population of harbour seals showed significant modelled losses in their population. While the stable impacted population declined six years after piling first commenced, the impacted and un-impacted declining populations both modelled a negative growth rate over the 25 years. The greatest decline in the stable harbour seal population was predicted to be just over 7%. On average however, there was less than 1% annual decline for the harbour seal population.

12.7.1.2.3 Effect Significance

335. A summary of magnitudes and resulting effect significances from all disturbance assessment methods covered in this section are listed in **Table 12-52**.

336. Overall, the sensitivity of harbour porpoise is **medium,** and the magnitude of impact is **negligible** to **low.** The effect is therefore of **negligible** to **minor adverse** significance, which is **not significant** in EIA terms. In addition, population modelling also identified a **negligible adverse** effect, which is **not significant** in EIA terms.

337. Overall, with a sensitivity **medium** for bottlenose dolphin, and a magnitude of impact of **negligible** to **low**, the effect is of **negligible** to **minor adverse** significance, which is **not significant** in EIA terms. In addition, population modelling also identified a **negligible adverse** effect, which is **not significant** in EIA terms.

338. For other dolphin species, with a sensitivity of **medium** and magnitude of impact of **negligible**, the effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

Table 12-52 Assessment of Effect Significance for Disturbance of Marine Mammals from Underwater Noise During Piling and ADD Activation (N/A = Not Applicable)

Species / receptor	Impact	Sensitivity	Magnitude	Effect significance
Harbour porpoise	26km EDR	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	DRC		**Low**	**Not Significant (minor adverse)**
	Disturbance during ADD activation		**Negligible**	**Not Significant (negligible adverse)**
	iPCoD modelling		*n/a*	
Bottlenose dolphin	26km EDR (for harbour porpoise)	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	DRC		**Low**	**Not Significant (minor adverse)**
	Disturbance during ADD activation		**Negligible**	**Not Significant (negligible adverse)**
	iPCoD modelling		*n/a*	
Common dolphin	26km EDR (for harbour porpoise)	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	DRC		**Negligible**	
	Disturbance during ADD activation		**Negligible**	
White-beaked dolphin	26km EDR (for harbour porpoise)	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	DRC		**Negligible**	
	Disturbance during ADD activation		**Negligible**	
Minke whale	Known disturbance range (30km)	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	Disturbance during ADD activation		**Negligible**	
	iPCoD modelling		*n/a*	

Species / receptor	Impact	Sensitivity	Magnitude	Effect significance
Grey seal	Known disturbance range (25km)	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	DRC		**Negligible**	
	Disturbance during ADD activation		**Negligible**	
	iPCoD modelling		*n/a*	
Harbour seal	Known disturbance range (25km)	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
	DRC		**Negligible**	
	Disturbance during ADD activation		**Negligible**	
	iPCoD modelling		*n/a*	**Not Significant (negligible to minor adverse)**

339. Overall, the sensitivity for minke whale is **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms. In addition, population modelling also identified a **minor adverse** effect.

340. With a sensitivity for seal species of **medium,** and the magnitude of impact of **negligible**, the effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms. For grey seal, population modelling also identified a **negligible adverse** effect, while for harbour seal the significance based on the population modelling is **negligible** to **minor adverse** (which **is not significant** in EIA terms).

341. The UK Government and Defra (2025) have released a policy paper in January 2025 on marine noise and "*expect that all offshore wind pile driving activity across all English waters will be required to demonstrate that they have utilised best endeavours to deliver noise reductions through the use of primary and/or secondary noise reduction methods in the first instance*". With respect to this policy paper and the effect it will have on commitments to NAS and consequently on reducing the level of disturbance, the Project will investigate and consider the requirement for the use of NAS prior to DCO submission.

12.7.1.3 Underwater Noise: Physical and Auditory Injury Resulting from Noise Associated with Other Construction and Maintenance Activities (MM-C-05)

12.7.1.3.1 Construction Activities (Other than Piling)

342. Potential sources of underwater noise during construction activities, other than piling, include drilling, dredging, rock placement and gravity base installation. The current cable installation methods being considered for DBD include ploughing and trenching (using jetting or mechanical cutting). Additionally, surface laying with cable protection is being considered where burial is not feasible.

343. Any dredging or seabed preparation activities or the installation of suction buckets have the potential to generate underwater noise at sound levels and frequencies, and for sufficient durations, that may disturb marine mammals.

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

345. The noise levels produced during dredging and cable installation activities can vary, for example, with dredger type, cable installation method, as well as environmental conditions, including sediment type, water depth, salinity and thermoclines, and ambient noise levels (Jones and Marten, 2016; Robinson *et al.,* 2011; Theobald *et al.,* 2011). These factors influence the distance at which sounds can be detected.

346. Reviews of published sources of underwater noise during dredging activity and cable installation activities (e.g. Thomsen *et al.,* 2006; Theobald *et al.,* 2011; Todd *et al.,* 2014), indicated that the sound levels that marine mammals may be exposed to are typically below auditory injury thresholds (PTS) exposure criteria (as defined in Southall *et al.,* 2019). Therefore, the potential risk of any auditory injury in marine mammals due to dredging activity is highly unlikely.

347. The thresholds for temporary loss in hearing sensitivity (TTS) could be exceeded during dredging, however, only if marine mammals remain in close proximity to the active dredger for extended periods (<1km), which is highly unlikely (Todd *et al.,* 2014).

12.7.1.3.2 Construction Vessels

348. There would be an increase in the number of vessels in the wind farm site during the construction phase. The maximum number of vessels that could be within the wind farm site, at any one time, has been estimated to be 90 vessels (**Table 12-9**). The actual number, type and size of vessels would vary, depending on the activities taking place, at any one time.

349. During the 14-day vessel traffic survey in summer 2023 (see **Chapter 15 Shipping and Navigation**), three and 12 vessels were recorded within the marine mammal Study Area (DBD Array Area and 10nm buffer) on the quietest and busiest day, respectively. The most common vessel types recorded within the marine mammal Study Area were cargo vessels (42%), tankers (16%), and commercial fishing vessels (12%).

350. The survey report identified that speeds ranged from 1.2 knots (kt) for a research vessel on transit to 19.5kt for a passenger cruise liner, whilst the average speed was 9.9kt. As the vessels undertaking work in the wind farm site are relatively slow moving or even stationary, most noise emitted is likely to be of a lower frequency. This is because stationary vessels emit less propulsion noise and experience reduced cavitation compared to moving vessels (Hildebrand, 2009; Ainslie, 2010). 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 is unlikely. The potential risk of PTS in marine mammals caused by vessel noise is highly unlikely, as the sound levels are well below the threshold for PTS (Southall *et al.,* 2019).

351. A study of the noise source levels from several different vessels (Jones *et al.,* 2017) indicated that, for a cargo vessel of 126m in length (on average), travelling at a speed of 11 kt (on average), would generate a mean sound level of 160dB re 1 µPa @ 1m (with a maximum sound level recorded of 187dB re 1 µPa @ 1m). These levels could be sufficient to cause local disturbance to marine mammals in the immediate vicinity of the vessel, depending on ambient noise levels. Trigg *et al (*2020) found the predicted exposure of grey seals to shipping noise did not exceed thresholds for TTS.

352. Thomsen *et al (*2006) reviewed the effects of ship noise on harbour porpoise and harbour seal. Ship noise at around 0.25 kilohertz (kHz) could be detected by harbour porpoise at distances of 1km and for harbour seal at about 20km distance, while ship noise at around 2kHz could be detected up to 3km away for both species.

353. Vessel movements to and from any port would be incorporated into existing vessel routes as much as possible. The assessment focused on the increased disturbance from underwater noise caused by construction vessels within the DBD Array Area and the offshore ECC.

12.7.1.3.3 Underwater Noise Modelling

354. Site-specific underwater noise modelling was undertaken to determine the potential risk for PTS and TTS from underwater noise from noise sources other than piling.

355. The underwater noise propagation modelling was conducted using a simple modelling approach, using measured sound source data, scaled to relevant parameters for the Project. To account for the weightings required for modelling using the Southall *et al (*2019) criteria, reductions in source level were applied to the various noise sources (see **Volume 2, Appendix 12.3 Underwater Noise Modelling Report** for further information).

356. **Table 12-53**Table 12-53 shows the assessed activities and their source levels.

Table 12-53 Estimated Source Levels from Construction Activities (Other than Piling) and Vessels

Activity	Source level (SPL)
Suction bucket installation	192 dB re 1 µPa @ 1m
Dredging (suction)	186 dB re 1 µPa @ 1m
Vibropiling	183 dB re 1 µPa @ 1m
Trenching	172 dB re 1 µPa @ 1m
Rock placement	172 dB re 1 µPa @ 1m
Cable laying	171 dB re 1 µPa @ 1m
Drilling	169 dB re 1 µPa @ 1m
Large vessels (>100m length; 10kt speed)	168 dB re 1 µPa @ 1m
Dredging (backhoe)	165 dB re 1 µPa @ 1m
Medium vessel (<100m length; 10kt speed)	161 dB re 1 µPa @ 1m

357. The non-impulsive thresholds for PTS onset in harbour porpoise (as the most sensitive species) is 173 dB SEL_{cum} (dB re 1 $µPa^2s$), as shown in **Table 12-27**, the. This means that construction activities only likely to exceed this threshold with any significance are vibropiling, suction dredging, and suction bucket installation. For all other species groups, the noise levels from the activities listed in **Table 12-54** are below the non-impulsive PTS onset thresholds.

358. The cumulative impact ranges were modelled to the nearest 100m, meaning that the ranges are likely to be smaller than those have not been presented, especially for PTS. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicated that the marine mammal would have to be within less than 100m at the onset of the works for any potential risk of PTS (**Volume 2, Appendix 12.3 Underwater Noise Modelling Report**).

359. 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 impact and may only be marginal. In most hearing groups, the noise levels are low enough that there is negligible risk.

360. For SEL_{cum} calculations, it is important to account for the duration of the noise. To provide a worst-case scenario (in terms of impact range), all noise sources are presumed to operate continuously for 24 hours. This, however, presents an unlikely case, and as such the presented impact ranges are conservative. As a result, the potential for PTS to occur in marine mammals from construction activities other than piling is highly unlikely and has not been assessed further.

361. It should be noted that the predicted impact ranges are the distances which represent the minimum exposure that could potentially lead to an effect. In most hearing groups, the noise levels were low enough that there is negligible risk.

362. The results of the underwater noise modelling (**Table 12-54**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source at the onset of the activity, to be exposed to noise levels that could induce PTS (see **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**).

363. For all species, except for harbour porpoise, the predicted TTS impact ranges are <100m for all construction activities (other than piling) (**Table 12-54**).

364. For harbour porpoise, the maximum predicted TTS impact ranges are 0.11km for cable laying, 0.23km for suction dredging, 0.99km for rock placement and 3.2km for the installation of suction buckets (**Table 12-54**).

365. For all species, the predicted TTS impact ranges were <100m for all vessels (**Table 12-54**).

Table 12-54 Predicted Impact Ranges (and Areas) for TTS from 24- Hour Cumulative Exposure During Other Construction Activities

<table>
<tr><th></th><th>Harbour porpoise
(VHF)</th><th>Dolphin species (HF)</th><th>Minke whale (LF)</th><th>Grey and Harbour seal (PCW)</th></tr>
<tr><td></td><td>SEL_{cum} Weighted (153 dB re 1 μPa²s)
Non-impulsive</td><td>SEL_{cum} Weighted (178 dB re 1 μPa²s)
Non-impulsive</td><td>SEL_{cum} Weighted (179 dB re 1 μPa²s)
Non-impulsive</td><td>SEL_{cum} Weighted (181 dB re 1 μPa²s)
Non-impulsive</td></tr>
<tr><td>• Dredging (backhoe)
• Drilling
• Trenching
• Vibropiling
• Large / Medium vessel</td><td colspan="4"><0.1km
(<0.03km²)</td></tr>
<tr><td>Dredging (suction)</td><td>0.23km
(0.17km²)</td><td colspan="3"><0.1km
(<0.03km²)</td></tr>
<tr><td>Cable laying</td><td>0.11km
(0.04km²)</td><td colspan="3"><0.1km
(<0.03km²)</td></tr>
<tr><td>Rock placement</td><td>0.99km
(3.08km²)</td><td colspan="3"></td></tr>
<tr><td>Suction bucket installation</td><td>3.2km
(32.2km²)</td><td colspan="3"></td></tr>
<tr><td>Four worst-case activities together</td><td>35.45km²</td><td colspan="3"></td></tr>
</table>

12.7.1.3.4 Receptor Sensitivity

366. The sensitivity for marine mammal receptors to TTS is considered to be **medium** for all marine mammal receptors (see details in **Section 12.1.1.1.1**).

12.7.1.3.5 Impact Magnitude

12.7.1.3.5.1 Construction Activities (Other than Piling)

367. **Table 12-55** provides an assessment of the number of marine mammals that could be at risk of TTS onset due to underwater noise during construction activities (other than piling). This has been assessed based on the number of animals present within each of the modelled impact ranges (**Table 12-54**).

368. It is unlikely for there to be any significant risk of TTS, as marine mammals would need to be within 100m of the activity at the onset to cause an effect. The exception is for harbour porpoise, which would have to be within 1km during the commencement of rock placement, or 230m during suction dredging to be at risk of TTS (**Table 12-54**). During the installation of suction buckets, harbour porpoise would be at risk of TTS if they were within 3.2km of the commencement of the noise source.

369. As a precautionary approach, it has been assumed that several activities could be taking place at the same time. For this scenario, the impact areas for suction dredging alongside cable laying, rock placement and suction bucket installation have been added, presenting the worst-case scenario to occur at the same time (**Table 12-54**).

370. The potential for TTS effects from underwater noise during other construction activities would be temporary in nature, would not occur consistently throughout the five-year offshore construction period and they would be limited to specific parts of the construction period and certain areas at any given time.

371. The magnitude of impact is therefore considered to be **negligible** for all species (**Table 12-55**).

Table 12-55 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS as a Result of Underwater Noise Associated with Other (Non-Piling) Construction Activities at the Project

Species	Potential Impact (TTS from cumulative SEL, based on 24 hour exposure)	Component specific density	Maximum number of individuals (% of reference population) for each individual activity	Maximum number of individuals (% of reference population) for four worst-case activities (cable laying, suction dredging, rock placement and suction bucket installation)	Magnitude (temporary effect)
Harbour porpoise	• Dredging (backhoe); • Drilling; • Trenching; or • Vibropiling.	DBD Array Area	0.03 (0.000008% of NS MU)	30 (0.009% of NS MU based on the DBD Array Area density) 22 (0.006% of NS MU; based on the Offshore ECC density))	**Negligible**
		Offshore ECC	0.02 (0.000006% of NS MU)		
	• Dredging (suction)	DBD Array Area	0.1 (0.00004% of NS MU)		
		Offshore ECC	0.1 (0.00003% of NS MU)		
	• Cable laying	DBD Array Area	0.03 (0.000009% of NS MU)		
		Offshore ECC	0.02 (0.000007% of NS MU)		
	• Rock placement	DBD Array Area	3 (0.0009% of NS MU)		
		Offshore ECC	2 (0.0006% of NS MU)		
	• Suction bucket installation	DBD Array Area	28 (0.008% of NS MU)		
		Offshore ECC	20 (0.006% of NS MU)		

Species	Potential Impact (TTS from cumulative SEL, based on 24 hour exposure)	Component specific density	Maximum number of individuals (% of reference population) for each individual activity	Maximum number of individuals (% of reference population) for four worst-case activities (cable laying, suction dredging, rock placement and suction bucket installation)	Magnitude (temporary effect)
Bottlenose dolphin	• Dredging (backhoe); • Dredging (suction); • Drilling; • Cable laying; • Rock placement; • Suction bucket installation; • Trenching; or • Vibropiling.	DBD Array Area	0.00004 (0.000002% of GNS MU; 0.00002% of CES MU)	0.0002 (0.000007% of GNS MU; 0.00006% of CES MU)	**Negligible**
		Offshore ECC	0.001 (0.00007% of GNS MU; 0.0006% of CES MU)	0.005 (0.0003% of GNS MU; 0.002% of CES MU)	
Common dolphin		DBD Array Area	0.0004 (0.0000004% of CGNS MU)	0.002 (0.000002% of CGNS MU)	
		Offshore ECC	0.0005 (0.0000005% of CGNS MU)	0.002 (0.000002% of CGNS MU)	
White-beaked dolphin		DBD Array Area	0.0003 (0.0000007% of CGNS MU)	0.001 (0.000003% of CGNS MU)	
		Offshore ECC	0.001 (0.000002% of CGNS MU)	0.004 (0.00001% of CGNS MU)	
Minke whale		DBD Array Area	0.0005 (0.000002% of CGNS MU)	0.002 (0.00001% of CGNS MU)	
		Offshore ECC	0.0002 (0.000001% of CGNS MU)	0.0009 (0.000004% of CGNS MU)	
Grey seal		DBD Array Area	0.003 (0.000004% of NE & SE MU)	0.01 (0.00002% of NE & SE MU)	
		Offshore ECC	0.009 (0.00002% of NE & SE MU)	0.03 (0.00006% of NE & SE MU)	
Harbour seal		DBD Array Area	0.0000003 (0.000000007% of NE & SE MU)	0.000001 (0.00000003% of NE & SE MU)	
		Offshore ECC	0.00003 (0.0000005% of NE & SE MU)	0.0001 (0.000002%of NE & SE MU)	

12.7.1.3.5.2 Construction Vessels

372. The number of marine mammals that could be impacted as a result of underwater noise from construction vessels has been assessed based on the number of animals that could be present in each of the modelled impact ranges (**Table 12-54**). The assessment for one vessel has not been repeated in **Table 12-56**, as the impact ranges are the same for those assessed in **Table 12-55** for backhoe dredging and drilling.

Table 12-56 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS as a Result of Underwater Noise Associated with Construction Vessels at the Project

Species	Component specific density	Maximum number of individuals (% of reference population) for 35 vessels in the DBD Array Area	Maximum number of individuals (% of reference population) for up to 55 vessels in the offshore ECC	Combined number of individuals (% of reference population) for up to 90 vessels	Magnitude (temporary effect)
Harbour porpoise	DBD Array Area	1 (0.0003% of NS MU)	-	3 (0.0009% of NS MU)	**Negligible**
	Offshore ECC	-	2 (0.0006% of NS MU)		
Bottlenose dolphin	DBD Array Area	0.002 (0.00008% of GNS MU; 0.0007% of CES MU)	-	0.07 (0.004% of GNS MU; 0.03% of CES MU)	
	Offshore ECC	-	0.07 (0.004% of GNS MU; 0.03% of CES MU)		
Common dolphin	DBD Array Area	0.01 (0.00001% of CGNS MU)	-	0.04 (0.00004% of CGNS MU)	
	Offshore ECC	-	0.03 (0.00003% of CGNS MU)		
White-beaked dolphin	DBD Array Area	0.01 (0.00003% of CGNS MU)	-	0.07 (0.0002% of CGNS MU)	
	Offshore ECC	-	0.06 (0.001% of CGNS MU)		
Minke whale	DBD Array Area	0.02 (0.00008% of CGNS MU)	-	0.03 (0.0001% of CGNS MU)	
	Offshore ECC	-	0.01 (0.00006% of CGNS MU)		
Grey seal	DBD Array Area	0.09 (0.0002% of NE & SE MU)	-	0.6 (0.001% of NE & SE MU)	
	Offshore ECC	-	0.5 (0.0008% of NE & SE MU)		
Harbour seal	DBD Array Area	0.00001 (0.0000002% of NE & SE MU)	-	0.001 (0.00003% of NE & SE MU)	
	Offshore ECC	-	0.001 (0.00003% NE & SE MU)		

373. The assessment in **Table 12-56** considers three different scenarios:

- Up to 35 vessels within the DBD Array Area (=1.1km^2);
- Up to 55 vessels in the offshore ECC (45 guard vessels plus ten cable installation vessels) (= 1.71km^2); and
- The combined number of affected animals for 90 vessels.

374. SELs have been estimated for vessels based on 24 hours continuous operation, although it is important to note that it is highly unlikely that any marine mammal would stay at a stationary location or within a fixed radius of a vessel for 24 hours. It is also important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would only be exposed to any potential risk of PTS if they were within less than 100m of the vessel (**Volume 2, Appendix 12.3 Underwater Noise Modelling Report**). Therefore, PTS due to vessel activity is highly unlikely and has not been assessed further.

375. There is also unlikely to be any significant risk of any TTS, as the modelling also indicated that a marine mammal would have to be within less than 100m of vessels based on 24 hours of activity (**Table 12-56**). Although TTS due to construction vessel noise is highly unlikely, it has been assessed as a precautionary approach.

376. The magnitude of the potential impact for any TTS, considering all three scenarios is considered to be **negligible** for all marine mammal receptors, with less than 1% of the reference populations exposed to any temporary impact (**Table 12-56**).

377. The potential for TTS effects from construction vessel underwater noise would be temporary in nature, would not occur consistently throughout the five-year offshore construction period and they would be limited to specific parts of the construction period and certain areas at any given time.

12.7.1.3.6 Effect Significance

378. Overall, it is predicted that the sensitivity of marine mammal receptors is **medium** to TTS onset from construction and vessel noise, and the magnitude of impact is **negligible**. The effect is therefore of **negligible** adverse significance, which is **not significant** in EIA terms for all species.

12.7.1.4 Underwater Noise: Behavioural Impacts Resulting from Other Construction and Maintenance Activities (MM-C-06)

379. A behavioural response to underwater noise from other construction activities and vessel noise is displacement from the area. It is predicted that marine mammals would return once the activity has been completed and, therefore, any impacts from underwater noise due to construction activities other than piling, would be both localised and temporary.

380. To conduct a quantitative assessment of disturbance, displacement as a metric of disturbance was used to present the worst-case behavioural scenario for marine mammals. However, other behavioural responses may occur that do not involve moving away from an area but are not quantifiable. These include changes in breathing patterns and diving behaviour, cessation of echolocation, or alterations in typical foraging behaviour. Although there may be the possibility of animals altering their behaviour (other than being displaced), it would only be short term.

381. These non-quantifiable responses depend on individual factors, such as the hearing sensitivity, habituation through past exposure, noise tolerance and demographic factors, as well as external factors that influence the response, such as the environmental conditions that influences the sound transmission, the proximity to the sound source and whether the source is moving or stationary (Wartzok *et al.,* 2003).

382. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources), but a few studies provide relevant evidence. For example, the results of tagged harbour seal in the Wash in 2012 (Russell, 2016) indicated foraging activity during wind farm construction activities at Sheringham Shoal and found that there was no significant displacement during construction.

383. Southall *et al (*2007) presented a summary review of behavioural response studies in marine mammals from various sources, according to behavioural severity scores. The severity response scale ranges from score 0, where no behavioural response is observed, to nine, in which the animal avoids the area. The observed corresponding behaviours were further separated into free-ranging and laboratory subjects, but responses were overlapping in similarity. 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 related to a study involving migrating grey whales, a species commonly found along the Pacific coast.

384. 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 to much higher received levels of up to 140dB re 1 μPa (RMS).

385. Studies undertaken during the construction of two Scottish wind farms (Beatrice OWF and Moray East OWF) (Benhemma-Le Gall *et al.,* 2021), found that there was a reduction in porpoise presence detected at up to 12km from pile driving, and up to 4km from construction activities. With construction activities 2km from Cetacean Porpoise Detectors (CPOD) locations, harbour porpoise activity decreased by up to 35.2%; with construction activities 3km from the CPODs, there was a decrease of up to 24%. At 4km from construction activities, there was an increase of harbour porpoise detection by 7.2%. This implies that harbour porpoise activity decreases within a 4km radius from the distance to the activity. At the time of the detections, there were multiple construction activities being undertaken with a variety of support vessels present.

386. Outside of the piling period, the study found that the presence of harbour porpoise decreased by 17%, with SPLs of 57dB (above ambient noise). While the study did not define which activities were taking place to cause the disturbance, the study occurred whilst a number of construction vessels were on site (Benhemma-Le Gall *et al.,* 2021).

387. Fernandez-Betelu *et al (*2024) found that in relation to decommissioning activities, harbour porpoise was only displaced up to 2km, in line with Benhemma-Le Gall *et al (*2021). As such, using the reported 4km radius in which harbour porpoise detections decreased, seem appropriate and a conservative potential disturbance range for other construction activities in this assessment. It would also cover possible behavioural effects, other than that of complete displacement.

388. Regarding noise disturbances affecting marine mammals at their foraging grounds or their prey, marine mammals have access to a diverse range of prey species that are abundant within the wind farm site. The potential noise disturbance would impact prey species only locally and temporarily (see **Section 12.7.1.8**). Both prey and marine mammals are expected to return to any productive feeding areas once the disturbance subsides. Alternatively, while marine mammals may be disturbed in one area, their typically large foraging ranges enable them to feed in other locations with less or no disturbance. Since construction activities will not occur 24 hours a day, the disturbance is expected to be intermittent, allowing breaks during which marine mammals and prey can return to the area. Observations have shown that harbour porpoises returned to baseline levels immediately after vessel departed following decommissioning activities at oil and gas structures (Fernandez-Betelu *et al.,* 2024). Although the study did not specify which noisy activities were conducted, the immediate recovery time serves as a useful indicator for the expected impact of similar or potentially less noisy activities.

12.7.1.4.1 Receptor Sensitivity

389. Marine mammals within the potential disturbance area were considered to have the capacity to avoid such effects. Any disturbance would be temporary, with the expectation to return to the area once the disturbance had ceased, or they have become habituated to the sound or presence of vessels (doing activities).

390. The sensitivity for marine mammal receptors to disturbance is considered to be **medium** for all species.

12.7.1.4.2 Impact Magnitude

12.7.1.4.2.1 Construction Activities (Other than Piling)

391. Underwater noise as a result of dredging and cable installation activities has the potential to disturb or result in behavioural responses in marine mammals (Pirotta *et al.,* 2013; Todd *et al.,* 2014; Southall *et al.,* 2007).

392. As outlined above, the following assessments are based on the precautionary approach of 4km disturbance distance for construction activities that could be on site during the construction period (Benhemma-Le Gall *et al.,* 2021).

393. As harbour porpoise are the most sensitive marine mammal species, this 4km potential disturbance range (with a potential impact area of 50.27km^2) has been used for all species assessed, due to the absence of any other data to inform an assessment (**Table 12-57**).

394. As a precautionary approach, the potential disturbance from four activities occurring at the same time was also assessed, based on a maximum impact area of 201.1km^2 (**Table 12-57**). This was considered a conservative impact range as the original 4km disturbance range was based on multiple activities and vessels ongoing at any one given time.

395. All related construction activities were considered to be moving sources, and therefore, once the activity / vessel moved past a certain area, the marine mammals would return to the area.

396. The magnitude of impact is therefore considered to be **negligible** for all species for individual activities and four activities together, with the exception of bottlenose dolphin of the CES MU, with a magnitude of **low** for both one and four activities (**Table 12-57**).

397. 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 (between three to five years; **Table 12-9**), and would be limited to only part of the overall construction period and area at any one time.

12.7.1.4.2.2 Construction Vessels

398. The distance at which animals may react to vessels is challenging to predict, as behavioural responses can vary widely depending on factors such as species, location, vessel type and size, speed, noise levels and frequency, ambient noise levels, and environmental conditions (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, **Section 12.6.6** for more details).

399. In coastal waters of SW Wales, vessel type and speed, rather than mere presence, appeared to be critical factors in harbour porpoise reactions to vessel traffic (Oakley *et al.,* 2017). A significant correlation was observed between vessel numbers and porpoise sightings. Over 729 hours of survey (268 total surveys), there were 39 instances of neutral or negative porpoise responses to vessels, with 75% of negative reactions triggered by high-speed, planing-hulled vessels.

400. As described in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, modelling by Heinänen and Skov (2015) indicated that ship traffic density plays a notable role in determining harbour porpoise density in the North Sea during summer. Specifically, higher traffic levels are linked to lower porpoise densities, with a threshold impact level of approximately 15,000 ships per year (around 50 vessels per day within a 5km grid cell; or approximately 2 vessels/km^2). For context, the maximum of 90 vessels expected on-site during construction would remain below this threshold. For example, 90 vessels over the 262km^2 DBD Array Area would amount to less than 0.4 vessels per km^2.

Table 12-57 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Other (Non-Piling) Construction Activities at the Project

Species	Component specific density	Maximum number of individuals (% of reference population) that could be disturbed for one activity ($50.27km^2$)	Maximum number of individuals (% of reference population) that could be disturbed for four activities (e.g. cable laying, suction dredging, rock placement and suction bucket installation) ($201.1km^2$)	Magnitude (temporary effect) for both one and four activities
Harbour porpoise	DBD Array Area	43 (0.01% of NS MU)	170 (0.050% of NS MU)	**Negligible**
	Offshore ECC	31 (0.009% of NS MU)	122 (0.036% of NS MU)	
Bottlenose dolphin	DBD Array Area	0.07 (0.004% of GNS MU; 0.03% of CES MU)	0.3 (0.014% of GNS MU; 0.13% of CES MU)	
	Offshore ECC	3 (0.15% of GNS MU; 1.33% of CES MU)	9 (0.45% of GNS MU; 3.98% of CES MU)	**Negligible** to **low**
Common dolphin	DBD Array Area	0.60 (0.0006% of CGNS MU)	3 (0.003% of CGNS MU)	**Negligible**
	Offshore ECC	0.85 (0.0008% of CGNS MU)	4 (0.004% of CGNS MU)	
White-beaked dolphin	DBD Array Area	0.52 (0.001% of CGNS MU)	3 (0.007% of CGNS MU)	
	Offshore ECC	2 (0.005% of CGNS MU)	7 (0.016% of CGNS MU)	
Minke whale	DBD Array Area	0.77 (0.004% of CGNS MU)	4 (0.020% of CGNS MU)	
	Offshore ECC	0.34 (0.002% of CGNS MU)	2 (0.010% of CGNS MU)	
Grey seal	DBD Array Area	5 (0.009% of NE & SE MU)	17 (0.030% of NE & SE MU)	
	Offshore ECC	14 (0.03% of NE & SE MU)	56 (0.099% of NE & SE MU)	
Harbour seal	DBD Array Area	0.0006 (0.00001% of NE & SE MU)	0.002 (0.00004% of NE & SE MU)	
	Offshore ECC	0.04 (0.0008% of NE & SE MU)	0.16 (0.003% of NE & SE MU)	

401. Brandt *et al (*2018) found that harbour porpoise detections declined several hours before piling began at seven German OWFs due to increased construction-related activity and vessel presence within a 2km vicinity of the construction sites. Similarly, studies in the Moray Firth during piling at the Beatrice OWF linked higher vessel activity within 1km to a greater likelihood of harbour porpoise responses (Graham *et al.,* 2019).

402. Disturbance caused by underwater sound from construction activities (other than piling) have been described in **Section 12.7.1.4**. This includes the presence of vessels from which the activities would have to be conducted. During piling and other construction activities, vessel noise is unlikely to add an additional impact, as both the vessels and vessel noise would already be within the maximum impact areas assessed.

403. As detailed in length in **Section 12.7.1.4,** a precautionary approach has been adopted based on the studies by Brandt *et al (*2018) and Benhemma-Le Gall *et al (*2021). Consequently, the following vessel disturbance assessment (see **Table 12-58**) utilises the 4km disturbance range for all marine mammal receptors (with a disturbance area of 50.27km^2). This is considered very precautionary for the following reasons:

- Dolphin, whales and seals are less sensitive to underwater noise disturbance than harbour porpoise, therefore assuming all species will react in the same way is precautionary;
- As presented by Benhemma-Le Gall *et al (*2021), at 2km from vessel activities, harbour porpoise activity decreased by up to 35.2%; with construction activities 3km from the CPODs, there was a decrease of up to 24%, and at 4km from construction activities, there was an increase of harbour porpoise detection by 7.2%. Therefore, assuming that all marine mammals will respond within a 4km radius is over-precautionary, as it is likely that only a small proportion would respond at up to 4km;
- Benhemma-Le Gall *et al (*2021) do not differentiate between vessels that are undertaking activities, and those that are transiting. Therefore, assuming the harbour porpoise response is the same in both cases may be overestimating the effect where vessels are transiting only;
- Other research has reported smaller disturbance ranges for vessels, either transiting or undertaking works (e.g. Diederichs *et al (*2010) found that dredging can disturb harbour porpoise up to 600m, and Frankish *et al (*2023) found that harbour porpoise deterrence was mostly observed at close distance to vessels only (<300m), while deterrence of 5-9% of individuals was still recorded for vessels at 2km away); and
- The assessments are undertaken based on the maximum number of vessels being present at any one time, which is only likely to occur occasionally.

404. The disturbance assessment based on one vessel is equivalent to that for one construction activity. This scenario has already been assessed in **Table 12-58** and has therefore not been repeated here. In summary, the magnitude of the potential disturbance impact of one vessel in the DBD Array Area or the offshore ECC is considered to be **negligible** for all species, with the exception of bottlenose dolphin of the CES MU, with a magnitude of **low**.

405. While the assessment for TTS from vessel presence provided three different scenarios for vessel distribution over the offshore components, applying the same approach to the disturbance assessment would result in unrealistic scenarios as the overlap in disturbance areas would not be considered. Therefore, an alternative approach to determining the potential disturbance area for multiple vessels has been provided as discussed below.

406. The disturbance caused by 55 individual vessels within the offshore ECC, would cover a total area of 2,764km^2, not taking into consideration any potential overlap of the 4km disturbance ranges with other nearby vessels. To account for that, 55 vessels were randomly distributed in the offshore ECC, using QGIS v.3.38. If an overlap in the disturbance areas of multiple adjacent vessels was identified, this area removed from the total area of effect to account for that. Therefore, a potential area of disturbance of 2,500km^2 has been identified for the worst-case of 55 construction vessels, as shown on **Figure 12-7**. The assessment is detailed in **Table 12-58**.

407. For coastal ecotype bottlenose dolphin from the CES MU, this scenario is not appropriate to apply as the animals would stay within an approximate distance to the coast of 12nm. Within that area, only approximately six vessels are likely to be present at the same time in the space between the coast and the 12nm limit (any more vessels would not significantly increase the potential disturbance area due to the extensive overlaps this would generate). **Figure 12-8** illustrates this scenario, which equates to a disturbance area of 301.59km^2. The assessment is detailed in **Table 12-58**.

408. The magnitude of the potential disturbance impact of 55 vessels (with a maximum potential disturbance area of 2,500km^2) in the offshore ECC is considered to be **medium** for bottlenose dolphin from the GNS MU; **low** for grey seal; and **negligible** for all remaining species. The magnitude of the potential disturbance impact of six vessels in the offshore ECC, within the 12nm limit, is considered to be **medium** for bottlenose dolphin from the CES MU.

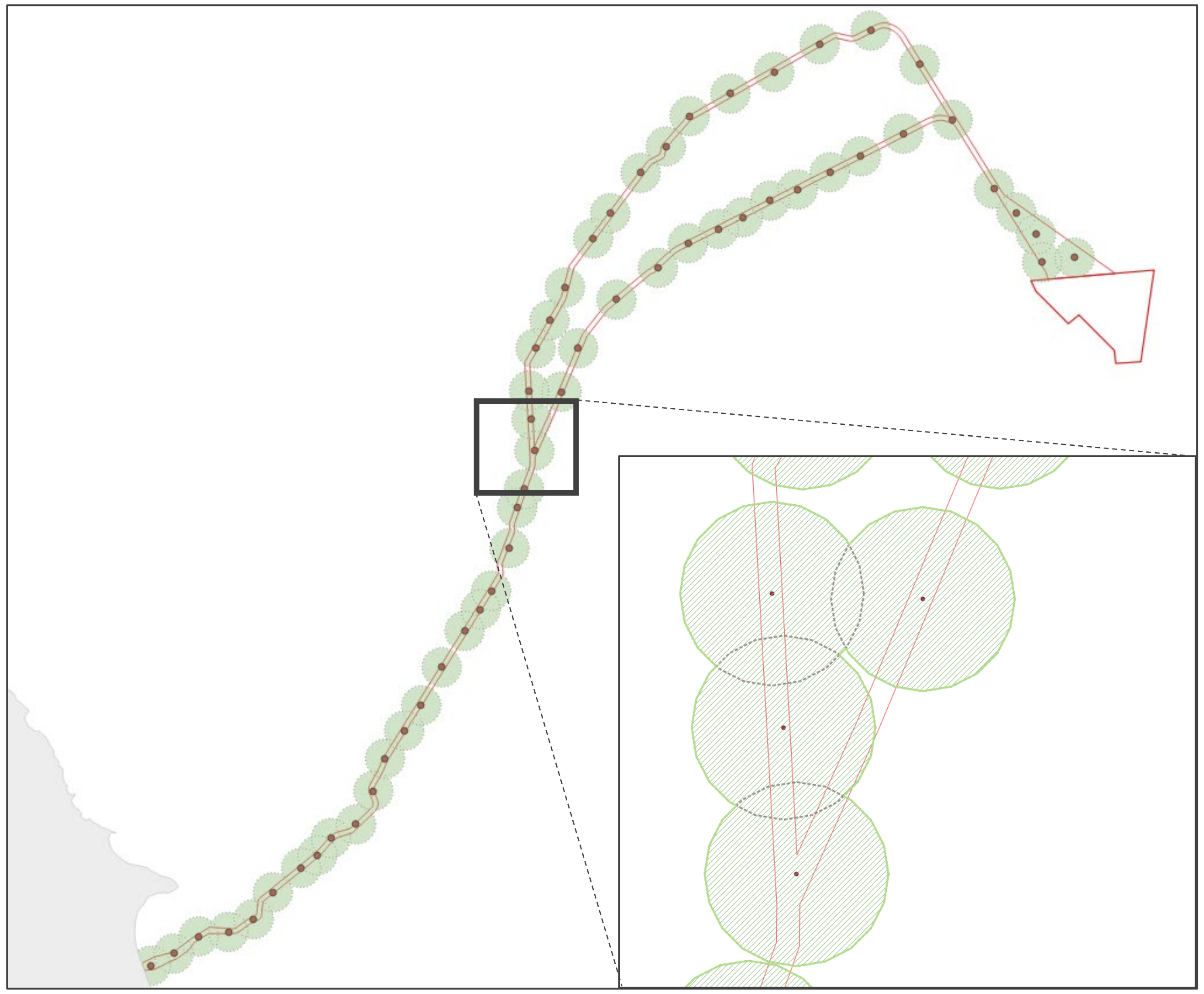

Figure 12-7 DBD Offshore ECC, with 55 Construction Vessels (Red Dots) and Their 4km Buffer (Grey Dotted Lines) Randomly Allocated Within the Offshore ECC. Where There Was Overlap of Disturbance Areas, the Area Was Merged into One (Green Hatched)

409. Assuming the disturbance caused by 35 vessels within the DBD Array Area would not overlap with that of other vessels, the total disturbed area would be 1,759km^2. This is significantly larger than the DBD Array Area itself, which has a total area of 262km^2. Presuming that all vessels would be in the DBD Array Area, the disturbance area for some vessels would extend beyond the DBD Array Area boundaries (see **Figure 12-9**). Taking this overlap into consideration, the actual maximum area of effect would be the DBD Array Area with a 4km buffer (equating to an area of 613km^2). **Figure 12-9** illustrates that the disturbance areas would not exceed a 4km buffer around the DBD Array Area. Therefore, the assessment in **Table 12-58** represents the maximum possible disturbance area of the DBD Array Area, including a 4km buffer.

410. The magnitude of the potential disturbance impact of 35 vessels (with a maximum potential disturbance area of 613km^2) in the DBD Array Area plus 4km buffer is considered to be **negligible** for all marine mammal species.

411. For all vessels in the offshore ECC and the DBD Array Area, the magnitude of effect would be **medium** for bottlenose dolphin, **low** for grey seal, and **negligible** for all other species (**Table 12-58**).

412. As noted in paragraph **403** above, the use of the 4km buffer is considered to be over-precautionary, particularly in the case of species other than harbour porpoise. For the reasons set out above, it is not expected that there would be a low magnitude of effect for grey seal, and it would be more appropriate to consider a reduced magnitude of **negligible**.

413. Bottlenose dolphins in the CES MU are primarily associated with the Moray Firth, located approximately 50 0km north of the offshore ECC, and the north-east coast of England. Although there are reports of southerly movements of individuals from the CES MU, the IAMMWG (2023) did not find that there was enough evidence available to extend the southern boundary of the CES MU, indicating that their southern range is somewhere within this area, still 250km north of the ECC. Consequently, it is unlikely that dolphins from the CES MU, which are more likely to be area faithful (Louis *et al.,* 2014a), to be at risk from the Project vessels or any ongoing activities. In addition, as noted in paragraph **403** above, the use of the 4km buffer is considered to be over-precautionary. For these reasons, it is not expected that there would be a medium magnitude of effect for bottlenose dolphin, and it would be more appropriate to consider a reduced magnitude of **low** for bottlenose dolphin of the CES MU.

12.7.1.4.3 Effect Significance

414. Overall, it is predicted that the sensitivity of marine mammal receptors to disturbance from construction activities (other than piling) is **medium**, and the magnitude of impact is **negligible** for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, and **negligible** to **low** for bottlenose dolphin. The effect significance for bottlenose dolphin is therefore **negligible** to **minor adverse** which is **not significant** in EIA terms, and for all other species is **negligible adverse**, which also is **not significant** in EIA terms (**Table 12-59**).

415. For disturbance from vessel presence in the offshore ECC and DBD Array Area, it is predicted that the sensitivity of marine mammal receptors to disturbance is **medium**, and the magnitude of impact is **negligible** for all species other than bottlenose dolphin, with a magnitude of **low**. The overall effect significance of vessel disturbance for bottlenose dolphin is therefore **minor adverse** (which is **not significant** in EIA terms), and for all other species is of **negligible adverse** significance, which is **not significant** in EIA terms (**Table 12-15**).

Figure 12-8 DBD Offshore ECC (partial view), with Construction Vessels (Red Dots) and Their 4km Buffer (Grey Dotted Lines) Randomly Allocated Within the UK 12nm Limit (Blue Shaded).

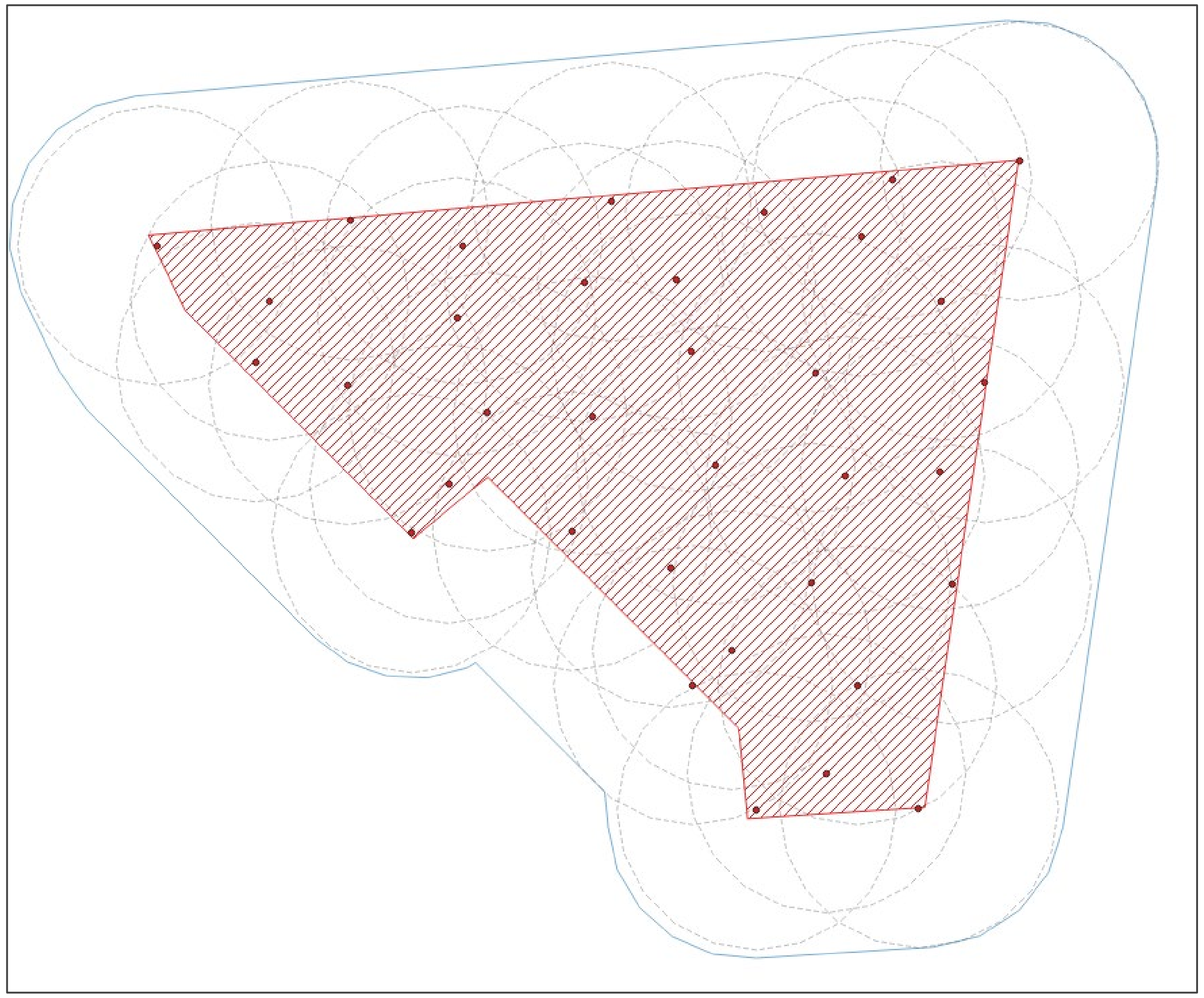

Figure 12-9 DBD Array Area (Hatched in Red), With 4km Buffer (Blue), and 35 Construction Vessels (Red Dots) and Their 4km Buffer (Grey Dotted Lines) Randomly Allocated within the Array Area.

Table 12-58 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at the Project

Species	Component specific density	Maximum number of individuals (% of reference population) for 55 vessels in the offshore ECC (2,500km^2)	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for DBD Array Area, including a 4km buffer (613km^2)	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for all construction vessels in the offshore ECC and DBD Array Area	Magnitude (temporary effect)
Harbour porpoise	DBD Array Area	-	-	517 (0.15% of NS MU)	**Negligible**	2,023 (0.60% of NS MU)	**Negligible**
	Offshore ECC	1,507 (0.44% of NS MU)	**Negligible**	-	-		
Bottlenose dolphin	DBD Array Area	-	-	1 (0.05% of GNS MU)	**Negligible**	106 (5.24% of GNS MU) 13 (5.75% of CES MU)	**Low** (Medium)
	Offshore ECC	105 (5.2% of GNS MU)	**Low** (Medium)	-	-		
		13 (5.6% of CES MU)[4]	**Low** (Medium)	-	-		
Common dolphin	DBD Array Area	-	-	8 (0.008% of CGNS MU)	**Negligible**	50 (0.05% of CGNS MU)	**Negligible**
	Offshore ECC	43 (0.04% of CGNS MU)	**Negligible**	-	-		
White-beaked dolphin	DBD Array Area	-	-	7 (0.016% of CGNS MU)	**Negligible**	92 (0.21% of CGNS MU)	**Negligible**
	Offshore ECC	85 (0.19% of CGNS MU)	**Negligible**	-	-		
Minke whale	DBD Array Area	-	-	10 (0.05% of CGNS MU)	**Negligible**	27 (0.13% of CGNS MU)	**Negligible**
	Offshore ECC	17 (0.09% of CGNS MU)	**Negligible**	-	-		
Grey seal	DBD Array Area	-	-	49 (0.09% NE & SE MU)	**Negligible**	734 (1.30% of NE & SE MU)	**Negligible** (Low)
	Offshore ECC	685 (1.2% of NE & SE MU)	**Negligible** (Low)	-	-		
Harbour seal	DBD Array Area	-	-	0.007 (0.0001% NE & SE MU)	**Negligible**	2 (0.04% of NE & SE MU)	**Negligible**
	Offshore ECC	2 (0.04% of NE & SE MU)	**Negligible**	-	-		

[4] As stated in **paragraph 407**, this precautionary assessment was based on six vessels that could be in the offshore ECC, within a 12nm limit.

Table 12-59 Assessment of Effect Significance for Disturbance from Underwater Noise of Construction Activities including Vessels

Potential impact	Species / receptor	Sensitivity	Magnitude	Effect significance
Disturbance from up to four construction activities at any one time	Harbour porpoise	**Medium**	**Negligible**	**Not Significant (Negligible adverse)**
	Bottlenose dolphin		**Negligible to low**	**Not Significant (Minor to Negligible adverse)**
	Common dolphin		**Negligible**	**Not Significant (Negligible adverse)**
	White-beaked dolphin		**Negligible**	
	Minke whale		**Negligible**	
	Grey seal		**Negligible**	
	Harbour seal		**Negligible**	
Disturbance from a maximum of 90 construction vessels in the offshore ECC and the DBD Array Area	Harbour porpoise	**Medium**	**Negligible**	**Not Significant (Negligible adverse)**
	Bottlenose dolphin (GNS MU) Bottlenose dolphin (CES MU)*		**Low**	**Not Significant (Minor adverse)**
	Common dolphin		**Negligible**	**Not Significant (Negligible adverse)**
	White-beaked dolphin		**Negligible**	
	Minke whale		**Negligible**	
	Grey seal		**Negligible**	
	Harbour seal		**Negligible**	

* assessment based on 6 vessels within the 12nm limit of the offshore ECC.

12.7.1.5 Barrier Effects due to Underwater Noise (MM-C-07)

416. Underwater noise during construction could have the potential to create a barrier effect, preventing movement or migration of marine mammals between important feeding and / or breeding areas, or potentially increasing swimming distances, if marine mammals avoid the area and go around it.

417. All marine mammal species could potentially be affected by barrier effects from underwater noise. For harbour porpoises, this could impact their access to foraging areas. Other cetacean species, such as bottlenose dolphins, common dolphins, white-beaked dolphins, and minke whales, might experience disruptions while moving between areas. Additionally, grey and harbour seals could be affected as they travel to and from haul-out sites.

12.7.1.5.1 Receptor Sensitivity

418. In line with disturbance from underwater noise, the sensitivity of marine mammals is considered to be **medium** for all marine mammal species.

12.7.1.5.2 Impact Magnitude

419. The maximum duration for the offshore construction period, including piling, is five years (**Table 12-9**). However, construction activities would not be underway constantly throughout this period.

420. Since the DBD Array Area is located approximately 210km from the nearest point on the coast, there is no potential for underwater noise to create a barrier effect that would restrict marine mammals' access to the coast or offshore regions. **Figure 12-10** indicates the largest TTS SEL_{cum} noise contours (at the SE location as the worst-case) for all hearing groups (**Table 12-26**) would leave a sufficiently large gap between the coast and the relevant TTS SEL_{cum} noise contour. While the size of the gap may vary slightly depending on the species and the maximum range TTS range modelled (**Table 12-29**), the differences are not significant in respect to the overall distance to the shore. Even under the conservative assumptions that all marine mammals would be prevented from 'accessing' the DBD Array Area due to underwater noise - accounting for a 26km radius buffer zone (based on the 26km EDR for harbour porpoise in response to monopile installation; JNCC *et al.*, 2020) - there would still be no potential for a barrier effect preventing access to feeding spots, haul-out sites, or migrating species. Feeding habits and preferred prey species are outlined in **Section 12.6** and **Volume 2, Appendix 12.2 Marine Mammals Technical Report**, indicating that all marine mammal receptors enjoy a wide range of prey species and are known to have large swimming ranges in order to obtain their food.

421. Underwater noise from construction activities in the offshore ECC has the potential to cause a temporary barrier effect for those species that are most likely to be present within coastal areas. It is expected that 10 vessels would be involved in cable installation activities, in addition to 45 guard vessels across the length of the cable corridor. As discussed in **Section 12.7.1.3**, the TTS ranges for most construction activities taking place in the offshore ECC would, however, be less than 100m for all species except harbour porpoise, for which the largest range was below 1km (see **Table 12-54**). Construction activities are primarily conducted from slow-moving vessels, and the distances at which TTS could affect an animal are minimal. This allows an animal to easily swim around the activity to reach its destination. Assuming that all marine mammal receptors would be prevented from crossing or accessing the offshore ECC area including a 4km radius buffer zone (based on the 4km disturbance buffer used to assess both other construction activities and vessels), then there would be some potential for a barrier effect from accessing feeding spots, haul-out sites or migrating species, particularly in the case of those activities being close to the coastline.

12.7.1.5.2.1 Harbour porpoise

422. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet these requirements. It has been estimated that, depending on the environmental conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.,* 1997). Therefore, any barrier effect that could restrict harbour porpoise accessing foraging areas could have implications for individuals.

423. Several studies that modelled harbour porpoise distribution in relation to environmental variables (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**), have found that harbour porpoise densities are typically associated with shallow waters of less than 80m water depths and in areas of high eddy activity (water depths within the wind farm site range from 21.2 – 34.6m relative to Lowest Astronomical Tide (LAT)). Furthermore, higher abundances of harbour porpoises were found in areas where habitat was heterogenous with a degree of coarseness of sediments. These environmental features are underlying the presence of prey aggregation that this species favours.

424. The southern North Sea, where water depths range between 15-30m (Bundesamt für Seeschiffahrt und Hydrographie (BSH), 2024), has high abundances of harbour porpoise year-round (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**). Harbour porpoise sightings during the aerial surveys were consistently high (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**), in line with research findings.

425. Considering that construction activities would not be continuous throughout the five-year construction phase, it is unlikely that harbour porpoises will be significantly restricted. This is due to their diverse range of preferred prey species, and extensive foraging ranges.

426. The magnitude of impact is therefore considered to be **negligible** for harbour porpoise.

12.7.1.5.2.2 Bottlenose dolphin

427. Bottlenose dolphin are a primarily inshore species, with most sightings within 10km of land. Studies of bottlenose dolphin off the east coast of Scotland found that the majority of sightings and movements were within 2km of the coastline, and in waters that are less than 30m deep (Quick *et al.,* 2014). In 2021, however, nine bottlenose dolphins in the Dutch Wadden See were photo-identification (ID) matched with known dolphins from the Moray Firth in Scotland (Hoekendijk *et al (*2021). This implies that there is some connectivity between territorial waters of the inshore ecotype individuals of the Moray Firth and the east coast Scotland for which a photo ID catalogue exist[5]. Therefore, there is the potential for coastal bottlenose dolphin to be restricted by barrier effects due to underwater noise and disturbance from construction activities (other than piling) in the offshore ECC.

428. However, it is unlikely that bottlenose dolphin from the Moray Firth population and / or the CES MU population would travel this far south. Provided that the noisy and disturbing activities within the offshore ECC are not taking place continuously over the five-year construction period, coastal bottlenose dolphin would not experience a barrier effect from short-term and localised underwater noise associated with construction activities.

429. The magnitude of impact is therefore considered to be **negligible** for bottlenose dolphin.

12.7.1.5.2.3 Common dolphin

430. As discussed in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**, presence of common dolphin is considered rare in the southern North Sea. As such, there is a lack of information regarding the species in the eastern seaboard of England and Scotland. Considering the absence of common dolphin, it is assumed that underwater noise generated from construction activities (other than piling) in the offshore ECC would not act as a barrier to the species.

431. The magnitude of impact is therefore considered to be **negligible** for common dolphin.

[5] https://www.abdn.ac.uk/sbs/outreach/lighthouse/gallery/index.php

12.7.1.5.2.4 White-beaked dolphin

432. Since this species predominantly inhabits shelf waters in the northern half of UK waters, the population of white-beaked dolphins in the southern North Sea is significantly lower compared to the northern regions (refer to **Volume 2, Appendix 12.2 Marine Mammals Technical Report**). Whilst migration behaviour in this species is not well known or understood, there may be some north-south movements between summer and winter (Ceteacean Research and Rescue Unit (CRRU), 2024).

433. Considering that the species is rare or not very abundant in the offshore ECC and prefers foraging in deeper shelf waters, where their preferred prey such as squid and octopus are found, white-beaked dolphins feed on a range of species. Therefore, they would not be inhibited by a barrier effect created construction activities (other than piling) in the offshore ECC.

434. The magnitude of impact is considered to be **negligible** for white-beaked dolphins.

12.7.1.5.2.5 Minke whale

435. In the southern North Sea, minke whales are less common compared to waters off the coast of Scotland, but seasonal aggregation has been observed close to the Dogger Bank, in the central North Sea (Tetley, 2010). Data regarding the migration patterns and winter habitats of minke whales are currently limited, but it is generally known that North Atlantic minke whales undertake seasonal migrations between high latitude summer feeding grounds and low latitude winter breeding grounds (Reid *et al.,* 2003; Risch *et al*, 2014). Risch *et al (*2014) examined acoustic recordings from across the North Atlantic and found that minke whales begin their northward migration around March / April and their southward migration starts between mid-October and November. Although the research focused primarily on the North-West Atlantic, similarities can be drawn to the population in the east, knowing that seasonal feeding aggregations have been identified to take place in the Southern Trench MPA on the Aberdeenshire coast. Here minke whales feed on shoals of herring, mackerel, cod and sandeels during the summer months (June to September) when levels of phytoplankton were highest (Tetley, 2010).

436. Taking into account that minke whale abundance was very low in the Dogger Bank area and based on the 24-month digital aerial surveys (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**), as well as the fact that minke whales migrate hundreds of kilometres between breeding and feeding grounds, the underwater noise at the DBD Array Area or the offshore ECC is not expected to pose a barrier to their migration.

437. The magnitude of impact is considered to be **negligible** for minke whale.

12.7.1.5.2.6 Seals

438. As outlined in **Section 12.6.10.6** and **12.6.10.7**, there are significant grey and harbour seal breeding or haul out sites in the SE and NE England MU (SCOS, 2022). The closest of these to landfall and the offshore ECC are Filey Brigg (20km) and Flamborough Head (14km).

439. There is no potential for underwater noise (PTS or TTS ranges) from the construction activities (other than piling) in the offshore ECC to create a barrier for seals moving to and from haul-out sites. Seals have been observed to avoid OWFs during foundation installation, but they return to the area within hours after piling ends (Russell *et al.,* 2016). Seals have vast foraging ranges, reported ranges of between 237km (harbour seal) to 448km (grey seal) (Carter *et al (*2022), and a diverse fish diet. Therefore, they are confined to specific areas for suitable prey and can find alternative foraging grounds. However, there could be an associated energetic cost due to longer foraging trips, and alternative habitats might not offer optimal conditions in terms of prey abundance.

440. As outlined in **Section 12.7.1.3** and **Section 12.7.1.4**, the potential for underwater noise from construction activities (other than piling) and vessels that could result in barrier effects would be temporary, would not occur consistently throughout the five-year offshore construction period, and they would be limited to specific parts of the construction period and certain areas at any given time.

441. The magnitude of impact is considered to be **negligible** for grey seal and harbour seal.

12.7.1.5.3 Effect Significance

442. Overall, it is predicted that the sensitivity for all marine mammal species is **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible** adverse significance, which is **not significant** in EIA terms.

12.7.1.6 Disturbance at Seal Haul-Out Sites (MM-C-08)

443. Grey seal and harbour seal are known to be sensitive to disturbance at haul-out sites from anthropogenic sources such as vessel traffic, construction activities (including piling), and approaches from land (Cates and Acevedo-Gutierrez, 2017; Paterson *et al.,* 2019; Machernis *et al.,* 2018). The most common disturbance effects at haul-out sites include increased vigilance and 'flushing' behaviour which describes when seals quickly rush into water to retreat from land. This behaviour can be energetically taxing, especially if pups are present, or during moulting season when seals tend to spend more time on land (Machernis *et al.,* 2018).

444. During construction, piling is the loudest and most likely source of disturbance to hauled -out seals, along with increased vessel activity. The number of seals spending time on land has been shown to decrease during the construction phase of wind farms, with studies indicating up to a 60% reduction in seals hauling out at sites 4km away from construction activities during piling periods (Edren *et al.,* 2010).

12.7.1.6.1 Receptor Sensitivity

445. Seals vary in their reaction to construction disturbance depending on the type of disturbance (e.g. vessel noise / presence, piling) and proximity to haul-out sites. A 2016 study at Sheringham Shoal OWF found no significant overall displacement of seals during construction. However, during pile driving activities, there was a significant reduction in seals at haul-out sites up to 25km away, with numbers returning to typical levels two hours after piling ceased (Russell *et al.,* 2016).

446. Disturbance to seals from vessel noise and presence has been demonstrated to be up to 500m away at haul-out sites in the UK (Cates and Acevedo-Gutierrez, 2017). In a similar study, harbour seals were 25 times more likely to flee into the water when cruise ships passed 100m from haul-out sites than when ships passed within 500m (Jansen *et al.,* 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

447. 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. However, some level of habituation has been seen where vessel traffic is high, and disturbance behaviours are generally reduced over time (Strong *et al.,* 2010).

448. The sensitivity of grey and harbour seal is therefore considered to be **medium**.

449. This is assessment takes a precautionary approach, acknowledging that both grey and harbour seal have some capacity to avoid, adapt to, tolerate, or recover from the anticipated impacts.

12.7.1.6.2 Impact Magnitude

12.7.1.6.2.1 Piling in the Dogger Bank D Array Area

450. The offshore construction period is expected to last a maximum of five years, but it is more likely to be completed within three to four years. The loudest activity, piling, is assumed to occur for up to 125 days for single installations of monopiles in the worst-case scenario. The haul-out sites are located at significant distances (>100km; see **Volume 2, Appendix 12.2 Marine Mammals Technical Report**) from the DBD Array Area where piling would take place, and therefore, would not be directly affected.

451. The magnitude of impact is therefore considered to be **negligible**.

12.7.1.6.2.2 Construction noise (other than piling)

452. As mentioned, construction activities (other than piling) would occur over a three-to-five-year period and would take place in the offshore ECC and the DBD Array Area. Since piling in the DBD Array Area would be the loudest activity, any other construction-related noise would be significantly lower (see **Section 12.7.1.3**). Therefore, only activities in the offshore ECC are relevant to seal-haut sites due to their proximity. The closest haul-out sites are approximately 20km away from the offshore ECC, but as identified in **Section 12.7.1.4**, potential effects from construction noise (other than piling) are unlikely to affect seals at these haul-out sites, considering the maximum potential impact range of such activities is approximately 4km.

453. A 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals returned to 52% of pre-disturbance levels at haul-out sites, and to 94% of pre-disturbance levels four hours after the event (Paterson *et al.,* 2019). Similarly, Russell *et al (*2016) found that within two hours of the cessation of pile driving, seals were distributed as they had been prior to piling. Any disturbance to seals at haul-out sites from construction activities in the offshore ECC is expected to be short-term and less noisy than piling and so seals would return to their haul-out sites in under two hours. To date, there have been no long-term population effects on seals from disturbance at haul-out sites, as a result of vessels or OWF construction activities (Edren *et al.,* 2010; Russell *et al.,* 2016; Cates and Acevedo-Gutierrez, 2017).

454. The magnitude of impact is therefore considered to be **low**.

12.7.1.6.2.3 Vessel Disturbance

455. The number of vessels relating to the wind farm are expected to increase during construction. A maximum of 55 vessels could be in the offshore ECC at any one time, and other vessels could be transiting to and from the port. Depending on the ports used, and the vessel routes to and from the DBD Array Area, there could be the potential for vessels to pass seal haul-out sites. The vessels transiting to and from the port would use main shipping channels and endeavour to stay at least 1km from the coast where possible.

456. A study carried out by the SMRU (Paterson *et al.,* 2015) involved a series of controlled disturbance tests at harbour seal haul-out sites. These tests included regular disturbances (every three days) through direct vessel approaches, effectively ‘chasing’ the seals into the water. Seal behaviour was recorded via Global Positioning System (GPS) tags, and it was found that even intense levels of disturbance did not cause seals to abandon their haul-out sites more than what would be considered normal (e.g. seals travelling between sites). The seals were observed to haul-out at nearby sites or to undertake foraging trips in response to the disturbance, but they would later return.

457. Further studies on the effects of vessel disturbance on hauled-out harbour seals suggest that even with repeated disturbance events severe enough to cause individuals to flee into the water, the likelihood of harbour seals moving to a different haul-out site does not increase. Additionally, this disturbance appears to have little effect on their movements and foraging behaviour (Paterson *et al.,* 2019).

458. The magnitude of impact is therefore considered to be **low**.

12.7.1.6.3 Effect Significance

459. Overall, it is predicted that the sensitivity of grey and harbour seal is **medium** and the magnitude of impact is **negligible** to **low.** The effect is therefore of **negligible** to **minor** adverse significance, which **is not significant** in EIA terms.

12.7.1.6.4 Best Practice Measures

460. Seals in the relevant study area(s) are already accustomed to vessels. All vessel movements would be kept to the minimum number that is required to develop the Project. Additionally, vessel operators would use industry best practice to reduce any risk of collisions with marine mammals (see commitment IDs CO18 and CO28 in **Table 12-8**).

461. Additionally, if required, vessel operators would use best practice measures, including a consideration of distances from seal haul-out sites when transiting outside of main shipping channels, particularly during sensitive periods for breeding and moulting.

462. These measures would be detailed within the final PEMP, with the draft measures included in the **Outline PEMP** (document reference 8.6).

12.7.1.7 Vessel Interaction (Increase in Risk of Collision) (MM-C-09)

463. During the construction phase there would be an increase in the number of vessels transiting to and from the DBD Array Area and within the offshore ECC. However, it is anticipated that vessels would follow an established shipping route to the relevant ports to minimise vessel volume in the area. The **Outline MMMP** (document reference 8.1) provides a protocol for minimising collision risk of marine mammals with vessels.

12.7.1.7.1 Receptor Sensitivity

464. Larger whale species, such as minke whales, are at a greater risk of vessel collisions compared to smaller cetaceans (this information is discussed below in **Section 12.7.1.7.2**. Evidence shows a lower incidence of physical trauma in strandings of smaller species, like dolphins and seals, which often display normal behaviour around vessels or even habituate to their presence. In contrast, harbour porpoises exhibit strong avoidance behaviour due to their sensitivity to noise and movement. However, minke whales, being less agile and more prone to ship strikes, do not demonstrate the same avoidance capabilities. Given their size, behaviour, and the documented increase in collisions among baleen whales, such as minke whales, they should be considered to have a higher sensitivity to vessel strikes than dolphins, seals, or porpoises.

465. Harbour porpoises, being small and highly mobile, are generally expected to avoid vessels due to their responses to vessel noise (e.g. Thomsen *et al.,* 2006; Polacheck & Thorpe, 1990). Predictive modelling indicates indicated a negative relationship between the number of ships and the distribution of harbour porpoises in the Irish and Celtic Seas, and North Sea during summer. This suggests that harbour porpoises may exhibit avoidance behaviour (Heinänen & Skov, 2015; Dyndo *et al.,* 2015, Frankish *et al.,* 2023), observed even at long ranges (2-9km; Dyndo *et al.,* 2015; Benhemma-Le Gall *et al.,* 2021; Pigeault *et al.,* 2024), thereby reducing the risk of collisions with vessels. In a study by Robbins (2022), the relative collision risk was calculated using Automatic Identification System (AIS) vessel density data overlaid on the cetacean distribution maps by Waggitt *et al (*2019). The study found that harbour porpoise in the southern North Sea is exposed to high shipping traffic year-round, exposing them to a significant risk of potential ship strikes.

466. In a telemetry study of harbour and grey seals, alongside vessel AIS data information across the British Isles, data indicated vessel and seal co-occurrence was high and that spatial overlap with ships occurred within 50km of the coast close to haul-out sites (Jones *et al.,* 2017). Areas with high risk of vessel exposure included 11 SAC. In an attempt to determine the likelihood of harbour seal injury occurring due to co-presence with large vessels within the Moray Firth, there appeared to be to be no relationship between areas in high co-occurrence and incidences of injury (Onoufriou *et al.,* 2016). In fact, seals were observed not to react to close passing vessels.

467. The sensitivity of marine mammals is therefore considered to be **medium** for minke whale, and **low** for all other marine mammal receptors.

12.7.1.7.2 Impact Magnitude

468. Being highly mobile, marine mammals have the potential to avoid vessels but if an individual receptor collides with a vessel, there is the potential for a very limited capacity to recover from the worst-case impact (**Table 12-11**).

469. Marine mammals can, to some extent, detect and avoid vessels (National Oceanic and Atmospheric Administration (NOAA), 2021). Research shows that larger vessels, such as cruise ships and cargo vessels over 80 meters in length, are more likely to cause severe or fatal injuries to marine mammals (Laist *et al.,* 2001; Keen *et al.,* 2023). High speeds are a key factor in collisions with cetaceans; for instance, the likelihood of a lethal injury to large whales, specifically the North Atlantic right whale in this study, increased from around 20% to 80% when vessel speeds increased from 8 to 15 kt (Vanderlaan & Taggart, 2007). Serious injuries have also been documented at lower speeds of 2 and 5.5 kt (Conn & Silber, 2013). Conversely, vessels traveling at speeds below 10 kt rarely cause serious injuries, making reduced speed one of the most effective mitigation strategies (Laist *et al.,* 2001; Conn & Silber, 2013; Laist *et al.,* 2014; Keen *et al.,* 2023).

470. The predictability of vessel movements by marine mammals is crucial in minimising the risks posed by vessel traffic (Nowacek *et al.,* 2001, Lusseau, 2003; 2006). Reducing vessel speed not only allows more time for marine mammals to move away, but also significantly reduces emitted vessel noise. This reduction in noise enables marine mammals to hear approaching ships and prevents interference with intra-species communication (Leaper, 2019).

471. An analysis of the IWC Ship Strike Database reveals that baleen whales, specifically fin and humpback whales, followed closely by right whales, constitute the majority of ship strike victims (Winkler *et al.,* 2020). However, a significant proportion of reported cases (12.1%) lacked species identification. Reports of collisions involving smaller cetacean species are generally scarce due to reporting biases, such as unnoticed collisions, quickly sinking carcasses, or less concern for smaller species (Schoeman *et al.,* 2020). The IWC report underscores that the lack of species identification and the mis- or underreporting of ship strikes remain global issues, leading to uncertainties in the numbers and species affected (Van Waerebeek *et al.,* 2007; Winkler *et al.,* 2020).

472. In the United Kingdom, approximately 4-6% of stranded small cetaceans (harbour porpoise, common dolphin, white-beaked dolphin and Risso’s dolphin) showed evidence of physical trauma during postmortem examinations, potentially attributable to ship strikes. This is compared to 15-20% of stranded whales, based on data from the Cetacean Strandings Investigation Programme (CSIP) database (1990-2010) (Evans *et al.,* 2011).

473. Vessel activity influences dolphin behaviour, with socialising and foraging often occurring in the presence of various vessel sizes, as demonstrated in a study conducted by Mills *et al (*2023) in a busy shipping channel in the Gulf of Mexico. It has been suggested in this study that vessel movements enhanced nutrient mixing, thereby increasing prey abundance. Locally, bottlenose dolphins in Cardigan Bay, Wales exhibit responses to vessels that vary based on the type of vessel and their degree of habituation (Koroza & Evans, 2022). Observations indicated that the resident bottlenose dolphins in Cardigan Bay were more likely to tolerate disturbances compared to more transient dolphins in the region (Hudson, 2014). At the time of writing there was no information or recorded instances on of ship strikes for bottlenose dolphin in Cardigan Bay. For bottlenose dolphin and common dolphin, the estimated collision risk rate with vessel traffic in the North Sea was relatively low compared to that of harbour porpoise (Robbins, 2022). In contrast, however, white-beaked dolphin was modelled to have high levels of spatial co-occurrence with vessels in the North Sea, although data for the NE coast of England shows this to be mainly in in the winter months (October to April) (Robbins, 2022).

474. A review on vessel disturbance, detailed in **Section 12.6.6** of **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**, indicated that most marine mammals are affected by vessel noise. The discussion above highlighted that these animals typically respond to noise by exhibiting avoidance or fleeing behaviours, particularly observed in harbour porpoise (as described in Dyndo *et al.,* 2015, Benhemma-Le Gall *et al.,* 2021 and 2023; Frankish *et al.,* 2023), or by co-existing with ships and seals.

475. The maximum number of vessels that could be in the Offshore Development Area at any one time has been estimated to be 90 vessels. The number, type and size of vessels would vary, depending on the activities taking place at any one time.

476. The magnitude of impact is therefore considered to be **low** for all marine mammal species.

12.7.1.7.3 Effect Significance

477. Overall, it is predicted that the sensitivity for marine mammals is **low** to **medium** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which is **not significant** in EIA terms.

12.7.1.7.4 Best Practice Measures

478. Marine mammals in the relevant study area(s) are already accustomed to vessels. All vessel movements would be kept to the minimum number that is required to develop the Project. Additionally, vessel operators would use industry best practice to reduce any risk of collisions with marine mammals (see Commitment IDs CO18 and CO28 in **Table 12-8**).

12.7.1.8 Changes to Prey Resource (MM-C-10)

479. Any impacts on prey species have the potential to indirectly affect marine mammals. 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 (FSE-C-02);
- Increased suspended sediment and sediment re-deposition (FSE-C-04);
- Remobilisation of contaminated sediments if present (offshore ECC) (FSE-C-06);
- Underwater noise and vibration (FSE-C-07); and
- Changes in fishing pressure (FSE-C-08).

12.7.1.8.1 Receptor Sensitivity

480. Information on the diet of marine mammal species is provided in **Volume 2, Appendix 12.2 Marine Mammals Technical Report**.

481. In summary, harbour porpoise have a diverse diet that varies geographically and seasonally, reflecting changes in available food resources. They have relatively high daily energy demands and need to capture enough prey to meet these requirements. It has been estimated that, depending on the environmental conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.,* 1997). The sensitivity of harbour porpoise is therefore considered to be **low** to **medium**.

482. All dolphin species considered in the assessment have a broad diet, feeding on a wide range of prey species and are considered to have large foraging ranges. The sensitivity of dolphin species is therefore considered to be **low**.

483. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species. The sensitivity of minke whale is therefore considered to be **low** to **medium**.

484. Grey and harbour seal are opportunistic feeders, feeding on a wide range of prey species. They are able to forage in other areas and have relatively large foraging ranges. The sensitivity of grey seal and harbour seal is therefore considered to be **low**.

12.7.1.8.2 Impact Magnitude

12.7.1.8.2.1 Temporary Habitat Loss / Physical Disturbance

485. During construction, approximately 28.85km^2 of seabed habitat across the Project would be temporarily disturbed or lost during the construction phase (see **Table 11-6** in **Chapter 11 Fish and Shellfish Ecology**). This represents approximately 11% of the Project area.

486. This area is the seabed preparation area required for installation of the infrastructure and includes the worst-case seabed footprint for all wind turbine foundations and OSP(s) foundations, scour protection, disturbance from jack-up vessels, and installation of cables.

487. The magnitude of impact of physical disturbance to seabed habitat during construction has been assessed as **negligible** in **Chapter 10 Benthic and Intertidal Ecology**, with a **negligible** to minor adverse effect significance. In **Chapter 11 Fish and Shellfish Ecology**, the magnitude of impact for temporary habitat loss / physical disturbance was considered to be low for elasmobranchs, demersal fish, pelagic fish (including herring outside of spawning season), and diadromous fish).

488. The magnitude of impact for marine mammals is therefore considered to be **low**.

12.7.1.8.2.2 Increased Suspended Sediment and Sediment Re-Deposition

489. Construction activities, such as seabed preparation, dredging, foundation and cable installation, may lead to the potential for increased SSCs in the water column and subsequent sediment re-deposition. Activities such as jack-up vessel and anchor deployment, placement of cable protection or scour protection are not expected to increase the suspended sediments to the extent to which it would cause an impact to benthic or fish receptors (see **Chapter 10 Benthic and Intertidal Ecology**).

490. As outlined in **Chapter 9 Marine Water and Sediment Quality**, the Offshore Development Area is predominantly composed of fine sand. Considering the sediment sizes and the hydrodynamic regimes, finer suspended sediments are expected to form a plume that could extend up to 35km from the source of the disturbance in the nearshore area due to faster tidal currents. In contrast, any sediment plumes that may arise offshore are predicted to extend to a maximum of 17.6km around the offshore ECC, and 9.1km when closer to the DBD Array Area.

491. The sediment release into the water column from an individual monopile foundation is 35,785m^3 (**Table 12-9**), however the worst-case scenario is that all the foundations would require seabed preparation and as such, the total volume of sediment would be up to 4,043,705m^3 (see **Chapter 8 Marine Physical Processes**). Increased suspended sediment and sediment re-deposition would only occur for a limited duration at specific locations (e.g. piling location), at any given time. Increases in suspended sediment concentrations and minimal disposal would occur within the 35.4km. The highest suspended sediment concentrations would cover a much smaller area (around 20km from release).

492. The effect significance in **Chapter 11 Fish and Shellfish Ecology** is therefore of **minor adverse**, which is **not significant** in EIA terms.

493. The magnitude of impact is therefore considered to be **negligible** for all marine mammal species.

12.7.1.8.2.3 Remobilisation of Contaminated Sediments if Present (Offshore Export Cable Corridor)

494. As outlined in **Chapter 9 Marine Water and Sediment Quality**, the sediment survey in the offshore ECC indicated that, for all parameters, all sediment contaminant concentrations were below significant levels.

495. The magnitude of impact is therefore **negligible**.

496. Any indirect effects from remobilisation of contaminated sediments, for instance the risk to prey species, which could affect marine mammals is also assessed as **negligible**.

497. As contaminant levels are not found to be present at levels where effects would arise, this impact to marine mammals was not assessed further for the construction, O&M or decommissioning phases.

498. The magnitude of impact is therefore considered to be **negligible** for all marine mammal species.

12.7.1.8.2.4 Underwater Noise and Vibration

499. High levels of underwater noise can cause physiological (mortality, permanent injury or temporary injury), behavioural (startled movements, swimming away from noise source, changed migratory patterns or ceased reproductive activities) and environmental (changes to prey species or feeding behaviours) effects on fish species.

500. From piling noise and vibration, as assessed in **Chapter 11 Fish and Shellfish Ecology**, the impact to all receptors is considered to be **minor adverse** significance, which is **not significant** in EIA terms.

501. During piling of two sequential monopiles at 8,000kJ, stationary fish with swim bladders involved in hearing could potentially die within a 6km radius or sustain recoverable injuries up to 9.4km away from the piling source (see **Table 11-23** in **Chapter 11 Fish and Shellfish Ecology**). Fish species that sustain recoverable injuries, TTS or show behavioural responses would still be available as prey to marine mammals. Like fish, marine mammals would also be displaced from the area. Therefore, these impacts on fish species would not affect the prey resources available to marine mammals.

502. The magnitude of impact is therefore considered to be **low** for all marine mammal species.

12.7.1.8.2.5 Changes in Fishing Pressure

503. As outlined in **Chapter 14 Commercial Fisheries**, there is the potential for commercial fishing activity to be displaced from within the Project Area, due to the presence of work vessels, foundation installation activity, and laying of inter-array and platform link cabling. Construction activities may act as a barrier to deployment of mobile fishing gear and may have safety zones. This may, in turn, displace fishing to nearby grounds. Overall, this may result in reduced fishing pressure on commercially exploited species within the Project Area or increase fishing pressure on fish and shellfish species within the Project Area.

504. No significant impacts in respect of loss of fishing grounds, and associated potential for displacement, have been identified. The magnitude of impact is therefore considered to be **negligible** for all marine mammal species.

12.7.1.8.3 Effect Significance

505. Overall, it is predicted that sensitivity of harbour porpoise and minke whale is **low** to **medium** and the magnitude of impact is **negligible** to **low**. The effect is therefore of **negligible** to **minor adverse** significance, which is **not significant** in EIA terms for both harbour porpoise and minke whale.

506. Overall, it is predicted that sensitivity of dolphin and seal species is **low** and the magnitude of impact is **negligible** to **low**. The effect is therefore of **negligible** to **minor adverse** significance, which is **not significant** in EIA terms for all dolphin and seal species.

12.7.1.9 Changes to Water Quality (Sediment Bound Contaminants in the Offshore Export Cable Corridor) (MM-C-12).

507. **Chapter 9 Marine Water and Sediment Quality** outlines the potential changes in water quality that could occur during construction as a result of the re-mobilisation of existing contaminated sediment in the offshore ECC (MWS-C-02) only as a result of the installation of cables and foundations (including seabed preparation).

12.7.1.9.1 Receptor Sensitivity

508. Increased suspended sediment is unlikely to have any direct or indirect impacts on marine mammals. Marine mammals 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).

509. The sensitivity of marine mammals is considered to be **negligible**.

12.7.1.9.2 Impact Magnitude

510. As outlined in **Chapter 9 Marine Water and Sediment Quality**, recent sediment survey results show that the sediment contamination within the ECC is **negligible**. Therefore, should sediment be disturbed during any phase of the Project, there is no pathway for effect.

511. The magnitude of impact is therefore considered to be **negligible** for all marine mammal receptors.

12.7.1.9.3 Effect Significance

512. Overall, it is predicted that the sensitivity for all marine mammal receptors is **negligible,** and the magnitude of impact is **negligible**. The effect is therefore of **negligible** adverse significance, which **is not significant** in EIA terms.

12.7.2 Potential Effects during Operation

12.7.2.1 Underwater Noise: Physical and Auditory Injury (MM-O-03)

513. Operational wind turbines will operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The Project O&M period is 35 years. There is, therefore, the potential that underwater noise from operational wind turbines could contribute to a consistent, long duration of sound to the marine environment. The underwater noise levels emitted during the operation of the wind turbines are low and not expected to cause physiological injury to marine mammals. Behavioural reactions could occur if the animals are in the immediate vicinity of the wind turbines (Tougaard *et al.,* 2009a; Sigray & Andersson, 2011).

514. The main source of underwater noise from operational wind turbines would be mechanically generated vibration from the rotating machinery within the wind turbines, which is transmitted into the sea through the structure of the wind turbine tower and foundations (Nedwell *et al.,* 2003; Tougaard *et al.,* 2020). Noise levels generated above the water surface are expected to be low enough that no significant airborne sound would pass from the air to the water (e.g. Godin, 2008).

515. Underwater noise from operational wind turbines has been described as continuous and non-impulsive, and is characterised by one or more tonal components that are typically at frequencies below 1kHz (Madsen *et al.,* 2006). Noise levels associated with operational OWFs are relatively low, with recorded levels between 142 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.,* 2009a). 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; Cheesman, 2016). At ranges between 14m and 40m from the foundations, it was found that the sound generated due to operational wind turbines was only detectable over underwater ambient noise at frequencies below 500Hz (Tougaard *et al.,* 2009a).

516. 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 10–20dB 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 wind turbines, in locations with high ambient noise from shipping or high wind speeds (Tougaard *et al.,* 2020).

517. An underwater noise study from a Chinese OWF in Shanghai found that the noise of ebb and flow around the wind farm was louder than the turbines (Yang *et al.,* 2018). It must be noted that the capacity of the OWFs in this study are between 3 - 6MW only, whereas the Project’s turbine capacity is expected to be at least three to fourfold higher.

518. The trend toward larger turbine sizes leads to the projection of elevated source levels. In particular, this extrapolation suggested a modelled source level of 177dB re 1μPa for a 10MW turbine, which in turn increases the areas affected by behavioural disruption in marine mammals (Stöber & Thomsen, 2021). Larger turbines have been modelled for the Project (**Volume 2, Appendix 12.3 Underwater Noise Modelling Report**). While there are limitations in extrapolating data for larger turbines, it is also important to note that larger turbines are typically spaced further apart than smaller ones. The spacing in between the turbine would offset the noise generated by the individual turbines, reducing the potential for barrier effects around a turbine and provide ‘quieter’ corridors through which marine mammals could travel.

519. In a separate study envisioning the deployment of large-scale turbine arrays across the North Sea using 5MW turbines with source levels reaching 167.6dB re 1µPa, predictions were made (van der Molen *et al., 2*014). The study presented a hypothetical scenario of several OWF arrays including a total of 2,400 turbines, each farm comprising of 60 turbines (5MW). The minimum broadband noise level within the farm were modelled at around 113 dB re 1 mPa (RMS), while within 400m of the farm noise levels were between 102 – 113 dB re 1 mPa (RMS). The expected noise levels would diminish below 102dB re 1µPa (RMS) in the spaces between two such farms with a 5km separation. It was noted that under specific sea-states, the noise levels might decrease even further, potentially falling below the typical ambient noise. This scenario would enable animals to travel through quieter corridors.

520. The proposed larger turbines for the Project (up to 27MW) have the potential to generate higher noise levels than smaller turbines currently in operation elsewhere (Stöber & Thomsen, 2021). This increase in turbine size has been taken into account in the underwater noise modelling for the Project. Methodological details on how data from smaller turbines were extrapolated to model the noise levels of larger turbines are provided in **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**.

12.7.2.1.1 Underwater Noise Modelling

521. To determine the potential risk for auditory injury (PTS / TTS) from underwater noise generated by operational wind turbines, site-specific underwater noise modelling was undertaken (in line with assumptions outlined in previous sections). Although the maximum turbine sizes considered at DBD are significantly larger than those used in the underwater noise modelling for the Project, a study by Bellmann *et al (*2023) found that the predictions for the smaller turbines likely overestimate the noise produced by the turbines, providing an additional margin of safety for the estimations (see **Volume 2, Appendix 12.3 Underwater Noise Modelling Report**). However, caution must be used when considering the predicted impact ranges.

522. The modelling assumed an average 6m/s wind speed, although wind speeds, and thus operational noise levels, may be greater than this. However, it is worth noting that the background noise level will also naturally increase with increased wind speed.

523. Ranges smaller than 100m for SEL_{cum} have not been presented and, therefore, may overestimate the maximum impact ranges. The operational wind turbine source is considered a non-impulsive or continuous source. For SEL_{cum} calculations, it has been assumed that the operational wind turbine noise is present 24 hours a day, and all marine mammals are treated as stationary receptors.

524. The results of the underwater noise modelling (**Table 12-60**) indicate that for a marine mammal to be exposed to noise levels that could induce auditory injury (PTS / TTS), it would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours, based on the Southall *et al (*2019) non-impulsive thresholds and criteria for SEL_{cum} (**Table 12-27**). This scenario is considered highly unlikely, as marine mammals would typically transit through and around the turbines, rather than remaining within 100m of any turbine for prolonged periods of time

525. The impact ranges for a 14MW or 27MW turbine are the same. As a precautionary approach, the potential impact area for up to 113 (14MW) wind turbines has also been determined (**Table 12-60**).

Table 12-60 Predicted Impact Ranges (And Areas) for auditory injury (PTS / TTS) from 24 Hour Cumulative Exposure of Underwater Noise from Operational Wind Turbines

Species	One operational wind turbine (14 or 27MW)	113 operational wind turbines (14MW)
All marine mammal species	<100m (0.03km^2)	3.55km^2

12.7.2.1.2 Receptor Sensitivity

526. The sensitivity of marine mammal receptors is considered to be **high** for PTS onset, and **medium** for TTS onset (as detailed in **Section 12.1.1.1.1**).

12.7.2.1.3 Impact Magnitude

527. The number of marine mammals that could be impacted due to underwater noise from operational wind turbines has been assessed based on the number of animals that could be present in the modelled impact area for one and for all 113 operational wind turbines (**Table 12-61**).

528. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicated that the marine mammal would have to remain within less than 100m for 24 hours for any potential risk of PTS (**Volume 2, Appendix 12.3 Underwater Noise Modelling Report**). Therefore, PTS is highly unlikely and has not been assessed further.

529. There is unlikely to be any significant risk of auditory injury as the modelling also indicated that the marine mammal would have to remain within less than 100m of operational wind turbines for 24 hours (**Table 12-60**) However, as a precautionary approach, the number of marine mammals that could be at risk of auditory injury has been estimated (**Table 12-61**). As outlined above, this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been rounded up to 100m.

Table 12-61 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Operational Turbine Noise at the Project

Species	Maximum number of individuals (% of reference population) for one wind turbine generator	Maximum number of individuals (% of reference population) for 113 wind turbine generators	Magnitude (long-term effect)
Harbour porpoise	0.03 (0.000008% of NS MU)	3 (0.0009% of NS MU)	**Negligible**
Bottlenose dolphin	0.00004 (0.000002% of GNS MU; 0.00002% of CES MU)	0.005 (0.0002% of GNS MU; 0.002% of CES MU)	
Common dolphin	0.0004 (0.0000004% of CGNS MU)	0.04 (0.00004% of CGNS MU)	
White-beaked dolphin	0.0003 (0.0000007% of CGNS MU)	0.04 (0.00008% of CGNS MU)	
Minke whale	0.0005 (0.000002% of CGNS MU)	0.05 (0.0003% of CGNS MU)	
Grey seal	0.003 (0.000004% of NE & SE MU)	0.3 (0.0005% of NE & SE MU)	
Harbour seal	0.0000003 (0.00000001% of NE & SE MU)	0.00004 (0.0000008% of NE & SE MU)	

530. The magnitude of the impact is therefore **negligible**.

12.7.2.1.4 Effect Significance

531. Overall, it is predicted that the sensitivity of marine mammal receptors is **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms for all species.

12.7.2.2 Underwater Noise: Behavioural Impacts (MM-O-04)

12.7.2.2.1 Receptor Sensitivity

532. Currently available data indicates that there is no lasting disturbance or exclusion of harbour porpoise or seals around wind farm 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 suggested that any behavioural responses for harbour porpoise and seal may only occur up to a few hundred metres away (Tougaard *et al.,* 2009b; McConnell *et al.,* 2012; Leemans & Fijn, 2023).

533. Monitoring was carried out at the Horns Rev and Nysted wind farms in Denmark, during their 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 either of the OWFs studied, following two years of operation.

534. 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). Tagged harbour seals have been recorded within two operational wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in the UK), with the movement of several of the seals suggesting foraging behaviour around wind turbine fixed foundation structures (Russell *et al.,* 2014). Both harbour porpoise and seals have been shown to forage within operational wind farm sites (e.g. Lindeboom *et al.,* 2011; Russell *et al.,* 2014, Leemans & Fijn, 2023), indicating no restriction to movements in operational OWF sites.

535. Modelling of noise effects of operational offshore wind turbines suggested that marine mammals are not considered to be at risk of displacement by operational wind farms (Marmo *et al.,* 2013).

536. The sensitivity of marine mammals is therefore considered to be **low** for harbour porpoise, dolphin and seal species.

537. Taking into account that minke whales are more sensitive to LF noise, it is probable that they could be more sensitive to operational wind turbine noise (Marmo *et al.,* 2013).

538. The sensitivity of minke whale is therefore considered to be **medium**.

539. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such impacts, but have shown to be present in near turbines which infer that they may become habituated to the sound.

12.7.2.2.2 Impact Magnitude

540. Part of the Dutch Governmental Offshore Wind Ecological Programme (WOZEP), Leemans & Fijn (2023), included reported observations of harbour porpoise in three OWFs: Luicherduinen, Gemini, and Borssele. The study highlighted that harbour porpoises tend to avoid the immediate vicinity of the turbines, with the closest recorded distance being 500m. Additionally, there was no statistical difference in porpoise densities within the wind farms compared to the borders of the arrays.

541. This report is one of the first to provide a qualitative analysis of the avoidance behaviour of harbour porpoises. Although data on behavioural responses to operational turbine noise is limited, it is unlikely to be significant, as disturbances do not extend beyond approximately 500 meters from a turbine. Consequently, while the DBD Array Area itself could be a disturbance area during operation, the literature indicates that marine mammals are using these areas and are not excluded from them.

542. The magnitude of impact is therefore considered to be **negligible**.

12.7.2.2.3 Effect Significance

543. Overall, it is predicted that the sensitivity of harbour porpoise, dolphin and seal species is **low** and the magnitude of impact is **negligible**. The effect is therefore of **negligible** adverse significance, which is **not significant** in EIA terms.

544. Overall, it is predicted that the sensitivity of minke whale is **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

12.7.2.3 Underwater Noise: Physical and Auditory Injury Resulting from Noise Associated with Other Operational and Maintenance Activities (MM-O-05)

545. During O&M, there is the potential for additional rock placement or cable re-burial activities to take place. Although the full scope and requirements of the work is currently unknown, the associated effects to marine mammals would be the same or less than those activities assessed to occur during construction (**Section 12.7.1.3**).

546. During O&M, there is the potential for vessels transiting and conducting maintenance activities in the offshore ECC and DBD Array Area. The number of vessels would be much less than those assessed during construction (**Section 12.7.1.3**), currently estimated to be a maximum of 16 vessels on site at any one time.

12.7.2.3.1 Receptor Sensitivity

547. The sensitivity for marine mammal receptors is (for TTS onset only) is considered to be **medium**.

12.7.2.3.2 Impact Magnitude

12.7.2.3.2.1 Construction Noise (Other than Piling)

548. The underwater noise modelling presented underwater noise ranges for several activities that may be associated with O&M activities. This includes cable laying, rock placement, trenching and dredging (**Volume 2, Appendix 12.3 Underwater Noise Modelling Report**). The PTS and TTS impact ranges (**Table 12-54**) and effects on marine mammals (**Table 12-55**) from these activities have already been provided in **Section 12.7.1.3**, and have therefore not been repeated here.

549. In summary of Table 12-55, the magnitude of impact is considered to be **negligible** for up to four of these activities taking place at the same time.

550. The potential for TTS effects that could result from underwater noise during operational maintenance activities would be localised and temporary to where and when the work was undertaken.

12.7.2.3.2.2 Vessel Noise

551. The TTS impact ranges (see **Table 12-54**) and effect on marine mammals from one, 35, 55 and 90 vessels (**Table 12-56**) have already been provided in **Section 12.7.1.3**, and has therefore not been repeated here. The effect of 16 O&M vessels would affect even less animals as those already assessed.

552. In summary of **Table 12-56**, the magnitude of impact is considered to be **negligible**.

12.7.2.3.3 Effect Significance

553. In summary, it is predicted that the sensitivity of marine mammal receptors to TTS onset as a result of O&M activities is **medium**, and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms for all species.

12.7.2.4 Underwater Noise: Behavioural Impacts Resulting from Other Operational and Maintenance Activities (MM-O-06)

554. The effects from O&M activities would be temporary in nature and limited to relatively short periods during the O&M 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.

555. During O&M, there is the potential for vessels transiting and conducting maintenance activities in the offshore ECC and DBD Array Area. The number of vessels would be much less than those assessed during construction (**Section 12.7.1.4**), currently estimated to be a maximum of 16 vessels on site at any one time.

556. Vessel movements to and from the O&M port (to be decided post-consent) would be incorporated within existing vessel routes where possible. The vessels conducting the maintenance work would be slow moving or stationary at times.

12.7.2.4.1 Receptor Sensitivity

557. The sensitivity for marine mammal receptors is considered to be **medium** for all marine mammal species.

12.7.2.4.2 Impact Magnitude

12.7.2.4.2.1 Operation and Maintenance Disturbance

558. The discussion on using a 4km disturbance range for construction activities and an assessment of disturbance effects on marine mammals from one and four activities (**Table 12-57**) has already been conducted in **Section 12.7.1.4**, and has therefore not been repeated here.

559. In summary of **Table 12-57**, the magnitude of impact is considered to be **negligible**, with the exception of bottlenose dolphin of the CES MU, with a magnitude of **low**.

560. The duration of maintenance activities would not be underway constantly but periodically throughout the lifetime of the wind farm.

12.7.2.4.2.2 Vessel Disturbance

561. Similarly, as discussed in **Section 12.7.1.4**, there is the potential for 16 O&M vessels to be present in the offshore area for maintenance activities. However, it is unlikely that all 16 vessels would be present simultaneously in either the DBD Array Area or the offshore ECC, and engaging in noisy activities. Thus, **Table 12-62** presents the number of animals affected by disturbance from eight vessels, each with a 4km disturbance radius, as a worst-case scenario in both offshore components, covering a total disturbance area of **402km²**.

562. **Table 12-62** also presents the total number of animals affected by vessels in both the Offshore ECC and the DBD Array Area at the same time (for the total of 16 vessels). The magnitude of this effect was presumed to have a long-term effect, as the vessels are often present throughout the lifetime of the Project. For bottlenose dolphin of the CES MU, a reduced number of vessels is assessed in line with **Section 12.7.1.4** (i.e. six vessels in the nearshore area).

Table 12-62 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with O&M Vessels at the Project

Species	Component specific density	Maximum number of individuals (% of reference population) for eight vessels in each area, or 16 vessels in total	Magnitude (long-term effect)
Harbour porpoise	DBD Array Area	339 (0.10% of NS MU)	**Negligible (Low)**
	Offshore ECC	243 (0.07% of NS MU)	**Negligible (Low)**
	Total for Offshore Development area	582 (0.17% of NS MU)	**Negligible (Low)**
Bottlenose dolphin	DBD Array Area	0.6 (0.03% of GNS MU; 0.25% of CES MU)	**Negligible (Low)**
	Offshore ECC	13 (0.64% of GNS MU; 5.75% of CES MU)	**Low; Low (High)**
	Total for Offshore Development area	14 (0.69% of GNS MU; 6.19% of CES MU)	**Low; Low (High)**
Common dolphin	DBD Array Area	5 (0.005% of CGNS MU)	**Negligible (Low)**
	Offshore ECC	7 (0.007% of CGNS MU)	**Negligible (Low)**
	Total for Offshore Development area	12 (0.0012% of CGNS MU)	**Negligible (Low)**
White-beaked dolphin	DBD Array Area	5 (0.011% of CGNS MU)	**Negligible (Low)**
	Offshore ECC	14 (0.03% of CGNS MU)	**Negligible (Low)**
	Total for Offshore Development area	19 (0.04% of CGNS MU)	**Negligible (Low)**
Minke whale	DBD Array Area	7 (0.03% of CGNS MU)	**Negligible (Low)**
	Offshore ECC	3 (0.01% of CGNS MU)	**Negligible (Low)**
	Total for Offshore Development area	10 (0.06% of CGNS MU)	**Negligible (Low)**

Species	Component specific density	Maximum number of individuals (% of reference population) for eight vessels in each area, or 16 vessels in total	Magnitude (long-term effect)
Grey seal	DBD Array Area	33 (0.06% of NE & SE MU)	**Negligible (Low)**
	Offshore ECC	111 (0.20% of NE & SE MU)	**Negligible (Low)**
	Total for Offshore Development area	144 (0.25% of NE & SE MU)	**Negligible (Low)**
Harbour seal	DBD Array Area	0.006 (0.0001% of NE & SE MU)	**Negligible (Low)**
	Offshore ECC	0.4 (0.008% of NE & SE MU)	**Negligible (Low)**
	Total for Offshore Development area	0.4 (0.008% of NE & SE MU)	**Negligible (Low)**

563. As described in paragraph 403403, assuming that all marine mammals that are within 4km of a vessel, particularly for species other than harbour porpoise, would be disturbed from the entire area, is very precautionary. For the reasons set out in paragraph 403, it is not expected that there would be either a low magnitude of effect for harbour porpoise, common dolphin, white-beaked dolphin, minke whale or grey seal, and it would be more appropriate to consider a reduced magnitude of **negligible**. For bottlenose dolphin of the CES MU, it is not expected that there would be a high magnitude of effect, given that it is unlikely there would be up to six vessels within the small area at all times. Therefore, in line with the reasons as set out in paragraph 403403, it is more appropriate to consider a magnitude of **low** for bottlenose dolphin of the CES MU.

564. In summary, the magnitude of impact is considered to be **low** for bottlenose dolphin from the CES MU; and **negligible** in all other cases.

12.7.2.4.3 Effect Significance

565. For disturbance caused by O&M activities, it is predicted that the sensitivity of marine mammal receptors is **medium**, and the magnitude of impact is **negligible** for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, and **negligible** to **low** for bottlenose dolphin.

566. The effect significance for bottlenose dolphin is therefore **negligible** to **minor adverse** which is **not significant** in EIA terms, and for all other species is **negligible adverse** which is **not significant** in EIA terms (see **Section 12.7.1.4.3**).

567. The effect significances are provided in **Table 12-63**.

Table 12-63 Assessment of Effect Significance for O&M Vessel Disturbance at the Project

Species	Sensitivity	Magnitude (long-term effect)	Effect Significance
Harbour porpoise	**Medium**	**Negligible**	**Not Significant (minor adverse)**
Bottlenose dolphin	**Medium**	**Low**	
Common dolphin	**Medium**	**Negligible**	**Not Significant (negligible adverse)**
White-beaked dolphin	**Medium**	**Negligible**	**Not Significant (minor adverse)**
Minke whale	**Medium**	**Negligible**	
Grey seal	**Medium**	**Negligible**	
Harbour seal	**Medium**	**Negligible**	**Not Significant (negligible adverse)**

12.7.2.5 Underwater Noise: Barrier Effects (MM-O-07)

568. As assessed for construction (**Section 12.7.1.5**), no barrier effects as a result of underwater noise during O&M are anticipated. As outlined in **Section 12.7.2.2**, animals have not been observed to be excluded from the operational array area. On the contrary, some species like seals specifically target the array are to forage.

12.7.2.5.1 Receptor Sensitivity

569. In line with their sensitivity to disturbance from underwater noise, the sensitivity of marine mammals is therefore considered to be **medium** for all marine mammal species.

12.7.2.5.2 Impact Magnitude

570. Observations by Leemans & Fijn (2023) in the Dutch North Sea revealed that harbour porpoise presence significantly decreased with proximity to wind turbines, stabilising at 500 meters. The report suggests that this avoidance is likely due to noise and occurs only at close range.

571. Furthermore, aerial imagery data indicated no significant difference in porpoise densities within the wind farm corridor, its border, or inside the OWF (Leemans & Fijn, 2023). These results imply that underwater noise does not create a barrier across the entire wind farm but is limited to individual turbines. Additionally, the minimum spacing between wind turbines in the DBD Array Area would also allow marine mammals to travel in between and there would be no potential for underwater noise around individual wind turbines to overlap.

572. The magnitude to impact is therefore considered to be **negligible** for all marine mammal receptors.

12.7.2.5.3 Effect Significance

573. Overall, it is predicted that the sensitivity for all species is **medium**, and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

12.7.2.6 Disturbance at Seal Haul-Out Sites (MM-O-08)

574. During construction (**Section 12.7.1.6**), it was assessed that underwater noise from piling and other activities in the DBD Array Area would not directly impact seals at haul-out sites due to the significant distance to shore (21 0km). It should also be noted that noise generated during O&M activities would be lower compared to the construction period.

575. Similarly, the annual vessel traffic that could potentially be passing seal haul-out sites during the O&M phase is projected to be lower than that during the construction period (**Table 12-9**).

12.7.2.6.1 Receptor Sensitivity

576. Based on information outlined in **Section 12.7.1.6**, the sensitivity of grey and harbour seal is considered to be **low**.

12.7.2.6.2 Impact Magnitude

577. The evidence presented in **Section 12.7.1.6** indicates that the likelihood of seals at their haul-out sites to be disturbed from O&M activities and vessels is unlikely. **Section 12.7.1.6** further details that vessels have to be in very close proximity (several hundred metres) to the haul-out to induce disturbance behaviours, which again is unlikely to occur from vessels from the Project as they would not be so close to the coast when transiting.

578. The magnitude of impact is therefore considered to be **low**.

12.7.2.6.3 Effect Significance

579. Overall, it is predicted that the sensitivity of grey and harbour seal is **low** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which is **not significant** in EIA terms.

12.7.2.6.4 Best Practice

580. For details on best practice measures for vessel operators, see **Section 12.7.1.7.4** and Commitment IDs CO18 and CO28 in **Table 12-8**.

12.7.2.7 Vessel Interaction (Increase in Risk of Collision) (MM-O-09)

581. The increased risk of marine mammal collision with operational and maintenance vessels would be the same or less than what was assessed for the construction period (**Section 12.7.1.7**), given the number of vessels required would be lower.

582. During the O&M phase, the maximum number of vessels that could be present in the Project offshore components at any one time has been estimated as 16 vessels (**Table 12-9**). The number, type and size of vessels would vary, depending on the activities taking place at any given time. These vessels are typically slow-moving or stationary.

583. As outlined in **Chapter 15 Shipping and Navigation**, on average there were six transits per day during the 14-day survey in 2023, and four transits each day during the 40-day survey in 2024 that intersected the shipping and navigation Study Area (DBD Array Area and a 10nm buffer).

12.7.2.7.1 Receptor Sensitivity

584. Detailed information regarding vessel collision risk with marine mammals is outlined in **Section 12.7.1.7.** Marine mammals can typically avoid vessels due to their high mobility. However, if an individual receptor were to collide with a vessel, there is the potential for it to have a very limited capacity to recover from the worst-case impact.

585. Given the existing levels of marine traffic, marine mammals in and around the DBD Array Site would typically be habituated to the presence of vessels and would be able to detect and avoid vessels.

586. The sensitivity of marine mammals is considered to be **medium** for minke whale, and **low** for all other species.

12.7.2.7.2 Impact Magnitude

587. A detailed literature review regarding vessel collision risk with marine mammals is outlined in **Section 12.7.1.7** and would be unchanged for O&M vessels.

588. The magnitude of impact is therefore considered to be **low** for all marine mammal species.

12.7.2.7.3 Effect Significance

589. Overall, it is predicted that the sensitivity for marine mammals is **low** to **medium** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which is **not significant** in EIA terms.

12.7.2.7.4 Best Practice

590. See **Section 12.7.1.7.4** for details on best practice measures for vessel operators (see Commitment IDs CO18 and CO28 in **Table 12-8**).

12.7.2.8 Changes to Prey Resource (MM-O-10)

591. Any changes to prey resources, such as fish and shellfish, during O&M would be less than those assessed for construction (**Section 12.7.1.8**).

592. Any impacts on prey species have the potential to affect marine mammals. As outlined in **Chapter 11 Fish and Shellfish Ecology**, the potential impacts on fish species during O&M could result from:

- Temporary habitat loss / physical disturbance (FSE-O-02);
- Habitat loss / alteration (FSE-O-03);
- Increased suspended sediment and sediment redeposition (FSE-O-04);
- Remobilisation of contaminated sediments if present - offshore ECC (FSE-O-06);
- Underwater noise and vibration (FSE-O-07);
- Changes in fishing pressure (FSE-O-08);
- EMF effects (FSE-O-09);
- Sediment heating from export cables (FSE-O-10); and
- Introduction of hard substrate (FSE-O-11).

593. Due to the interaction between prey and marine mammals, the effect significances on fish receptors have been extracted from **Chapter 11 Fish and Shellfish Ecology** and form the basis of the magnitude assessment for marine mammals.

12.7.2.8.1 Receptor Sensitivity

594. Detailed information is outlined in **Section 12.7.1.8**. The sensitivity of dolphin species and seal species is considered to be **low**. The sensitivity of harbour porpoise and minke whale is considered to be **low** to **medium**.

12.7.2.8.2 Impact Magnitude

12.7.2.8.2.1 Temporary Habitat Loss / Physical Disturbance and Increased Suspended Sediment and Sediment Re-Deposition and Remobilisation of Sediments if Present - Offshore Export Cable Corridor

595. Seabed disturbance may be disturbed by maintenance activities, for example when conducting repairs on cables. The extent to which this may occur is lower than that for the construction phase but would occur as intermittent (short term) events throughout the 35-year operational period of the Project. As outlined in **Section 9.6.1.1** of **Chapter 9 Marine Sediment and Water Quality**, recent sediment survey results show that the sediment contamination within the offshore ECC is **negligible** and thus there is no pathway of effect.

596. Based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact on fish species is considered to be **minor adverse**, which is **not significant** in EIA terms.

597. The magnitude of impact for marine mammals is therefore considered to be **negligible**.

12.7.2.8.2.2 Habitat Loss / Alteration

598. As outlined in **Table 12-9**, the worst-case area of total habitat loss due to the footprint of infrastructure within the DBD Array Area is $2.07km^2$, including wind turbines, OSP(s), scour protection and cable protection. This represents approximately <0.01% of seabed habitat in the DBD Array Area ($262km^2$). The estimated loss of habitat within the Offshore ECC is $1.80km^2$, representing <0.01% of the offshore ECC.

599. Based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact on fish species is considered to be minor adverse, which **is not significant** in EIA terms.

600. The magnitude of impact for marine mammals is therefore considered to be **negligible**.

12.7.2.8.2.3 Underwater noise and vibration

601. As outlined in **Volume 2, Appendix 12.3 Underwater Noise Modelling Report** and **Chapter 11 Fish and Shellfish Ecology**, the risk of recoverable injury or TTS from continuous underwater noise exposure from operational turbines is minimal. A highly sensitive fish receptor would need to remain within 50m of an operational turbine for 48 hours in order for a recoverable injury threshold to breached.

602. For other for maintenance activities (e.g. rock placement) and vessels, the impact ranges were also less than 50m for recoverable injury and TTS.

603. Based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact on fish species is considered to be of **minor adverse** significance, which is **not significant** in EIA terms.

604. The magnitude of impact for marine mammals is therefore considered to be **negligible**.

12.7.2.8.2.4 Changes in Fishing Pressure

605. As outlined in **Chapter 14 Commercial Fisheries**, there is potential for commercial fishing activity (using static gear or pelagic trawls) to be displaced from within the DBD Array Area, due to presence of the subsurface structures. However, fishing activity is expected to return to some degree during operation. To note, that all bottom-towed gear across the Dogger Bank SAC is prohibited as per the introduction of the Dogger Bank byelaw in 2022. Further, the level of fishing within the DBD Array Area is relatively low, and as discussed in **Chapter 14 Commercial Fisheries**, no significant displacement effects are identified during Operation.

606. Based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact on fish species is considered to be of **minor adverse** significance, which is **not significant** in EIA term.

607. The magnitude of effect for marine mammals is therefore considered to be **negligible**.

12.7.2.8.2.5 Electromagnetic Field Effects

608. The Project would transmit energy produced along the network of inter-array and export cables, linking the individual wind turbines, wind turbines to the OSP(s), and the OSP(s) to landfall. As energy is transmitted, the cables emit low-energy EMF. The electrical and magnetic fields generated increase proportionally to the amount of electricity transmitted.

609. Common practice is to bury the cables, and by doing so, the magnetic field at the seabed is reduced due to the distance between the cable and the seabed surface as a result of field decay with distance from the cable (CSA Ocean Sciences Inc. and Exponent 2019). Cables would be buried to a depth range of minimum 0.2m to a maximum of 2.5m (with potential for 1m overburial to 3.5m depth) where conditions allow, substantially reducing the levels of EMF in the surrounding area. Where cable burial is not possible, for example due to hard substrate or for cable crossings, protection would be added to reduce the levels of EMF.

610. There would be no direct effects of EMF on marine mammals. While demersal fish such as cod, (blue) whiting, and sandeel lack electromagnetic receptors to detect EMF, migratory and pelagic species might experience navigation interference due to EMF, potentially affecting the speed and / or direction of their movements (refer to **Chapter 11 Fish and Shellfish Ecology** for further information).

611. Given the small area around the cables where the presence of EMF may be detected by fish, contact with EMF would be limited. In the context of the wider available habitat, and based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact to fish species is considered to be **minor adverse**, which is **not significant** in EIA terms.

612. The magnitude of impact for marine mammals is therefore considered to be **negligible**.

12.7.2.8.2.6 Sediment Heating from Export Cables

613. Operational cables may cause localised heating of surrounding sediment, but this is limited to distances of tens of cm and meaningful effects at the population scale are unlikely for all receptors. Effects of sediment warming is specifically related to buried sandeel (refer to **Chapter 11 Fish and Shellfish Ecology** for further information).

614. Although sandeel specifically is a favoured prey species of harbour porpoise (see **Volume 2, Appendix 12.2 Marine Mammals Technical Report** for details on diet) and based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact is considered to be of **minor adverse** significance, which is **not significant** in EIA terms and would not affect the diet of harbour porpoise.

615. The magnitude of impact of marine mammals is therefore considered to be **negligible**.

12.7.2.8.2.7 Introduction of hard substrate

616. Man-made structures introduced to the marine mammals Study Area such as foundations and scour protection may be colonised by a range of benthic invertebrate species. The introduction of this hard substrate in predominantly soft sediment areas increases and changes habitat availability and type, potentially increasing ecological diversity at a local level, by acting as an artificial reef, and with the potential to act as fish aggregating devices.

617. The worst-case area of hard substrate within Study Area that is expected to be introduced and has the potential to be colonised is approximately 3.73km^2.

618. It is important to recognise that this impact could be considered as beneficial, depending on the species being considered. However, to reflect the fact that any impact represents a change from what might be considered natural or baseline conditions, a precautionary approach is to assume that the impact may be adverse.

619. However, this effect could have a positive effect on marine mammals through potential additional prey resources. Several studies have identified that there was an increase in acoustic activity of harbour porpoise inside the operating wind farm which may have been attributed to the reef effect, attracting more prey species (Scheidat *et al.,* 2011; Leemans & Fijn, 2023). Immediately after decommissioning activities at oil and gas structure, high porpoise activity was recorded, and it was suggested that the removal of benthic structures was attracting fish (Fernandez-Betelu *et al.,* 2024). A possibility is that the turbines have a sheltering effect from heavy ship traffic (Scheidat *et al.,* 2011).

620. Based on **Chapter 11 Fish and Shellfish Ecology**, the effect significance of this impact on fish species is considered to be **minor adverse**, which is **not significant** in EIA terms.

621. The magnitude of impact for marine mammals is therefore considered to be **negligible**.

12.7.2.8.3 Effect Significance

622. Overall, it is predicted that the sensitivity for dolphins and seals is **low**, and the magnitude of impact is **negligible** in all cases. Therefore, for dolphin and seal species, the overall effect is **negligible adverse** which is **not significant** in EIA terms.

623. For harbour porpoise and minke whale, the sensitivity is **low** to **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

12.7.2.9 Changes to Water Quality (Sediment Bound Contaminants in the Offshore Export Cable Corridor) (MM-O-12)

624. As outlined in **Chapter 9 Marine Water and Sediment Quality**, potential changes in water quality could occur during O&M as a result of the re-mobilisation of existing contaminated sediment in the offshore ECC due to scour and routine maintenance (MWS-O-02).

12.7.2.9.1 Receptor Sensitivity

625. The sensitivity of marine mammals is as outlined in **Section 12.7.1.8.3**, and is therefore considered to be **negligible**.

12.7.2.9.2 Impact Magnitude

626. As outlined in **Chapter 9 Marine Water and Sediment Quality**, recent sediment survey results show that the sediment contamination within the ECC is **negligible**. Therefore, should sediment be disturbed during any phase of the Project, there is no pathway for effect.

627. The magnitude of impact for marine mammals is therefore considered to be **negligible**.

12.7.2.9.3 Effect Significance

628. Overall, it is predicted that the sensitivity for all marine mammal receptors is **negligible,** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

12.7.2.10 Physical Barrier Effects (MM-O-13)

629. The presence of a wind farm could be perceived as a physical barrier, potentially hindering the movement or migration of marine mammals between important feeding and breeding areas. Additionally, if marine mammals choose to avoid the site, it could result in increased swimming distances as they navigate around it.

12.7.2.10.1 Receptor Sensitivity

630. In line with disturbance from underwater noise (see **Section 12.7.1.4.1**), the sensitivity of marine mammals is considered to be **medium** for all marine mammal species.

12.7.2.10.2 Impact Magnitude

631. As detailed in **Section 12.7.1.5** and **Section 12.7.2.5,** there is no evidence of either the underwater noise or the turbines themselves exclude animals from OWF (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).

632. Research by Fernandez-Betelu *et al (*2022) found that the investigated offshore structures (oil and gas platforms and Beatrice Demonstrator platform) attracted harbour porpoises and therefore played an important role as foraging areas. It was unclear if the turbines were operational, but nonetheless, the structure itself was not hindering animals to travel. Scheidat *et al (*2011) inferred similar findings from increased acoustic activities of harbour porpoise between pre-construction and O&M phase of the Egmond aan Zee OWF.

633. According to Leemans & Fijn (2023), harbour porpoise was recorded year-round within the OWFs, with occasional foraging behaviour noted (though this behaviour was recorded incidentally). While there was some avoidance around individual turbines (~500m), porpoise densities were similar within the wind farm corridor, at the border, and inside the OWFs.

634. The DBD Array Area is not hindering or restricting any marine mammal receptor to travel into any direction due to its offshore location and the space between Project and the coast (210km). The minimum spacing between wind turbines (**Table 12-9**Table 12-9) would allow marine mammals to move between turbines and through the operational wind farm site.

635. The magnitude of impact is therefore considered to be **negligible**.

12.7.2.10.3 Effect Significance

636. Overall, it is predicted that the sensitivity is **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

12.7.3 Potential Effects during Decommissioning

637. No decision has been made regarding the final decommissioning strategy for the offshore infrastructure, as it is recognised that regulatory requirements and industry best practice change over time.

638. Commitment ID CO21 (see **Volume 2, Appendix 6.3 Commitments Register**) requires an Offshore Decommissioning Plan to be prepared and agreed with the relevant authorities prior to the commencement of offshore decommissioning works. This will ensure that decommissioning marine mammal impacts will be assessed in accordance with the applicable regulations and guidance at that time of decommissioning where relevant, with appropriate mitigation implemented as necessary to avoid significant effects.

639. The detailed activities and methodology for decommissioning will be determined later within the Project's lifetime, but would be expected to include:

- Removal of all the wind turbine components and part of the foundations (those above seabed level);
- Removal of some or all of the array and export cables; and
- The Inter-Array and Offshore Export Cables will likely be cut at the cable ends and left in-situ below the seabed, and scour and cable protection would likely be left in-situ other than where there is a specific condition for its removal.

640. Whilst a detailed assessment of decommissioning impacts cannot be undertaken at this stage, for this assessment, it is assumed that decommissioning is likely to operate within the parameters identified for construction (i.e. any activities are likely to occur within the temporary construction working areas and require no greater amount or duration of activity than assessed for construction). The decommissioning sequence will generally be the reverse of the construction sequence. It is therefore assumed that decommissioning impacts would likely be of similar nature to, and no worse than, those identified during the construction phase.

641. The magnitude of decommissioning effects will be comparable to, or less than, those as assessed during the construction phase. Accordingly, given that all effects were assessed to be **minor adverse** significance, or less, for the identified commercial fisheries receptors during the construction phase, it is anticipated that the same would be valid for the decommissioning phase regardless of the final decommissioning methodologies. Therefore, all would be considered as **not significant** in EIA terms.

642. It is not possible to provide details of the methods that would be used during decommissioning at this time. However, is it expected that the activity levels would be comparable to construction (with the exception of pile driving noise, which would not occur).

643. During decommissioning, the potential effects on marine mammals are anticipated to be similar, or less, than the worst-case assessment for the construction phase, noting no piling (or UXO clearance) would be required. The overall level of effect would depend on the decommissioning methods used.

12.8 Cumulative Effects

644. Cumulative effects are the result of the impacts of the Project acting in combination with the impacts of other proposed and reasonably foreseeable developments on receptors. This includes plans and projects that are not inherently considered as part of the current baseline.

645. The overarching framework used to identify and assess cumulative effects is set out in **Chapter 6 Environmental Impact Assessment Methodology**. The four-stage approach is based upon the Planning Inspectorate Advice Note Seventeen: CEA (Planning Inspectorate, 2024) and the Offshore Wind Marine Environmental Assessments: Best Practice Advance for Evidence and Data Standards (Parker *et al.,* 2022). The fourth stage of the process is the assessment stage, which is detailed within the sections below for potential cumulative effects on marine mammal receptors.

646. Further information on marine mammal-specific methodologies / assumptions are provided in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**.

12.8.1 Screening for Potential Cumulative Effects

647. The first step of the CEA identifies which impacts associated with the Project alone, as assessed under **Section 12.7**, have the potential to interact with other plans and projects to give rise to cumulative effects. All potential cumulative effects to be taken forward in the CEA are detailed in **Table 12-64** with a rationale for screening in or out. Only impacts determined to have a residual effect of **negligible** or greater are included in the CEA. Those assessed as 'no impact' are excluded, as there is no potential for them to contribute to a cumulative effect.

Table 12-64 Marine Mammals – Potential Cumulative Effects

Impact ID	Impact and Project Activity	Potential for Cumulative Effects	Rationale
Construction			
MM-C-01 MM-C-05	Underwater noise: physical and auditory injury – from impact piling during construction Underwater noise: physical and auditory injury resulting from noise associated with other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Sections 12.5.3.1** and **12.5.3.2** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-C-02 MM-C-06	Underwater noise: behavioural impacts – from impact piling during construction Underwater noise: behavioural impacts resulting from other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap in construction periods which could have a cumulative effect in relation to disturbance to marine mammals caused by underwater noise (see **Sections 12.5.3.2** and **Table 12-2** in **Volume 2, Appendix 12.4 Cumulative Assessment Screening** for the activities and projects screened in).
MM-C-07	Barrier effects due to underwater noise – from piling activities and other construction activities, and presence of vessels offshore	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Section 12.5.3.3** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-C-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap in construction periods which could have a cumulative effect in relation to disturbance at seal haul-out sites.
MM-C-09	Vessel interaction (increase in risk of collision) – from vessel movement relating to all aspects of construction of the project	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap in construction periods which could have a cumulative effect in relation to an increase in vessel collision risk due to an overall increase in vessels.
MM-C-10	Changes to prey resource – from construction of wind turbines, cables and foundations	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap in construction periods which could have a cumulative effect in relation to changes to prey resources.
MM-C-12	Changes to water quality (sediment bound contaminants in the offshore ECC – from installation of cables and foundations	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Section 12.5.3.6** and **Section 12.5.3.2** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
Operation and Maintenance			
MM-O-03 MM-O-05	Underwater noise: physical and auditory injury – from operational and maintenance noise, operation of wind turbines Underwater noise: physical and auditory injury from noise associated with maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Section 12.5.3.1** and **Section 12.5.3.2** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-O-04 MM-O-06	Underwater noise: behavioural impacts – from operation of wind turbines Underwater noise: behavioural impacts from maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	Yes	There is potential for O&M vessels at other plans and projects to have a cumulative effect in relation to disturbance to marine mammals. No potential for cumulative impact has been identified for maintenance activities or operational turbine noise, and these pathways have therefore been screened out from the CEA. See **Sections 12.5.4.1** and **Section 12.5.4.2** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.

Impact ID	Impact and Project Activity	Potential for Cumulative Effects	Rationale
MM-O-07	Barrier effects due to underwater noise – from underwater noise due to the operation of the wind turbines, as well as disturbance associated with underwater noise from O&M activities along with the presence of vessels offshore	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Section 12.5.3.3** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-O-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap with the operation of DBD which could have a cumulative effect in relation to disturbance at seal haul-out sites.
MM-O-09	Vessel interaction (increase in risk of collision) – from all vessel movements relating to operation and maintenance activities	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap with the operation of DBD which could have a cumulative effect in relation to an increase in vessel collision risk due to an overall increase in vessels.
MM-O-10	Changes to prey resource – from presence of wind turbines, cables and foundations	Yes	Depending on the construction timetable for other OWFs, there is potential for temporal overlap with the operation of DBD which could have a cumulative effect in relation to changes to prey resources.
MM-O-12	Changes to water quality (sediment bound contaminants in the offshore ECC) – from presence of cables and foundations	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Section 12.5.3.6** and **Section 12.5.3.2** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-O-13	Physical Barrier Effect – from presence of wind farm infrastructure	No	No potential for cumulative impact has been identified and has therefore been screened out from the CEA. See **Section 12.5.3.6** and **Section 12.5.3.2** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
Decommissioning			
MM-D-05	Underwater noise: physical and auditory injury – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-D-06	Underwater noise: behavioural impacts – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-D-07	Underwater noise: barrier effects – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-D-08	Disturbance at seal haul-out sites – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-D-09	Vessel interaction (increase in risk of collision) – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-D-10	Changes to prey resource – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.
MM-D-12	Changes to water quality (Sediment bound contaminants in the offshore ECC) – decommissioning activities not yet defined.	No	No potential for cumulative impact has been identified and has therefore been screened out form the CEA. See **Section 12.5.4.4** of **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for more information.

12.8.2 Screening for Other Plans / Projects

648. The second step of the CEA identifies a short-list of other plans and projects that have the potential to interact with the Project to give rise to significant cumulative effects during the construction and O&M phases. The short-list provided in **Table 12-65** has been produced specifically to assess cumulative effects on marine mammal receptors. The exhaustive list of all offshore plans and projects considered in the development of the Project's CEA framework is provided in **Volume 2, Appendix 6.2 Impacts Register**.

649. Developments that were fully operational during baseline characterisation, including at the time of site-specific surveys, are considered as part of baseline conditions for the surrounding environment. It is assumed that any residual effects associated with these developments are captured within the baseline information. As such, these developments are not subject to further assessment within the CEA and excluded from the screening exercise presented in **Table 12-65**.

650. For developments that were not fully operational, including those in planning / pre-construction stages or under construction, during baseline characterisation and operational developments with potential for ongoing impacts, these are included in the screening exercise presented in **Table 12-65**.

651. The screening exercise has been undertaken based on available information on each plan or project as of 09.12.2024. Information has been obtained from the Planning Inspectorate's NSIP portal, and MMO's marine licence register) and directly from other developer websites. It is noted that further information regarding the identified plans and projects may become available between PEIR publication and DCO application submission or may not be available in detail prior to construction. The assessment presented here is therefore considered to be conservative at the time of PEIR publication. The list of plans and projects will be updated at ES stage to incorporate more recent information at the time of writing.

652. Plans and projects identified in **Table 12-65** have been assigned a tier based on their development status, the level of information available to inform the CEA and the degree of confidence. A seven-tier system based on the guidance issued by Natural England and Defra has been adopted (Parker *et al.,* 2022).

653. The Zone of Influence (ZoI) used to identify relevant plans and projects for the marine mammals CEA (see Figure 12.5.1 in **Volume 2, Appendix 12.5 Marine Mammals Cumulative Assessment Screening**) is based on:

- The NS MU for harbour porpoise, white-beaked dolphin, common dolphin, and minke whale;
- The CES and GNS MU for bottlenose dolphin; and
- The NE and SE MU for both seal species.

654. Each plan or project in **Table 12-65** has been considered on a case-by-case basis. Only plans and projects with potential for significant cumulative effects with the Project are taken forward to a detailed assessment, which are screened based on the following criteria:

- There is potential that a pathway exists whereby an impact could have a cumulative effect on a receptor;
- The impact on a receptor from the Project and the plan or project in consideration has a spatial overlap (i.e. occurring over the same area);
- The impact on a receptor from the Project and the plan or project in consideration has a temporal overlap (e.g. occurring at the same time);
- There is sufficient information available on the plan or project in consideration and moderate to high data confidence to undertake a meaningful assessment; and
- There is some likelihood that the residual effect (i.e. after accounting for mitigation measures) of the Project could result in significant cumulative effects with the plan or project in consideration.

655. The CEA for marine mammals has identified a total of 28 plans and projects where significant cumulative effects could arise in combination with the Project. A detailed assessment of cumulative effects is provided in the section below.

Table 12-65 Short List of Plans / Projects Screened in for the Marine Mammals Cumulative Effect Assessment

Project / Plan	Development Type	Status	Tier	Construction / Operational Period	Closest Distance to Array Area (km)	Closest Distance to Offshore ECC (km)	Potential for Significant Cumulative Effects	Rationale
Caledonia (00011015)	Offshore Wind Farm	Pre-Planning	6	Construction: 2028 to 2030 Operation: 2030	448	377	Yes	Potential for spatial and temporal overlap of construction activities in the array areas
Dogger Bank South (DBS) (East) (EN010125)	Offshore Wind Farm	Pre-Examination	1	Construction: 2027 to 2031 Operation: 2033	71	46	Yes	Potential for spatial and temporal overlap of construction activities in the array areas
DBS (West) (EN010125)	Offshore Wind Farm	Pre- Examination	1	Construction: 2027 to 2031 Operation: 2033	79	16	Yes	Potential for spatial and temporal overlap of construction activities in the array areas.
Dudgeon Extension (EN010109)	Offshore Wind Farm	Consented	3	Construction: 2028 to 2030 Operation: 2030	202	101	Yes	Potential for spatial and temporal overlap of construction activities in the array areas
Five Estuaries (EN010115)	Offshore Wind Farm	Application Submitted	4	Construction: 2028 to 2030 Operation: 2030	330	263	Yes	Potential for spatial and temporal overlap of construction activities in the array areas.
Nordsee Cluster B - N-3.5	Offshore Wind Farm	Pre-construction	3	Construction: 2028 to 2029 Operation: 2029	260	285	Yes	Potential for spatial and temporal overlap of construction activities in the array areas
Nordsee Cluster B - N-3.6	Offshore Wind Farm	Pre-construction	3	Construction: 2028 to 2029 Operation: 2029	260	285	Yes	Potential for spatial and temporal overlap of construction activities in the array areas.
North Falls (EN010119)	Offshore Wind Farm	Pre-Examination	4	Construction: 2027 to 2030 Operation: 2030	333	254	Yes	Potential for spatial and temporal overlap of construction activities in the array areas
Outer Dowsing (EN010130)	Offshore Wind Farm	Examination	4	Construction: 2026 to 2030 Operation: 2030	170	77	Yes	Potential for spatial and temporal overlap of construction activities in the array areas.
Rampion 2 (EN010117)	Offshore Wind Farm	Application Submitted	4	Construction: 2027 to 2030 Operation: 2030	523	363	Yes	Potential for spatial and temporal overlap of construction activities in the array areas

Project / Plan	Development Type	Status	Tier	Construction / Operational Period	Closest Distance to Array Area (km)	Closest Distance to Offshore ECC (km)	Potential for Significant Cumulative Effects	Rationale
Sheringham Shoal Extension (EN010109)	Offshore Wind Farm	Consented	3	Construction: 2028 to 2030 Operation: 2030	224	108	Yes	Potential for spatial and temporal overlap of construction activities in the array areas.
West Of Orkney	Offshore Wind Farm	Application Submitted	4	Construction: 2028 to 2029 Operation: 2029	578	508	Yes	Potential for spatial and temporal overlap of construction activities in the array areas
Sea Link (EN020026)	Sub-sea Cable	Pre-Planning	6	Construction: 2026 to 2030 Operation: 2030	342	275	Yes	Potential for spatial and temporal overlap of construction activities in the array areas.
Greenwich Light East 473/1	Aggregate / Dredging Project	Active	1	License start: 2021 License end: 2036	556	481	Yes	Potential for cumulative disturbance with piling activities at the Project
Greenwich Light East 473/2	Aggregate / Dredging Project	Active	1	License start: 2021 License end: 2036	547	474	Yes	Potential for cumulative disturbance with piling activities at the Project
Inner Dowsing 481/1-2	Aggregate / Dredging Project	Active	1	License start: 2023 License end: 2038	238	95	Yes	Potential for cumulative disturbance with piling activities at the Project
Inner Owers North 488	Aggregate / Dredging Project	Active	1	License start: 2023 License end: 2038	598	535	Yes	Potential for cumulative disturbance with piling activities at the Project
Thames D 524	Aggregate / Dredging Project	Active	1	License start: 2022 License end: 2036	300	360	Yes	Potential for cumulative disturbance with piling activities at the Project
West Bassurelle 458	Aggregate / Dredging Project	Active	1	License start: 2022 License end: 2037	460	529	Yes	Potential for cumulative disturbance with piling activities at the Project
West Bassurelle 464	Aggregate / Dredging Project	Active	1	License start: 2022 License end: 2037	460	529	Yes	Potential for cumulative disturbance with piling activities at the Project
Dogger Bank A (EN010021)	Offshore Wind Farm	Under construction	2	Construction: 2022 to 2023 Operation: 2024	43	31	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.

Project / Plan	Development Type	Status	Tier	Construction / Operational Period	Closest Distance to Array Area (km)	Closest Distance to Offshore ECC (km)	Potential for Significant Cumulative Effects	Rationale
Dogger Bank B (EN010021)	Offshore Wind Farm	Under construction	2	Construction: 2023 to 2024 Operation: 2025	52	9	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.
Dogger Bank C	Offshore Wind Farm	Under construction	2	Construction: 2024 to 2025 Operation: 2026	0	3	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.
Hornsea Project Four (EN010098)	Offshore Wind Farm	Consented	3	Construction: 2026 to 2028 Operation: 2028	134	31	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.
Hornsea Project Three (EN010080)	Offshore Wind Farm	Pre-construction	3	Construction: 2024 to 2027 Operation: 2027	106	107	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.
Hornsea Project Two (EN010053)	Offshore Wind Farm	Active	1	Construction: n/a Operation: 2022	121	63	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.
Sofia (EN010051)	Offshore Wind Farm	Under construction	2	Construction: 2024 to 2026 Operation: 2026	18	23	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.
Triton Knoll (EN010005)	Offshore Wind Farm	Active	1	Construction: n/a Operation: 2022	206	68	Yes	Potential for spatial and temporal overlap of vessel-related O&M effects.

12.8.3 Assessment of Cumulative Effects

12.8.3.1 Cumulative Impact 1: Behavioural Impacts Resulting from Other Projects and Activities (MM-C-02)

656. Following the initial screening of UK and European OWFs (see **Volume 2, Appendix 12.5 Cumulative Assessment Screening** for further details), twelve OWF projects (**Table 12-65**) were identified to overlap in construction window with the possibility in an overlap of their piling programme (**Table 12-66**).

Table 12-66 Summary of Projects Screened in for Overlap with Piling at the Project and Relevant Species Assessed within Each Project's ES (✓ = Included in Quantified CEA, ✓= Also Included in iPCoD population modelling)

Project	Marine mammal species screened in for						
	Harbour porpoise	Bottlenose dolphin[6]	Common dolphin	White-beaked dolphin	Minke whale	Grey seal	Harbour Seal
The Project	✓	✓	✓	✓	✓	✓	✓
DBS (East)	✓	✓	✓	✓	✓	✓	✓
DBS (West)	✓	✓	✓	✓	✓	✓	✓
Caledonia[7]	✓	✓	✓	✓	✓	×	×
Sheringham Shoal Extension	✓	✓	×	✓	✓	✓	✓
Dudgeon Extension	✓	✓	×	✓	✓	✓	✓
Five Estuaries	✓	×	×	×	×	✓	✓
Nordsee Cluster B - N-3.5[7]	✓	✓	✓	✓	✓	×	×
Nordsee Cluster B - N-3.6[7]	✓	✓	✓	✓	✓	×	×
North Falls	✓	×	×	×	✓	✓	✓
Outer Dowsing	✓	✓	×	✓	✓	✓	✓
Rampion 2	✓	✓	✓	×	✓	x	x
West Of Orkney	✓	×	✓	✓	✓	x	x

657. All screened in OWFs have the potential for an overlap in piling programmes with the Project, and therefore in all cases, piling is considered to be the worst-case activity included in the following assessments for OWFs. While other activities may take place at other OWFs at the same time as the Project, they would have smaller effect ranges than that of piling, and therefore the inclusion of piling represents the most precautionary approach. For the same reason, piling is included as the worst-case for the Project in all following assessments on the potential for disturbance.

658. In addition to piling at other OWFs, other noisy activities are occurring within the ZoI that could cause disturbances simultaneously with the piling at the Project. Therefore, this cumulative impact is divided into several assessment sections:

- **Cumulative Effect 1a: Disturbance from Piling at Other OWFs (Section 12.8.3.1.2)**: This section will present a quantified assessment of the twelve OWF projects overlapping with the piling at the Project, along with population modelling (iPCoD model) to evaluate the long-term consequences of the disturbance;
- **Cumulative Effect 1b: Disturbance from Other Industries and Activities (Section 12.8.3.1.3)**: This section will present a quantified assessment of other noisy activities occurring simultaneously with the piling at the Project. Of the following activities, offshore cables, aggregate extraction and dredging projects are the only activities known to occur with certainty, while the remaining activities (i., iii., iv.) are indicative only and timeframes are not known. The activities therefore included are:
  - i.) Geophysical Surveys;
  - ii.) Aggregate Extraction and Dredging ;
  - iii.) Seismic Surveys;
  - iv.) UXO Clearances; and

[6] Projects are screened in for the GNS MU only; none are within the CES MU

[7] No ESs available so all species (projects are outwith the seal screening area) were screened in for the quantitative assessment on a precautionary basis. These projects have not been included in the population modelling due to a lack of project specific information.

- v.) Sub-sea Cable Installation.

- **Cumulative Effect 1c: Disturbance from Other Industries and Activities (Section 12.8.3.1.4)**: Finally, this section presents a quantified assessment for the combined disturbance from piling at the Project and other OWFs, with all other industries and activities.

12.8.3.1.1 Receptor Sensitivity

659. As outlined in **Section 12.7.1.2.1**, the sensitivity for all species is considered to be **medium.**

12.8.3.1.2 1a) Disturbance from Piling at Other Offshore Wind Farms

12.8.3.1.2.1 Magnitude - Quantified Assessment

660. Within the following cumulative assessment, the potential disturbance effect from piling activities at the Project is based on the worst-case disturbance ranges for each marine mammal species that have been assessed in **Section 12.1.1.1.1**, as summarised in **Table 12-67**.

Table 12-67 Worst-Case Estimated Number of Marine Mammals to be Disturbed During Each Piling Event at DBD

Species	Number of animals disturbed during each piling event at the Project	Assessment method
Harbour porpoise	5,015	DRC (**Table 12-42**)
Bottlenose dolphin	67	DRC (**Table 12-42**)
Common dolphin	111	DRC (**Table 12-42**)
White-beaked dolphin	184	DRC (**Table 12-42**)
Minke whale	44	30km disturbance range (Richardson *et al.*, 1999) (**Table 12-40**Table 12-40)
Grey seal	184	DRC (**Table 12-42**)
Harbour seal	0.03	DRC (**Table 12-42**)

661. For all other OWF projects, the worst-case disturbance numbers are taken from the relevant ESs for the cumulative assessment wherever project specific data is available. Where project specific information is not available, a generic assessment approach has been used (as indicated by **Table 12-66**Table 12-66 above). For these OWF projects, densities for each species were used as outlined in **Volume 2, Appendix 12.5 Cumulative Assessment Screening** (**Section 12.5.2.3**), with the relevant generic disturbance distance for each species as outlined below:

- For harbour porpoise and dolphin species, any generic assessments for OWF piling is undertaken based on the 26km EDR as outlined in **Section 12.7.1.2.2.1.1** and **Section 12.7.1.2.2.1.2**;
- For minke whale, any generic assessments for OWF piling are undertaken based on the 30km disturbance range as outlined in **Section 12.7.1.2.2.1.3**; and
- For both grey and harbour seal, any generic assessments for OWF piling is undertaken based on the 25km disturbance range as outlined in **Section 12.7.1.2.2.1.4**.

662. As a worst-case scenario for the CEA, it is assumed that all wind turbines and OSP foundations at the Project are to be piled. It is also assumed that all other OWF projects would be fully (100%) piled, as a worst-case, if piled foundations were an option for wind turbines or OSP(s) for that project. It is also assumed there would be no spatial overlap of the disturbance areas between different projects. The assessment is therefore conservative.

663. The approach to the CEA for piling at OWFs considered the potential for single piling activity at each OWF to occur simultaneously with single piling at the Project. Both the Sheringham Shoal Extension (SEP) and Dudgeon Extension projects (DEP) and the DBS projects have been submitted as single DCO applications. In both cases, the individual projects are assessed for piling either in isolation as two separate projects, or concurrently as one project in their respective DCO applications. In December 2024, SEP and DEP announced they would proceed as one joint project, although this has not been reflected in this assessment due to the timing of the announcement. To account for a worst-case scenario, the following CEA therefore assumes that both the SEP and DEP, and the DBS projects (East and West) would pile in isolation, thus treating them as separate projects. It should be noted the in both cases, it would be expected that the two separate projects would be constructed as one due to the significant construction cost savings, and therefore it is likely there would be only one piling campaign (with one vessel) at each of SEP and DEP and the two DBS projects, therefore making the following assessment precautionary and worst-case.

664. It is important to note that the actual duration of active piling (based on 5.33 hours per pile for the Project), which could disturb marine mammals, constitutes only a very small proportion of the potential construction period. This is based on the estimated maximum duration to install individual piles (see **Table 12-45**). This means that there would be a limited window for any cumulative impact to occur.

665. The cumulative impact for marine mammal receptors for OWFs that could be undertaking piling activities at the same time as Project piling is provided in **Table 12-68**.

Table 12-68 Quantified CEA For the Potential Disturbance for all Marine Mammal Species During Single Piling at the OWF Projects Which Could Be Piling at the Same Time as the Project

Project	Generic approach		Source of project specific information	Maximum number of individuals potentially disturbed during single piling
	Density (/km²)	Impact area (km²)		
Harbour porpoise				
The Project	*N/A*		*DRC*	*5,014*
Caledonia[8]	0.2813	2,123.7	N/A	598
DBS (East)	N/A		ES[9]	4,295.5
DBS (West)	N/A		ES[9]	5,097.7
Dudgeon Extension	N/A		ES[10]	5,161
Five Estuaries	N/A		ES[11]	6,583
Nordsee Cluster B - N-3.5[8]	0.6158	2,123.7	N/A	1,308
Nordsee Cluster B - N-3.6[8]	0.6158	2,123.7	N/A	1,308
North Falls	N/A		ES[12]	6,832
Outer Dowsing	N/A		ES[13]	2,012
Rampion 2	N/A		ES (Rev F)[14]	752
Sheringham Shoal Extension	N/A		ES[10]	1,338
West of Orkney	N/A		ES[15]	1,349
Total number of harbour porpoise				41,648
Percentage of NS MU				12.29%
Magnitude of cumulative effect				**High**
Bottlenose dolphin				
The Project	*N/A*		*DRC*	*67*
Caledonia[8]	0*	2,123.7	N/A	-
DBS (East)	N/A		ES[9]	0.14
DBS (West)	N/A		ES[9]	0.10
Dudgeon Extension	N/A		ES[10]	0.012
Nordsee Cluster B - N-3.5[8]	0*	2,123.7	N/A	-
Nordsee Cluster B - N-3.6[8]	0*	2,123.7	N/A	-
Outer Dowsing	N/A		ES[13]	66
Rampion 2	N/A		ES (Rev F)[14]	126

[8] Assessments are based on the relevant SCANS-IV survey block (Gilles *et al.* 2023) for the project
[9] RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited (2024)
[10] Equinor (2022)
[11] Five Estuaries OWF Limited (2024)
[12] SSE & RWE (2024)
[13] Outer Dowsing Offshore Wind (2024)
[14] Rampion 2 Wind Farm (2024)
[15] Offshore Wind Power Limited (2023)

Project	Generic approach		Source of project specific information	Maximum number of individuals potentially disturbed during single piling
	Density (/km²)	Impact area (km²)		
Sheringham Shoal Extension	N/A		ES[10]	0.009
Total number of bottlenose dolphin				259.3
Percentage of GNS MU				12.82%
Magnitude of cumulative effect				**High**
Common dolphin				
The Project	*N/A*		*DRC*	*111*
Caledonia[8]	0*	2,123.7	N/A	-
DBS (East)	N/A		ES[9]	0.06
DBS (West)	N/A		ES[9]	0.04
Nordsee Cluster B - N-3.5[8]	0.0006	2,123.7	N/A	2
Nordsee Cluster B - N-3.6[8]	0.0006	2,123.7	N/A	2
Rampion 2	N/A		ES (Rev F)[14]	582
West of Orkney	N/A		ES[15]	90
Total number of common dolphin				787
Percentage of CGNS MU				0.77%
Magnitude of cumulative effect				**Negligible**
White-beaked dolphin				
The Project	*N/A*		*DRC*	*184*
Caledonia[8]	0.1352	2,123.7	N/A	288
DBS (East)	N/A		ES[9]	0.11
DBS (West)	N/A		ES[9]	0.09

Project	Generic approach		Source of project specific information	Maximum number of individuals potentially disturbed during single piling
	Density (/km²)	Impact area (km²)		
Dudgeon Extension	N/A		ES[10]	0.0024
Nordsee Cluster B - N-3.5[8]	0*	2,123.7	N/A	-
Nordsee Cluster B - N-3.6[8]	0*	2,123.7	N/A	-
Outer Dowsing	N/A		ES[13]	24
Sheringham Shoal Extension	N/A		ES[10]	0.0018
West of Orkney	N/A		ES[15]	1,709
Total number of white-beaked dolphin				2,205
Percentage of CGNS MU				5.02%
Magnitude of cumulative effect				**Medium**
Minke whale				
The Project	*0.0153*	*2,827.4*	*N/A*	*44*
Caledonia[8]	0.0116	2,827.4	N/A	33
DBS (East)	N/A		ES[9]	28.3
DBS (West)	N/A		ES[9]	56.5
Dudgeon Extension	N/A		ES[10]	11
Nordsee Cluster B - N-3.5[8]	0*	2,827.4	N/A	-
Nordsee Cluster B - N-3.6[8]	0*	2,827.4	N/A	-
North Falls	N/A		ES[12]	25
Outer Dowsing	N/A		ES[13]	25

Project	Generic approach		Source of project specific information	Maximum number of individuals potentially disturbed during single piling
	Density (/km²)	Impact area (km²)		
Rampion 2	N/A		ES (Rev F)[14]	8
Sheringham Shoal Extension	N/A		ES[10]	7.2
West of Orkney	N/A		ES[15]	90
Total number of minke whale				318
Percentage of CGNS MU				1.58%
Magnitude of cumulative effect				**Low**
Grey seal				
The Project	*N/A*		*DRC*	*184*
DBS (East)	N/A		ES[9]	3,124.2
DBS (West)	N/A		ES[9]	2,378.7
Dudgeon Extension	N/A		ES[10]	1,531.5
Five Estuaries	N/A		ES[11]	102
North Falls	N/A		ES[12]	138
Outer Dowsing	N/A		ES[13]	342
Sheringham Shoal Extension	N/A		ES[10]	1,769.1
Total number of grey seal				9,570
Percentage of NE & SE MU				16.94%
Magnitude of cumulative effect				**High**
Harbour seal				
The Project	*N/A*		*DRC*	*0.03*
DBS (East)	N/A		ES[9]	8.1

Project	Generic approach		Source of project specific information	Maximum number of individuals potentially disturbed during single piling
	Density (/km²)	Impact area (km²)		
DBS (West)	N/A		ES[9]	7.0
Dudgeon Extension	N/A		ES[10]	149
Five Estuaries	N/A		ES[11]	1
North Falls	N/A		ES[12]	7
Outer Dowsing	N/A		ES[13]	154
Sheringham Shoal Extension	N/A		ES[10]	510.5
Total number of harbour seal				836.8
Percentage of SE MU				16.76%
Magnitude of cumulative effect				**High**

* No marine mammal presence within relevant SCANS-IV survey block, and therefore effectively screened out of assessment

12.8.3.1.2.2 Cumulative Effect Significance – Quantified Assessment Only

666. As previously outlined, there are numerous caveats to consider when qualitatively assessing the effects of piling from multiple projects, as shown in **Table 12-68**Table 12-68. For instance, all included projects were assigned their worst-case disturbance numbers, while for others, no data was available, and a generic assessment approach was used. Although the DRC for harbour porpoise provides a more realistic scenario for piling disturbance, it is inappropriate to apply the DRC to other cetacean species with different or less sensitive hearing sensitivities. As highlighted in previous sections, the 26km EDR is a highly precautionary approach, whereas more recent findings at the Moray West OWF, through the results of the PrePARED[16] research, suggest a 10km EDR may be more appropriate (Benhemma-Le Gall *et al (*2024).

667. As a result of the quantified assessment, applied assumptions and potentially inflated numbers of animals, particularly for common and white-beaked dolphin, the overall impact assessment may be conservative, and any interpretations made need to have these caveats in mind. Furthermore, none of the projects included any noise abatement **(Section 12.2**) in their assessments which has the potential to reduce the number of individuals at risk.

668. The sensitivity for all marine mammal species is **medium**. For harbour porpoise, bottlenose dolphin, grey seal and harbour seal, based on this quantitative assessment approach, the magnitude of impact is **high**. The effect is therefore of **major adverse** significance, which is **significant** in EIA terms.

669. The magnitude of impact for common dolphin is **negligible** based on this quantitative assessment approach, and the overall effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

670. The magnitude of impact for white-beaked dolphin is **medium**. The effect is therefore of **moderate adverse** significance, which is **significant** in EIA terms.

671. The magnitude of impact is **low** for minke whale. The effect is therefore of **minor adverse** significance, which is **not significant** in EIA terms.

672. Mitigation and management of cumulative disturbance is discussed in **Section 776**.

673. Further assessment has been undertaken in the form of population modelling for harbour porpoise, bottlenose dolphin, grey seal and harbour seal, and is presented below in **Section 12.8.3.1.2.3**. For minke whale, modelling has also been undertaken as biological information is available.

12.8.3.1.2.3 Population Modelling due to Cumulative Disturbance

674. Population modelling has been conducted for harbour porpoise, bottlenose dolphin, minke whale, harbour seal and grey seal. The iPCoD framework (Harwood *et al.,* 2013, King *et al.,* 2015) was used to predict the potential medium- and long-term population consequences of the predicted amount of disturbance resulting from piling at the Project.

675. The model only has capacity to run simulations for species that have sufficient data on population-specific demographic rates and have undergone the expert elicitation process (Harwood *et al.,* 2013). This is essential in capturing how disturbance modifies the demographic rates and underpins the functioning of the model.

676. The iPCoD modelling methods, including key assumptions and chosen model inputs, are detailed in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance** in **Section 12.6.2**.

677. As outlined in **Section 12.7.1.2.2.5**, if, as a result of PTS, a population shows a continued decline of >1% per year (versus a modelled un-impacted reference population) over a set period of time (e.g. the first 6 years, based on the former FCS reporting period), then there is a high likelihood that a significant effect cannot be ruled out (NRW, 2023). It should also be noted that the results of the population modelling show the significance of a population level of effect, rather than a magnitude.

678. For context, for each species assessed, the estimated number of animals disturbed or potentially exposed to PTS for each monopile event are set out in **Table 12.6-5** in **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance**. The number of disturbed animals at the Project has been determined based on the worst-case assessment presented in Table 12-67. The worst-case for harbour porpoise, bottlenose dolphin, grey seal and harbour seal is the dose-response assessment, and for minke whale is the known disturbance ranges.

[16] PrePARED is a collaborative research project, funded by the Offshore Wind Evidence & Change programme and The Crown Estate Scotland. Find more information on the website https://owecprepared.org/.

12.8.3.1.2.3.1 Harbour Porpoise

679. Assuming a worst-case of ten projects to be overlapping in piling periods (including the Project) (**Table 12-66**), the iPCoD model estimated there to be only the slightest discernible impact to the harbour porpoise population (**Figure 12-10** and **Table 12-69**).

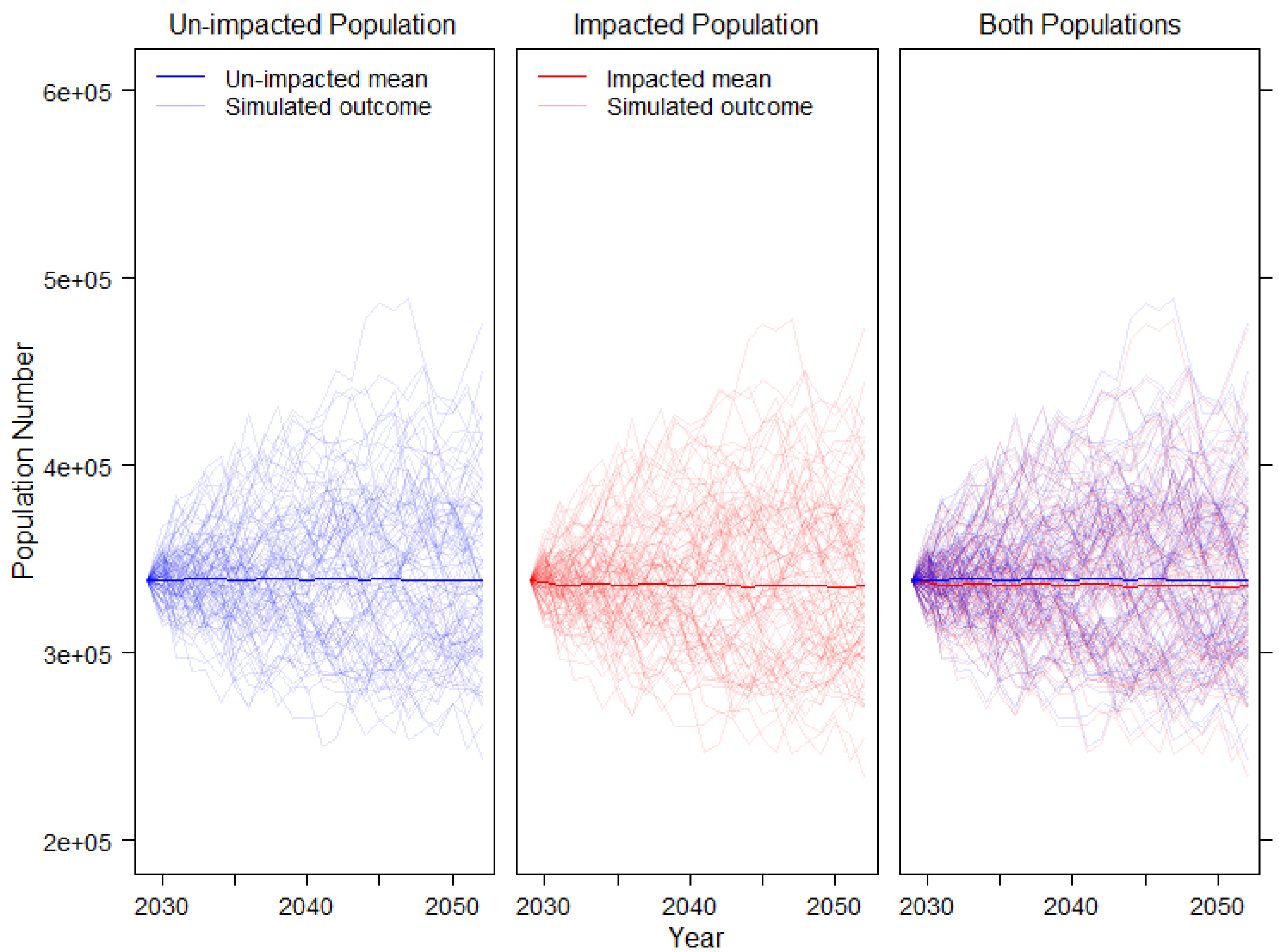

Figure 12-10 Simulated Worst-Case Harbour Porpoise Population Sizes for Both the Un-Impacted and the Impacted Population

680. The results from the cumulative disturbance effects of piling at the Project in combination with other projects have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-46**). There is a slight decline over the first six years (2029 to 2034 inclusive) of less than 1%. At the end of the modelling period, the impacted population has experienced a decline of 1.04% over the 25 years since piling first commenced. Whilst this is over a 25-year period, the results show a less than 1% average annual decline over the first six years and over the 25-year period for both the mean and median. Due to the slight reduction in population levels, the significance of effect is **minor** adverse which **is not significant** in EIA terms.

Table 12-69 Results of the iPCoD Modelling for the CEA, Giving the Mean Population Size for the Harbour Porpoise Population (NS MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted)
Start 2029	338,918	338,918	100.00%	**100.00%**	-
End 2030	338,603	337,888	99.79%	**99.75%**	<1%
End 2032	339,545	336,622	99.14%	**99.12%**	<1%
End 2034	340,099	337,358	99.19%	**99.11%**	<1%
End 2054	339,046	335,831	99.05%	**98.96%**	<2%

12.8.3.1.2.3.2 Bottlenose Dolphin

681. Assuming a worst-case of seven projects to be overlapping in piling periods (including the Project) (**Table 12-66**), the iPCoD model estimated there to be no noticeable impact to the bottlenose dolphin of the GNS population (**Table 12-70** and **Figure 12-11**).

Table 12-70 Results of the iPCoD Modelling for the CEA, Giving the Mean Population Size for the Bottlenose Dolphin Population (GNS MU) for Years up to 2056 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	2,024	2,024	100.00%	**100.00%**	-
End 2030	2,026	2,027	100.05%	**100.00%**	-
End 2032	2,028	2,030	100.10%	**100.20%**	-
End 2034	2,031	2,034	100.15%	**100.15%**	-
End 2054	2,032	2,036	100.20%	**100.30%**	-

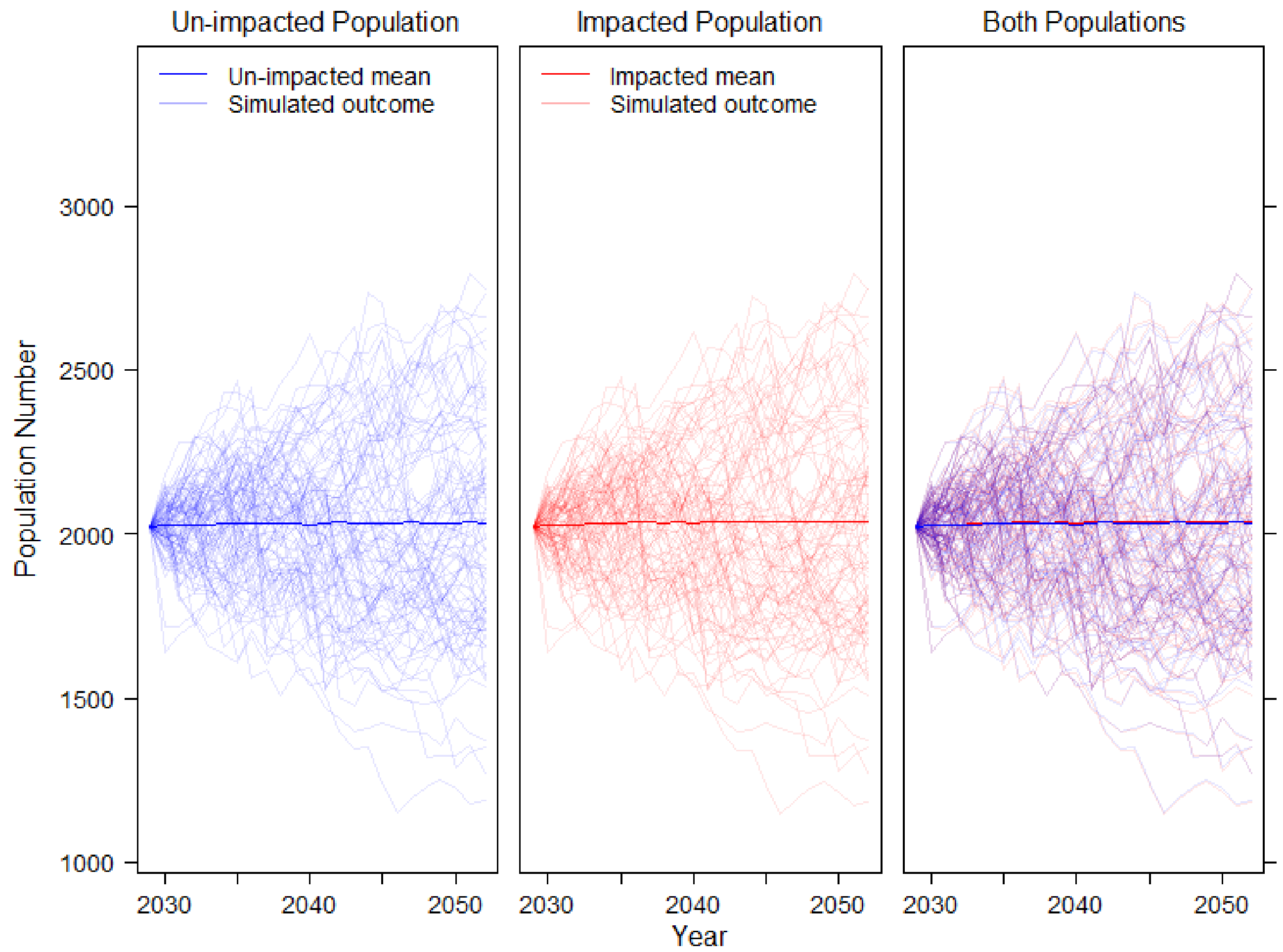

Figure 12-11 Simulated Worst-Case Bottlenose Dolphin (GNS MU) Population Sizes for Both the Un-Impacted and the Impacted Population

682. The results from the cumulative disturbance effects of piling at the Project in combination with other projects have been presented as mean and median ratios of impacted: unimpacted population size (**Table 12-70**). The lack of discernible effect on the impacted population is maintained until 2054, which marks the end point of the modelling.

683. The results show no change in the population either over the first six years or over the 25-year period for both the mean and median. Therefore, the significance of effect is **negligible** adverse which **is not significant** in EIA terms.

12.8.3.1.2.3.3 Minke Whale

684. Assuming a worst-case of nine projects to be overlapping in piling periods (including the Project) (**Table 12-66**), the iPCoD model estimated there to be a discernible impact to the minke whale CGNS population (**Figure 12-12** and **Table 12-71**).

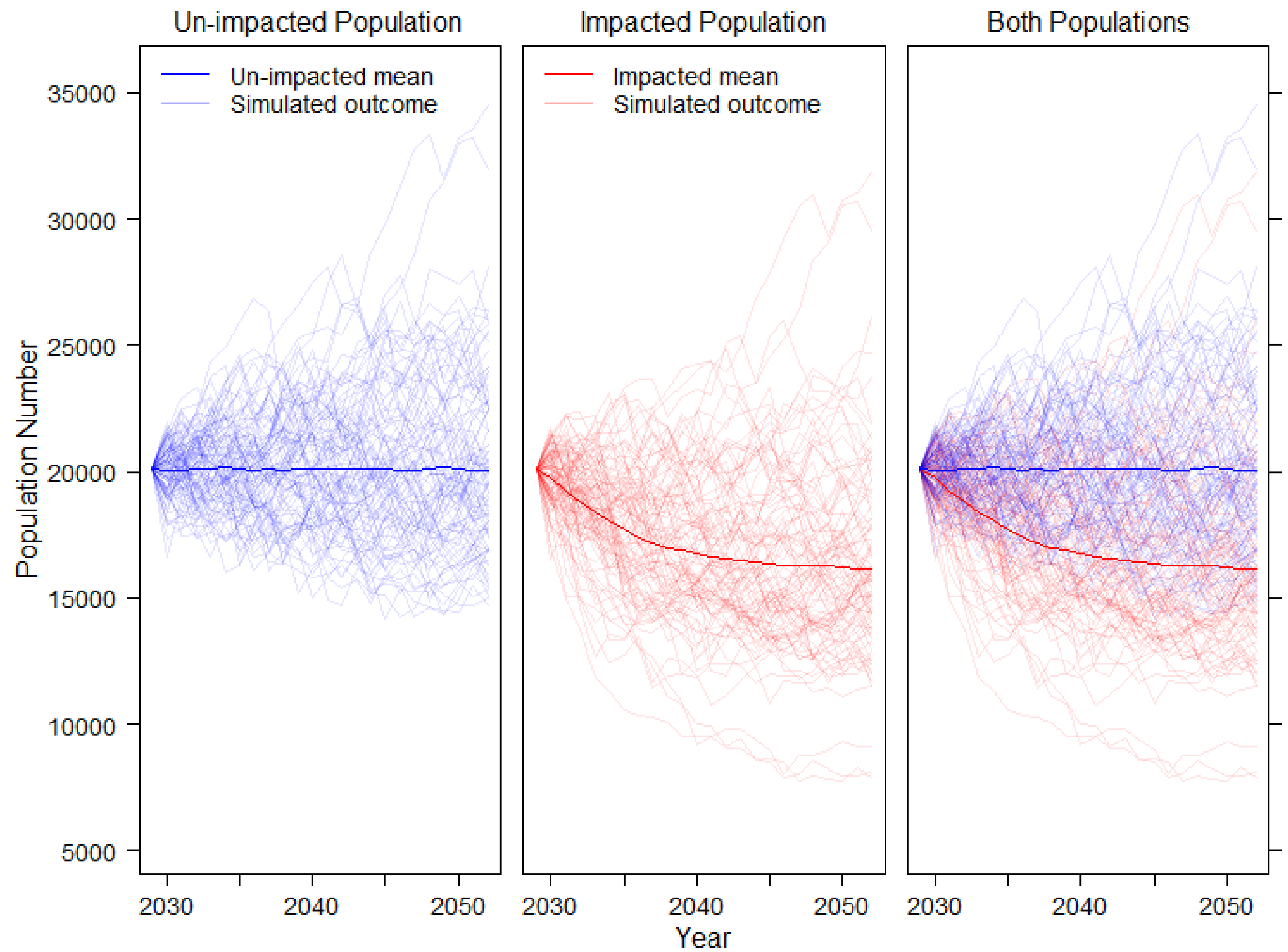

Figure 12-12 Simulated Worst-Case Minke Whale (CGNS MU) Population Sizes for Both the Un-Impacted and the Impacted Population

685. The results from the cumulative disturbance effects of piling at the Project in combination with other projects have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-48**). The population modelling indicates that the population experiences a steep decline during the first ten years (see **Figure 12-12**) with annual declines in the population above 1%. Following this period, the decline is anticipated to flatten, remaining at this rate until the end of the modelling period in 2054. After 25 years, the estimated loss to the CGNS minke whale population is 19%.

686. On average, the annual decline over the first six years is more than 1% (total decline of 8.9%), with a decline of 9% over the first four years, and over the 25-year period for both the mean and median is less than 1% (total decline of 19%). Therefore, a significant level of effect was assigned to minke whale, with a **major adverse** effect which is **significant** in EIA terms.

Table 12-71 Results of the iPCoD Modelling for the CEA, Giving the Mean Population Size for the Minke Whale Population (CGNS MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	20,120	20,120	100.00%	**100.00%**	-
End 2030	20,052	19,792	98.70%	**98.70%**	>1%
End 2032	20,125	18,383	91.34%	**91.79%**	>1%
End 2034	20,167	18,058	89.54%	**91.11%**	>1%
End 2054	20,010	16,097	80.44%	**81.04%**	19%

12.8.3.1.2.3.4 Grey Seal

687. Assuming a worst-case of eight projects to be overlapping in piling periods (including the Project) (**Table 12-66**), the iPCoD model estimated there to be only the slightest discernible impact to the grey seal NE & SE England MU population (**Figure 12-13** and **Table 12-72**).

688. The results from cumulative disturbance effects of piling at the Project in combination with other projects have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-48**). Although both the impacted and un-impacted populations exhibit near-exponential growth each year throughout the modelling period, the impacted population ultimately shows a slightly smaller overall size after 25 years.

689. The results show a less than 1% average annual decline in the first six years and over the 25-year period for both the mean and median, and is there assessed as having a **negligible adverse** effect which is **not significant** in EIA terms.

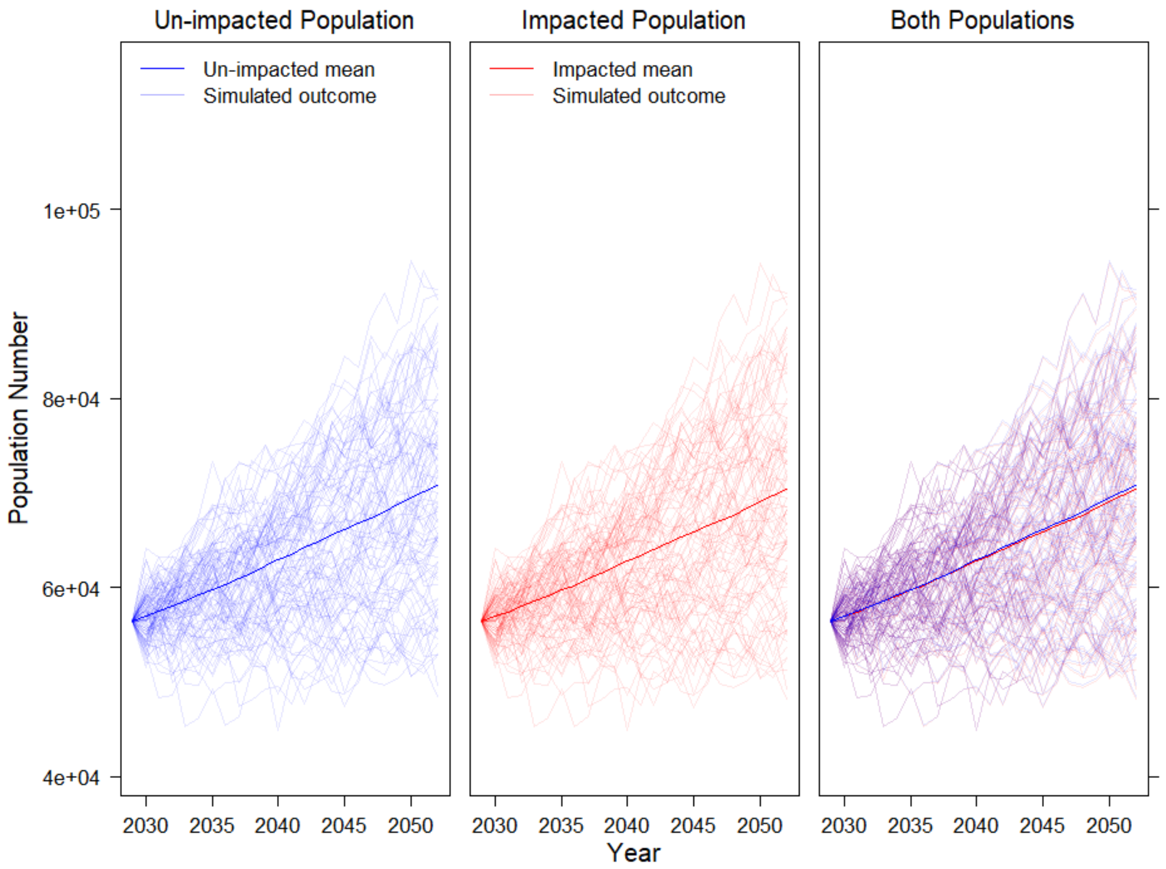

Figure 12-13 Simulated Worst-Case Grey Seal (NE & SE England MU) Population Sizes for Both the Un-Impacted and the Impacted Population

Table 12-72 Results of the iPCoD Modelling for the CEA, Giving the Mean Population Size for the Grey Seal Population (NE and SE England MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	56,502	56,502	100.00%	**100.00%**	-
End 2030	56,977	56,961	99.97%	**99.96%**	<1%
End 2032	58,599	58,566	99.94%	**99.95%**	<1%
End 2034	59,198	59,165	99.94%	**99.92%**	<1%
End 2054	72,341	71,892	99.38%	**99.47%**	<1%

12.8.3.1.2.3.5 Harbour Seal

690. Assuming a worst-case of eight projects to be overlapping in piling periods (including the Project) (**Table 12-66**), the iPCoD model, assuming a stable population (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance** for details and parameters), estimated there to be a discernible impact to the harbour seal NE & SE England MU population (**Table 12-73** and **Figure 12-14**).

691. The results from cumulative disturbance effects of piling at the Project in combination with other projects have been presented as mean and median ratios of impacted: unimpacted population sizes (**Table 12-73**). For the first ten years, both the un-impacted and impacted population follow the same trajectory, then there is gradual, though slight decline in the population that is affected by piling. After 25 years, the impact of piling has affected 7.5% of the harbour seal population.

692. The results show a less than 1% average annual decline over the first six years, with a total decline of 7.5% over the 25-year period for both the mean and median, resulting in an effect significance of **minor adverse** which is **not significant** in EIA terms.

Table 12-73 Results of the iPCoD Modelling for the CEA, Giving the Mean Population Size for the Harbour Seal (Stable) Population (NE and SE England MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	4,990	4,990	100.00%	**100.00%**	-
End 2030	4,984	**4,996**	99.64%	**99.64%**	**<1%**
End 2032	4,979	**4,972**	99.74%	**99.70%**	**<1%**
End 2034	4,983	**4,979**	99.78%	**99.72%**	**<1%**
End 2054	4,988	**4,942**	92.52%	**92.49%**	**7.5%**

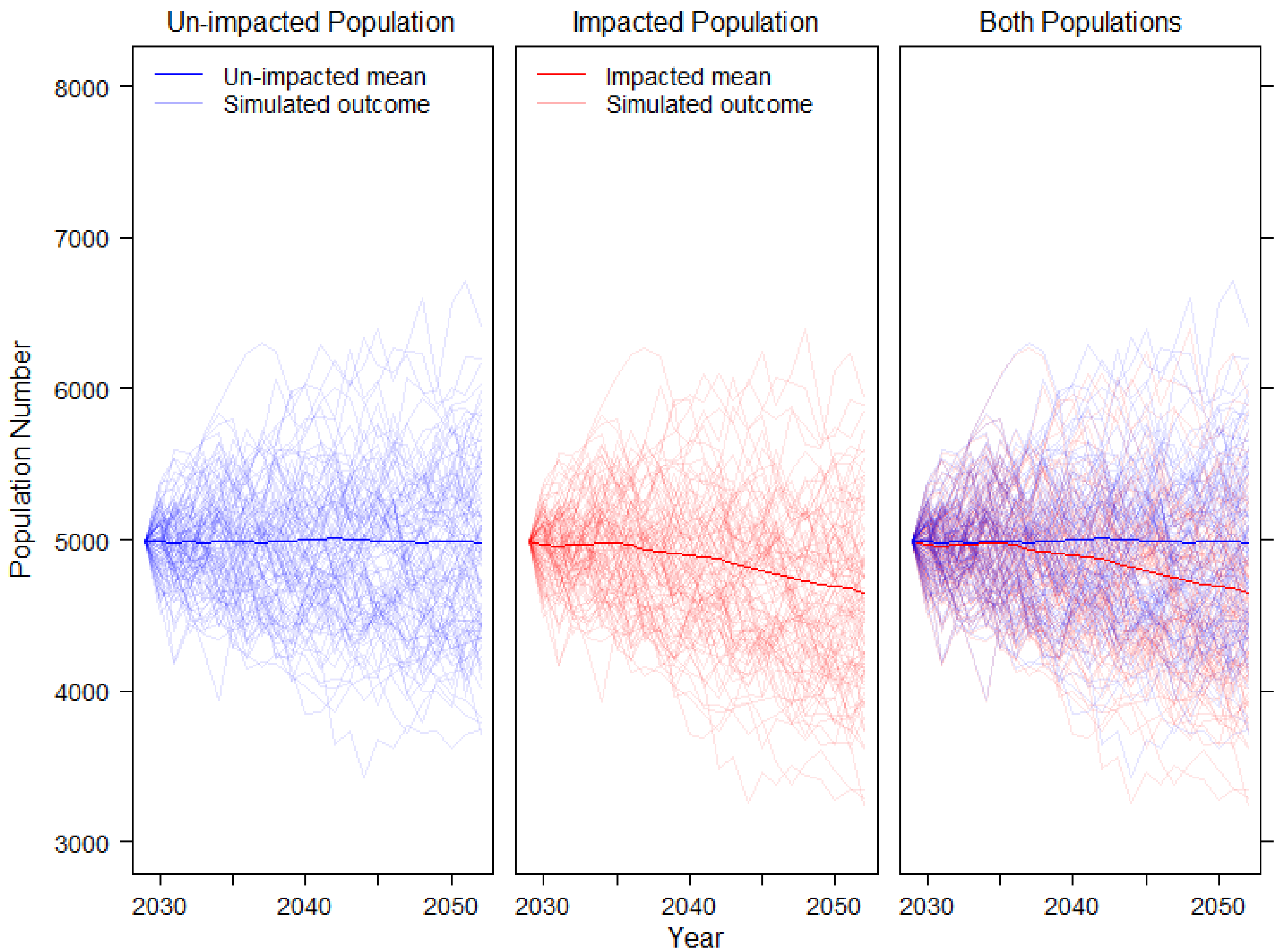

Figure 12-14 Simulated Worst-Case Harbour Seal (Stable) (NE & SE England MU) Population Sizes for Both the Un-Impacted and the Impacted Population

693. Reports on declining populations in the SE England MU (SCOS, 2022) led to the following presentation of population modelling using parameters for a declining population (see **Volume 2, Appendix 12.6 Information and Modelling Methods for Disturbance** for details and parameters). It is estimated that there is a significant impact to the harbour seal NE & SE England MU population (**Figure 12-15** and **Table 12-74**).

694. Whether a population is affected by piling or not, both experience a significant decline in their population under the scenario of a declining population, with no discernible change in the population levels. Therefore, there is a **negligible adverse** significance of effect which is **not significant** in EIA terms.

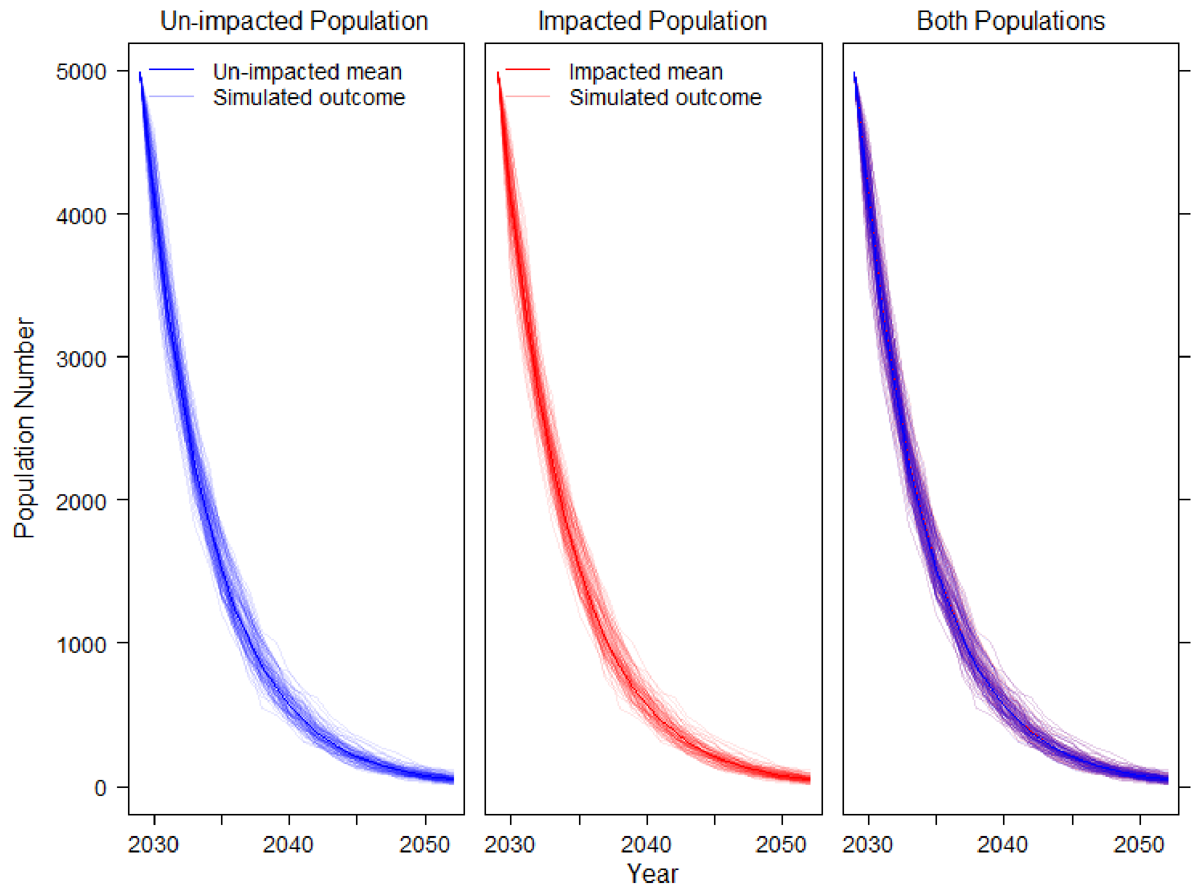

Figure 12-15 Simulated Worst-Case Harbour Seal (Declining) (NE & SE England MU) Population Sizes for Both the Un-Impacted and the Impacted Population

Table 12-74 Results of the iPCoD Modelling for the CEA, Giving the Mean Population Size for the Harbour Seal Population (NE and SE England MU) for Years up to 2054 for Both Impacted and Un-Impacted Populations, in Addition to the Mean and Median Ratio Between Their Population Sizes

Year	Un-impacted population mean	Impacted population mean	Mean impacted as % of un-impacted	Median impacted as % of un-impacted	% change between time points (impacted vs un-impacted [median])
Start 2029	4,992	4,992	100.00%	**100.00%**	-
End 2030	4,093	4,096	100.07%	**100.10%**	-
End 2032	2,255	2,263	100.35%	**100.36%**	-
End 2034	1,849	1,858	100.49%	**100.60%**	-
End 2054	35	36	102.86%	**100.00%**	-

12.8.3.1.2.4 1a) Cumulative Effect Significance

695. As outlined above, the population modelling does not result in a magnitude per so, but the result itself is effect significance.

696. The result presented in the quantified disturbance assessment highlighted that there are significant effects to the harbour porpoise, bottlenose dolphin, grey seal and harbour seal populations (see **Section 12.8.3.1.2.2**). As a result, population modelling was conducted for these species, as well as minke whale for which the necessary modelling parameters are available.

697. The population modelling indicates that for all species with the exception of minke whale, there is no significant effect, as the average annual change over the six-year FCS period was below 1% (as defined by NRW, 2023). However, a significant effect was assigned to minke whale, due to the significant modelled losses to the population.

698. The current knowledge on the exact piling windows for each project however is of medium confidence. For the modelling, piling days were distributed randomly over the known construction periods, typically around two years for most projects, without accounting for the unlikelihood of piling during winter due to adverse weather and limited daylight. However, this assessment was deemed precautionary enough to comfortably encompass the likely uncertainty and variability. Throughout the assessment, it has been made clear where multiple and compounding precautionary assumptions have been made.

699. A summary of magnitudes and resulting effect significances from all disturbance assessment methods covered in this section are listed in **Table 12-75**.

700. All marine mammal species have a sensitivity of **medium** as a result of disturbance from underwater noise.

701. For harbour porpoise, bottlenose dolphin, grey seal and harbour seal, under the quantitative assessment, the overall effect significance is **major adverse** which is **significant** in EIA terms, while the population modelling identified a **negligible to minor adverse** effect which is **not significant** in EIA terms.

702. For common dolphin, the quantitative assessment resulted in a magnitude of **negligible**, therefore the effect significance is **negligible adverse** overall which is **not significant** in EIA terms.

703. For white-beaked dolphin, the quantitative assessment resulted in a magnitude of **medium**, therefore the effect significance is **moderate adverse** overall which is **significant** in EIA terms.

704. For minke whale, the quantitative assessment resulted in a magnitude of **low**, therefore the effect significance is **minor adverse** overall which is **not significant** in EIA terms, while the population modelling identified a **major adverse** effect which is **significant** in EIA terms.

705. Therefore, as shown in **Table 12-75**, all marine mammal species (with the exception of common dolphin) have the potential for significant effect which will require management.

12.8.3.1.2.5 Additional Mitigation and Residual Effect

706. As set out in **Table 12-7**, the **Outline MMMP** (document reference 8.1) will include information on noise reduction methods. The assessments of effect for disturbance from piling at the Project will be undertaken assuming the use of noise reduction technology at the DCO stage, assuming that monopiles remain within the project design and a significant effect is predicted.

707. The UK Government and Defra (2025) have released a policy paper in January 2025 on marine noise and "*expect that all offshore wind pile driving activity across all English waters will be required to demonstrate that they have utilised best endeavours to deliver noise reductions through the use of primary and/or secondary noise reduction methods in the first instance*". With respect to this policy paper and the effect it will have on commitments to NAS, the Project will investigate and consider the requirement for the use of NAS prior to DCO submission.

708. Note that while the Project will further investigate the requirement for the use of NAS prior to DCO submission, the potential for any cumulative effects to be effectively managed may rely on other OWFs also committing to the use of noise reduction, as DBD reducing noise at source alone may not sufficiently reduce the potential for a significant disturbance effect for all species.

12.8.3.1.3 1b) Other Industries and Activities

709. The cumulative disturbance assessment considered the following activities occurring at the same time as piling for the Project:

i. Geophysical Surveys;
ii. Aggregate Extraction and Dredging;
iii. Seismic Surveys;
iv. UXO Clearance; and
v. Interlink cable.

710. The assessments of effects from geophysical surveys, seismic surveys and the potential for UXO clearances occurring simultaneously with Project construction are provided as indicative only, as there is currently no information on the potential for these activities to occur at the same time as construction of the Project. More information for each activity is outlined in the following sections as well as in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**.

12.8.3.1.3.1 Impact Magnitude – Quantified Assessment

12.8.3.1.3.1.1 i) Geophysical Surveys – Indicative Assessment

711. As outlined in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**, OWF geophysical surveys, using Acoustic Sub-bottom Profilers (SBPs) and Ultra-Short Base Line (USBL) systems, have the potential to disturb marine mammals and have therefore screened into the CEA as a precautionary approach.

712. It is not currently possible to estimate the location, or number, of potential geophysical surveys that could be undertaken at the same time as construction and potential piling activity at the Project, however, it is estimated that there could be up to two taking place at any one time.

713. Geophysical surveys are a moving source of noise, rather than a stationary one (i.e. the distance at which a survey vessel could travel in one day, with the species relevant buffer area).

714. It is difficult to determine what the potential area of effect would be when taking into account geophysical surveys as a moving source (as it is difficult to predict how far a vessel may survey in a day). Based on survey vessels travelling at a speed of 4.5 to 5 kt, up to 199km could be surveyed in one day. This however does not take into account the survey downtime for line changes, weather, or other technical reasons. Approximately only 52% of the surveying time was spent surveying, as per review of seismic surveys within the UK (BEIS, 2020). These assumptions have been applied to geophysical surveys due to their similarity in approach. Taking these into account, then up to 103.5km could be surveyed in one day by one geophysical survey vessel.

715. **Table 12-76** summarises the total impact area for each marine mammal species, taking into account the recommended disturbance ranges as discussed separately for each species below.

716. It must be noted that this approach was highly precautionary as it is unlikely that the whole geophysical survey transect area would cause disturbance to marine mammal species, as animals would return once the vessel had passed, and the disturbance had ceased.

Table 12-75 Assessment of Effect Significance for Cumulative Disturbance of Marine Mammals from Underwater Noise During Piling at the Project and at Other OWFs (N/A = Not Applicable)

Species / receptor	Impact	Sensitivity	Magnitude	Effect significance	Additional mitigation measures proposed	Residual effect
Harbour porpoise	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**	Additional management measures to be considered prior to DCO submission. See **Section 12.8.3.1.2.5** below.	**Significant (major adverse)**
	iPCoD modelling		*n/a*	**Not Significant (minor adverse)**		**Not Significant (minor adverse)**
Bottlenose dolphin	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**		**Significant (major adverse)**
	iPCoD modelling		*n/a*	**Not Significant (negligible adverse)**		**Not Significant (negligible adverse)**
Common dolphin	Quantitative assessment	**Medium**	**Negligible**	**Not Significant (negligible adverse)**		**Not Significant (negligible adverse)**
White-beaked dolphin	Quantitative assessment	**Medium**	**Medium**	**Significant (moderate adverse)**		**Significant (moderate adverse)**
Minke whale	Quantitative assessment	**Medium**	**Low**	**Not Significant (minor adverse)**		**Not Significant (minor adverse)**
	iPCoD modelling		*n/a*	**Significant (major adverse)**		**Significant (major adverse)**
Grey seal	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**		**Significant (major adverse)**
	iPCoD modelling		*n/a*	**Not Significant (negligible adverse)**		**Not Significant (negligible adverse)**
Harbour seal	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**		**Significant (major adverse)**
	iPCoD modelling		*n/a*	**Not Significant (negligible to minor adverse)**		**Not Significant (negligible to minor adverse)**

Table 12-76 Impact Area of Geophysical Surveys Calculated for the Marine Mammal Species in the ZoI Based on a 103.5km Survey Length

Species	Survey length	Disturbance buffer (km)	Total geophysical survey area including turning area (km²)	
			One survey	Two surveys
Harbour porpoise	103.5km	5.0[17]	1,113.5	2,227.0
Seal species		3.77[18]	434.9	869.7
Dolphin species and minke whale		3.12[19]	353.5	707.0

717. The locations of the potential geophysical surveys were unknown, thus the following assessments were based on the density estimates discussed in **Section 12.3** in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**.

12.8.3.1.3.1.2 Harbour Porpoise

718. The potential disturbance ranges used in the cumulative assessment are based on the SNCB guidance for assessment for harbour porpoise. Assessments for the Review of Consents (RoC) HRA for the SNS SAC (BEIS, 2020), modelled the potential for disturbance in harbour porpoise due to the use of a SBP, and results indicate that there is the potential for a possible behavioural response in harbour porpoise at up to 3.77km from the source. However, the most recent guidance for assessing the significance of noise disturbance for harbour porpoise SACs (JNCC *et al.,* 2020; JNCC, 2023b) recommended the use of an EDR of 5km for geophysical surveys.

719. Based on the potential impact area using a 5km EDR and the worst-case scenario of two geophysical surveys coinciding with piling activities on the Project, less than 2% of the harbour porpoise reference population could be temporarily disturbed (**Table 12-77**). The magnitude of impact is therefore considered to be **low**.

Table 12-77 Indicative Quantified CEA for the Potential Disturbance of Harbour Porpoise During Geophysical Surveys at OWF Projects

Project	Harbour porpoise density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
The Project	*DRC*		*5,015*
Disturbance from two geophysical surveys	0.55	2,227	1,225
Total number of harbour porpoise			6,240
Percentage of NS MU			1.8%
Magnitude of cumulative effect			**Low**

12.8.3.1.3.1.3 Dolphins and Minke Whale

720. Assessments for the EPS Protected Sites and Species Risk Assessment (Scottish and Southern Energy, 2020) modelled the potential for a possible behavioural response in marine mammals up to 3.12km from the source in water depths at 10m, and 4.22km in water depths at 100m. Given the shallow water depths in the Project area (21.2 – 34.6m below LAT), the disturbance distance of 3.12km has been taken forward and applied to the approach described above (**Table 12-76**), resulting in an impact area of 707km² for marine mammals.

721. Based on the potential impact area using a 3.12km disturbance range and the worst-case scenario of two geophysical surveys coinciding with piling activities on the Project, less than 4% of the bottlenose dolphin (GNS MU) and less than 5% of the bottlenose dolphin (CES MU) could be disturbed, with a resultant magnitude of **low** (**Table 12-78**).

722. Less than 1% of the common dolphin, white-beaked dolphin and minke whale reference population could be temporarily disturbed (**Table 12-78**); the magnitude of impact is therefore considered to be **negligible**.

[17] JNCC *et al*. 2020
[18] Based on BEIS (2020) as a precautionary worst-case, due to a lack of data on seal disturbance distances
[19] Scottish and Southern Energy, 2020

Table 12-78 Indicative Quantified CEA for the Potential Disturbance of Dolphins and Minke Whale During the Geophysical Surveys at other OWF Projects

Projects	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Bottlenose dolphin - GNS MU			
The Project	*DRC*		*67*
Disturbance from two geophysical surveys	0.0037	707	3
Total number of bottlenose dolphin			70
Percentage of GNS			3.4%
Magnitude of cumulative effect			**Low**
Bottlenose dolphin - CES MU			
The Project	*Other construction activities*[20]		*9*
Disturbance from two geophysical surveys	0.0019	707	2
Total number of bottlenose dolphin			11
Percentage of CES MU			4.87%
Magnitude of cumulative effect			**Low**
Common dolphin			
The Project	*DRC*		*111*
Disturbance from two geophysical surveys	0.031	707	22
Total number of common dolphin			133
Percentage of CGNS MU			0.13%
Magnitude of cumulative effect			**Negligible**
White-beaked dolphin			
The Project	*DRC*		*184*
Disturbance from two geophysical surveys	0.052	707	37
Total number of white-beaked dolphin			221
Percentage of CGNS MU			0.50%
Magnitude of cumulative effect			**Negligible**
Minke whale			
The Project	*30km disturbance range*		*44*
Disturbance from two geophysical surveys	0.0063	707	5
Total number of minke whale			49
Percentage of CGNS MU			0.24%
Magnitude of cumulative effect			**Negligible**

12.8.3.1.3.1.4 Seals

723. Based on the potential impact area using a 3.77km disturbance range (BEIS, 2020) and the worst-case scenario of two geophysical surveys coinciding with piling activities on the Project, less than 1% of the grey and harbour seal reference population could be temporarily disturbed (**Table 12-79**). The magnitude of impact is therefore considered to be **negligible**.

[20] Based on the worst-case disturbance for bottlenose dolphin (within the CES MU) due to other construction activities, as piling will not affect this population (**Table 12-57**).

Table 12-79 Indicative Quantified CEA for the Potential Disturbance of Seals During the Geophysical Surveys at other OWF Projects

Project	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Grey seal			
The Project	*DRC*		*184*
Disturbance from two geophysical surveys	0.245	869.7	214
Total number of grey seal			398
Percentage of SE & NE MU			0.70%
Magnitude of cumulative effect			**Negligible**
Harbour Seal			
The Project	*DRC*		*0.03*
Disturbance from two geophysical surveys	0.034	869.7	30
Total number of harbour seal			30
Percentage of SE MU			0.60%
Magnitude of cumulative effect			**Negligible**

12.8.3.1.3.1.5 ii) Aggregate Extraction and Dredging

724. Taking into account the small potential impact ranges and the distances between the aggregate extraction and dredging projects and the Project, the potential for contributing to cumulative effects is minimal.

725. Seven aggregate / dredging projects have been screened in that could have potential cumulative disturbance impacts with piling taking place at the Project (see **Volume 2, Appendix 12.5 Cumulative Assessment Screening**):

- Greenwich Light East 473/1 (one project area owned by CEMEX UK Marine and one by Hanson Aggregates Marine Ltd.) (screened in for all marine mammal species except bottlenose dolphin);
- Greenwich Light East 473/2 (one project area owned by CEMEX UK Marine and one by Hanson Aggregates Marine Ltd.) (screened in for all marine mammal species except bottlenose dolphin);
- Inner Dowsing 481/1-2 (screened in for all marine mammal species except bottlenose dolphin of the CES MU);
- Inner Owers North 488 (screened in for all marine mammal species except bottlenose dolphin, grey seal and harbour seal);
- Thames D 524 (screened in for all marine mammal species except bottlenose dolphin of the CES MU);
- West Bassurelle 458 (screened in for all marine mammal species except bottlenose dolphin); and
- West Bassurelle 464 (screened in for all marine mammal species except bottlenose dolphin).

726. As outlined in the BEIS (2020) RoC HRA for the SNS SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600m of the activities (Diederichs *et al.,* 2010). This would result in a potential disturbance area of 1.13km^2 for each project. This range has been used to inform the following assessments for all species due to a lack of information of other species groups, and as harbour porpoise are the most sensitive species assessed.

727. The screened in aggregate / dredging projects are located along the south / south-east coast of England. The densities outlined in **Volume 2, Appendix 12.5 Cumulative Assessment Screening** were applied. For bottlenose dolphin from the CES MU, these projects are outside their usual range, so they would not affect the CES MU population. Therefore, the assessment has been based solely on the GNS MU.

728. The cumulative effect of piling at the Project in combination with seven aggregate / dredging projects in the NS MU affects less than 2% of the harbour porpoise reference population (**Table 12-80**). The magnitude of impact is therefore considered to be **low** for harbour porpoise.

729. For all remaining species, the cumulative effect could result in the disturbance of less than 0.5% of the relevant reference population. The magnitude of impact is therefore considered to be **negligible** for all other marine mammal species.

Table 12-80 Quantified CEA for the Potential Disturbance of Marine Mammals During Extraction and Dredging Activities

Projects	Species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Harbour porpoise			
The Project	*DRC*		*5,015*
Greenwich Light East 473/1	0.55	1.13	1
Greenwich Light East 473/2	0.55	1.13	0.62
Inner Dowsing 481/1-2	0.55	1.13	0.62
Inner Owers North 488	0.55	1.13	0.62
Thames D 524	0.55	1.13	0.62
West Bassurelle 458	0.55	1.13	0.62
West Bassurelle 464	0.55	1.13	0.62
Total number of harbour porpoise			5,019.4
Percentage of NS MU			1.48%
Magnitude of cumulative effect			**Low**
Bottlenose dolphin – GNS MU			
The Project	*DRC*		*66*
Inner Dowsing 481/1-2	0.0037	1.13	0.004
Thames D 524	0.0037	1.13	0.004
Total number of bottlenose dolphin			66.01
Percentage of GNS MU			0.33%
Magnitude of cumulative effect			**Negligible**
Common dolphin			
The Project			*111*
Greenwich Light East 473/1	0.031	1.13	0.04
Greenwich Light East 473/2	0.031	1.13	0.04
Inner Dowsing 481/1-2	0.031	1.13	0.04
Inner Owers North 488	0.031	1.13	0.04
Thames D 524	0.031	1.13	0.04
West Bassurelle 458	0.031	1.13	0.04
West Bassurelle 464	0.031	1.13	0.04
Total number of common dolphin			111.3
Percentage of CGNS MU			0.00003%
Magnitude of cumulative effect			**Negligible**
White-beaked Dolphin			
The Project	*DRC*		*184*
Greenwich Light East 473/1	0.052	1.13	0.06
Greenwich Light East 473/2	0.052	1.13	0.06
Inner Dowsing 481/1-2	0.052	1.13	0.06
Inner Owers	0.052	1.13	0.06
Thames D 524	0.052	1.13	0.06
West Bassurelle 458	0.052	1.13	0.06
West Bassurelle 464	0.052	1.13	0.06
Total number of white-beaked dolphin			184.4
Percentage of CGNS MU			0.42%
Magnitude of cumulative effect			**Negligible**

Projects	Species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed during single piling
Minke whale			
The Project	*30km disturbance range*		*44*
Greenwich Light East 473/1	0.0063	1.13	0.007
Greenwich Light East 473/2	0.0063	1.13	0.007
Inner Dowsing 481/1-2	0.0063	1.13	0.007
Inner Owers	0.0063	1.13	0.007
Thames D 524	0.0063	1.13	0.007
West Bassurelle 458	0.0063	1.13	0.007
West Bassurelle 464	0.0063	1.13	0.007
Total number of minke whale			44
Percentage of CGNS MU			0.22%
Magnitude of cumulative effect			**Negligible**
Grey Seal			
The Project	*DRC*		*184*
Greenwich Light East 473/1	0.245	1.13	0.3
Greenwich Light East 473/2	0.245	1.13	0.3
Inner Dowsing 481/1-2	0.245	1.13	0.3
Thames D 524	0.245	1.13	0.3
West Bassurelle 458	0.245	1.13	0.3
West Bassurelle 464	0.245	1.13	0.3
Total number of grey seal			186
Percentage of NE & SE MU			0.33%
Magnitude of cumulative effect			**Negligible**
Harbour Seal			
The Project	*DRC*		*0.03*
Greenwich Light East 473/1	0.034	1.13	0.04
Greenwich Light East 473/2	0.034	1.13	0.04
Inner Dowsing 481/1-2	0.034	1.13	0.04
Thames D 524	0.034	1.13	0.04
West Bassurelle 458	0.034	1.13	0.04
West Bassurelle 464	0.034	1.13	0.04
Total number of harbour seal			0.30
Percentage of NE & SE MU			0.006%
Magnitude of cumulative effect			**Negligible**

12.8.3.1.3.1.6 iii) Seismic Surveys – Indicative Assessment

730. It is not possible to estimate the location, or number, of potential seismic surveys that could be undertaken at the same time as construction and potential piling activity for the Project due to the short lead-in times for these projects.

731. As a precautionary approach, the potential for cumulative impacts from oil and gas seismic surveys has been screened into the CEA for further consideration. It is assumed, as a worst-case scenario, that there could potentially be two seismic surveys in the North Sea at any one time during construction (piling) of the Project. Given the coastal nature of the bottlenose dolphin CES MU, it is not expected that there would be any seismic surveys within the MU, and therefore this MU has not been considered further under this indicative assessment.

732. Seismic surveys are a moving source, travelling up to 199km in one day (based on a speed of 4.5 kt), of which 52% (103.5km) is active survey time (BEIS, 2020). **Table 12-81** summarises the total impact area for each marine mammal species, taking into account the daily survey distance and the recommended disturbance ranges, which are discussed in the relevant species assessment section below.

Table 12-81 Impact Area of Seismic Surveys Calculated for the Marine Mammal Species in The Marine Mammal Study Area Based on a 103.5km Survey Length

Species	Survey length	Disturbance buffer (km)	Total seismic survey area including turning area (km^2)	
			One survey	Two surveys
Harbour porpoise	103.5km	12	2,936.4	5,872.8
Dolphin species	103.5km	11	2,657.1	5,314.3
Minke whale	103.5km	10	2,384.2	4,768.3
Seals	103.5km	17	4,426.9	8,853.8

733. For harbour porpoise, the potential impact area during seismic surveys is based on a buffer of 12km, following the current JNCC disturbance guidance (JNCC, 2023b) (**Table 12-81**).

734. For all dolphins, the potential impact area is based on the largest potential disturbance range of 11km for bottlenose dolphins: strong avoidance from a 2D seismic survey (with 470 cubic inch airguns, and a peak sound source level of 243dB 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) (**Table 12-81**).

735. For minke whale, there is little available information on the potential for disturbance from seismic surveys, however, a radius of 10km (Macdonald *et al.,* 1995) has been suggested (**Table 12-81**).

736. For seals, there is little information on the potential for disturbance from seismic surveys. 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, showed potential disturbance ranges from 13.3km to 17.0km from the source (BEIS, 2020). These ranges were 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. As such, the potential disturbance range of 17km has been applied to both species, due to a due to a lack of species-specific information (**Table 12-81**).

737. It must be noted that this approach is highly precautionary as it is unlikely that the whole seismic survey transect area would cause disturbance to marine mammal species, as animals would return once the vessel had passed, and the disturbance had ceased.

738. The cumulative effect of piling at the Project at the same time as two seismic surveys in the NS MU could disturb up to 0.5% of the relevant populations for common dolphin and minke whale. The magnitude of impact is therefore considered to be **negligible** for these two species (**Table 12-82**).

Table 12-82 Indicative Quantified CEA for the Potential Disturbance of All Marine Mammal Species During Seismic Surveys

Projects	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Harbour Porpoise			
The Project	*DRC*		*5,015*
Disturbance from two seismic surveys	0.55	5,872.8	3,231
Total number of harbour porpoise			8,146
Percentage of NS MU			2.40%
Magnitude of cumulative effect			**Low**
Bottlenose dolphin - GNS MU			
The Project	*DRC*		*67*
Disturbance from two seismic surveys	0.0037	5,314.3	20

Projects	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Total number of bottlenose dolphin			87
Percentage of GNS / CES MU			4.30%
Magnitude of cumulative effect			**Low**
Common dolphin			
The Project	*DRC*		*111*
Disturbance from two seismic surveys	0.031	5,314.3	165
Total number of common dolphin			276
Percentage of CGNS MU			0.27%
Magnitude of cumulative effect			**Negligible**
White-beaked Dolphin			
The Project	*DRC*		*184*
Disturbance from two seismic surveys	0.052	5,314.3	277
Total number of white-beaked dolphin			461
Percentage of CGNS MU			1.05%
Magnitude of cumulative effect			**Low**
Minke Whale			
The Project	*30km disturbance range*		*44*
Disturbance from two seismic surveys	0.0063	4,768.3	31
Total number of minke whale			75
Percentage of CGNS MU			0.37%
Magnitude of cumulative effect			**Negligible**

Projects	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Grey seal			
The Project	*DRC*		*184*
Disturbance from two seismic surveys	0.245	8,853.8	2,170
Total number of grey seal			2,354
Percentage of SE & NE MU			4.17%
Magnitude of cumulative effect			**Low**
Harbour Seal			
The Project	*DRC*		*0.03*
Disturbance from two seismic surveys	0.034	8,853.8	302
Total number of harbour seal			302
Percentage of NE & SE MU			6.05%
Magnitude of cumulative effect			**Medium**

739. For harbour porpoise, bottlenose dolphin, white-beaked dolphin and grey seal, the cumulative effect could cause disturbance to up to 5% of the relevant reference populations. The magnitude of impact is therefore considered to be **low** for harbour porpoise, bottlenose dolphin, white-beaked dolphin and grey seal (**Table 12-82**).

740. For harbour seal, disturbance due to seismic surveys at the same time as piling at the Project could disturb over 6% of the population, and therefore the magnitude is considered to be **medium** (**Table 12-82**).

12.8.3.1.3.1.7 iv) Unexploded Ordnance Clearance – Indicative Assessment

741. It is 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 for the Project. An indicative assessment of a single UXO high-order detonation (worst-case) and one low-order clearance event on the same day is presented in this section (as outlined in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**).

742. A more detailed and indicative assessment of potential injury and disturbance arising from UXO clearances at the Project can be found in **Volume 2, Appendix 12.4 Unexploded Ordnance Assessment**. A separate Marine Licence application for any required UXO clearance for the Project would be submitted prior to any planned activities and would consider any potential cumulative effects.

12.8.3.1.3.1.8 Harbour Porpoise, Minke Whale and Seal

743. For harbour porpoise, minke whale and seal, the potential effect area during a UXO clearance event was determined using the modelled worst-case effect ranges for TTS (weighted SEL, impulsive criteria) (see assessments in the **Volume 2, Appendix 12.4 Unexploded Ordnance Assessment**). The TTS ranges for high-order clearance for harbour porpoise and minke whale, at 28km (=2,463km^2) and 120km (=45,239km^2), exceeded the 26km EDR (JNCC, 2023b) respectively. For seals, the 24km TTS range (=1,810km^2), was taken forward for the assessments in **Table 12-83**. For a low-order clearance, the 5km EDR (JNCC, 2023b) was applied to all species, which represents the larger impact range.

744. Using this approach, less than 5% of the reference populations of harbour porpoise, minke whale, grey seal and harbour seal experience disturbance. The magnitude of impact on these species is therefore considered to be **low**.

Table 12-83 Indicative Quantified CEA For the Potential Disturbance of Harbour Porpoise, Minke Whale and Seal Species During High- And Low-Order UXO Clearances at OWF Projects

Project	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Harbour porpoise			
The Project	*DRC*		*5,015*
Disturbance from high-order UXO clearance (without mitigation)	0.55	2,463	1,355
Disturbance from low-order UXO clearance	0.55	78.5	44
Total number of harbour porpoise			6,413
Percentage of NS MU			1.89%
Magnitude of cumulative effect			**Low**
Minke Whale			
The Project	*30km disturbance range*		*44*
Disturbance from high-order UXO clearance (without mitigation)	0.0063	45,239	285
Disturbance from low-order UXO clearance	0.0063	78.5	0.5
Total number of minke whale			330
Percentage of CGNS MU			1.64%
Magnitude of cumulative effect			**Low**
Grey seal			
The Project	*DRC*		*184*
Disturbance from high-order UXO clearance (without mitigation)	0.245	1,810	444
Disturbance from low-order UXO clearance	0.245	78.5	20
Total number of grey seal			648
Percentage of SE & NE MU			1.15%
Magnitude of cumulative effect			**Low**
Harbour Seal			
The Project	*DRC*		*0.03*
Disturbance from high-order UXO clearance (without mitigation)	0.034	1,810	62
Disturbance from low-order UXO clearance	0.034	78.5	3
Total number of harbour seal			65
Percentage of SE & NE MU			1.30%
Magnitude of cumulative effect			**Low**

12.8.3.1.3.1.9 Dolphins

745. The potential impact area for dolphins was determined to be based on the 26km EDR (=2,124km^2) for high-order UXO detonation (unmitigated) and a 5km EDR (=78.5km^2) for low-order clearance. This approach is following the current JNCC (2023a) guidance for the assessment of impact to harbour porpoise in the SNS SAC and has been applied to dolphins as a precautionary approach, due to the lack of information on the potential disturbance of dolphin species to UXO clearance. The TTS ranges for dolphins, as detailed in **Volume 2, Appendix 12.3 Underwater Noise Modelling**, were significantly smaller, approximately 100m. Consequently, using the EDR for assessment may be overly precautionary. Although the JNCC has recommended this EDR, it is primarily based on piling activities, which differ fundamentally in sound type and propagation.

746. For bottlenose dolphins (of the GNS MU), less than 4% would be at risk of disturbance due to UXO clearance at the same time as piling at the Project. The magnitude of impact is therefore considered to be **low** for bottlenose dolphin of the GNS MU. For bottlenose dolphin (of the CES MU), more than 6% of the population may be at risk of disturbance, with a magnitude of **medium** (**Table 12-84**).

747. For common dolphin and white-beaked dolphin, less than 1% of the populations could be disturbance as a result of piling at the Project and UXO clearance, with a magnitude of **negligible** for both species.

Table 12-84 Indicative Quantified CEA For the Potential Disturbance of Dolphins During High- and Low-Order UXO Clearances at OWF Projects

Projects	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Bottlenose dolphin – GNS MU			
The Project	*DRC*		*67*
Disturbance from high-order UXO clearance (without mitigation)	0.0037	2,124	8
Disturbance from low-order UXO clearance	0.0037	78.5	0.3
Total number of bottlenose dolphin			75.3
Percentage of GNS MU			3.72%
Magnitude of cumulative effect			**Low**
Bottlenose dolphin - CES MU			
The Project	Other construction activities		9
Disturbance from high-order UXO clearance (without mitigation)	0.0019	2,124	5
Disturbance from low-order UXO clearance	0.0019	78.5	0.1
Total number of bottlenose dolphin			14.1
Percentage of CES MU			6.2%
Magnitude of cumulative effect			**Medium**
Common dolphin			
The Project	*DRC*		*111*
Disturbance from high-order UXO clearance (without mitigation)	0.031	2,124	66
Disturbance from low-order UXO clearance	0.031	78.5	3
Total number of common dolphin *(without the Project)*			180
Percentage of CGNS MU			0.18%
Magnitude of cumulative effect			**Negligible**
White-beaked Dolphin			
The Project	*DRC*		*184*
Disturbance from high-order UXO clearance (without mitigation)	0.05200	2,124	111
Disturbance from low-order UXO clearance	0.05200	78.5	5

Projects	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Total number of white-beaked dolphin			299
Percentage of CGNS MU			0.68%
Magnitude of cumulative effect			**Negligible**

748. 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, were 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 suggested that disturbance behaviour was not predicted to occur from UXO clearance, if undertaken over a short period of time (JNCC, 2010b).

749. Furthermore, it is unlikely that more than one UXO high-order detonation would occur simultaneously or on the same day, even with overlapping UXO clearance operation durations. Therefore, the assessment focused on the potential disturbance from a single UXO high-order detonation (worst-case) and one low-order clearance event on the same day. However, the likelihood of this and its temporal overlap with piling for the Project is low.

750. Current guidance, in a Joint Position Statement by all UK Regulators and SNCBs (UK Government *et al* (2025), states a strong preference of using low-order deflagration over a high-order detonation, and therefore it is likely that the majority of any UXO clearance would be undertaken by low-order techniques, which would significantly reduce the potential for effect.

12.8.3.1.3.1.10 v) Sub-Sea Cables

751. Only one subsea pipeline has been screened into the CEA: Sea Link. This project is currently at scoping stage and therefore there is limited information available on construction timelines, potential effects and disturbance ranges.

752. As described in **Section 12.7.1.4**, the disturbance ranges for construction activities (other than piling), including cabling works and vessels would be up to 4km (with a disturbance area of 50.3km^2), for all marine mammal species. This disturbance range has been applied in the absence of any project-specific information.

753. Sea Link is outside the CES MU for bottlenose dolphin and has therefore this MU has not been assessed. **Table 12-85** presents the assessment with piling at the Project.

Table 12-85 Quantified CEA For the Potential Disturbance of Marine Mammals During Subsea Cable Construction at OWF Projects

Project	Species density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
Harbour porpoise			
The Project	*DRC*		*5,015*
Sea Link	0.55	50.3	28
Total number of harbour porpoise			5,043
Percentage of NS MU			1.49%
Magnitude of cumulative effect			**Low**
Bottlenose dolphin – GNS MU			
The Project	*DRC*		*67*
Sea Link	0.0037	50.3	0.2
Total number of bottlenose dolphin			67.2
Percentage of GNS MU			3.3%
Magnitude of cumulative effect			**Low**
Common dolphin			
The Project	*DRC*		*111*
Sea Link	0.031	50.3	2
Total number of common dolphin			113
Percentage of CGNS MU			0.11%
Magnitude of cumulative effect			**Negligible**
White-beaked Dolphin			
The Project	*DRC*		*184*
Sea Link	0.052	50.3	3

Project	Species density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
Total number of white-beaked dolphin			187
Percentage of CGNS MU			0.43%
Magnitude of cumulative effect			**Negligible**
Minke Whale			
The Project	*-*	*2,827.4*	*44*
Sea Link	0.0063	50.3	0.3
Total number of minke whale			44.3
Percentage of CGNS MU			0.22%
Magnitude of cumulative effect			**Negligible**
Grey seal			
The Project	*-*	*1,963.5*	*184*
Sea Link	0.245	50.3	13
Total number of grey seal			197
Percentage of SE & NE MU			0.35%
Magnitude of cumulative effect			**Negligible**
Harbour Seal			
The Project	*DRC*		*0.03*
Sea Link	0.034	50.3	2
Total number of harbour seal			2
Percentage of SE & NE MU			0.03%
Magnitude of cumulative effect			**Negligible**

754. For harbour porpoise and bottlenose dolphin, less than 5% of the populations may be at risk of disturbance from piling at the Project at the same time as activities at Sea Link. Therefore, both species have a magnitude of **low** (**Table 12-85**Table 12-85).

755. For all other marine mammal species (common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal), less than 1% of the populations may be at risk of disturbance from piling at the Project at the same time as activities at Sea Link, with a resultant magnitude of **negligible** (**Table 12-85**).

12.8.3.1.3.2 1b) Cumulative Effect Significance

756. As previously outlined, several assessments presented in the section above are based on indicative timelines and apply precautionary disturbance ranges to unspecified densities. These assumptions are likely to overestimate the number of marine mammals expected to be disturbed. However, none of the species assessed are disturbed beyond 4% of their respective reference populations.

757. All marine mammals have a sensitivity of **medium** to disturbance effects.

758. Overall, for harbour porpoise, bottlenose dolphin (of the GNS MU), common dolphin, white-beaked dolphin, minke whale, and grey seal the magnitude of impact is **negligible** to **low**, and the effect is therefore of **negligible** to **minor adverse** significance, which **is not significant** in EIA terms.

759. Overall, for bottlenose dolphin (of the CES MU) the magnitude is **low** to **medium**. The effect is therefore of **minor** to **moderate adverse** significance, which **is significant** in EIA terms.

760. Overall, the magnitude of impact **negligible** to **medium** for harbour seal. For harbour seal, the effect is therefore of **negligible** to **moderate adverse** significance, which **is significant** in EIA terms.

12.8.3.1.4 c) Combined Disturbance from All Other Industries and Activities (i. – iv.)

12.8.3.1.4.1 Impact Magnitude – Quantified Assessment

761. A quantitative assessment for disturbance from all underwater noise sources associated with various industries and activities (i. -iv.) is presented in **Table 12-86**. It is crucial to consider all caveats and assumptions detailed in each assessment section (1a and 1b) when interpreting the magnitudes derived from this assessment. The table also emphasises on the magnitudes if assessed only based on known activities ("*without indicative activities*").

Table 12-86 Quantified Assessment of Disturbance for All Potential Noisy Sources Occurring Simultaneously with Piling at the Project and other OWFs (activities in grey are indicative only; no formal application has been made; green shades are to help with visual presentation only)

Impact	**Number of Individuals**							
	Harbour porpoise	Bottlenose dolphin – GNS	Bottlenose dolphin - CES	White-beaked dolphin	Common dolphin	Minke whale	Grey seal	Harbour seal
Worst-case disturbance from The Project	*5,015*	*67*	*9*	*184*	*111*	*44*	*184*	*0.03*
Piling at other OWF	36,634	192	*not assessed*	2,021	676	274	9,386	837
Geophysical surveys	*1,225*	*3*	*2*	*37*	*22*	*5*	*214*	*30*
Aggregates and dredging	4.4	0.01	*not assessed*	0.4	0.2	0.05	1.9	0.3
Seismic surveys	*3,230*	*19.7*	*10.1*	*276.3*	*164.7*	*30*	*2,169.2*	*301*
UXO clearance	*1,398*	*8.1*	*13.2*	*114.5*	*68.3*	*285.5*	*462.6*	*64.2*
Sub-sea Cables	28	0	*not assessed*	3	2	0.3	12	2
Total number of individuals	**47,534**	**290**	**34**	**2,636**	**1,044**	**639**	**12,430**	**1,234**
(without indicative activities)	*41,681*	*259*	*9*	*2,208*	*789*	*318*	*9,584*	*839*
Percentage of MU	**14.03%**	**14.35%**	**15.17%**	**6.00%**	**1.02%**	**3.18%**	**22.00%**	**24.72%**
(without indicative activities)	*12.30%*	*12.83%*	*3.98%*	*5.02%*	*0.77%*	*1.58%*	*16.96%*	*16.80%*
Magnitude of cumulative effect	**High**	**High**	**High**	**Medium**	**Low**	**Low**	**High**	**High**
(without indicative activities)	*High*	*High*	*Low*	*Medium*	*Negligible*	*Low*	*High*	*High*

762. This quantitative assessment is, however, highly precautionary, as some activities (geophysical surveys, seismic surveys, and UXO clearance) are included as indicative only, with no current information as to the potential for these activities to be taking place at the same time as piling at the Project. Regarding piling at other OWFs, it should also be noted that the inclusion of all other OWFs with similar construction dates is an unlikely scenario; many of these projects construction programmes will be refined closer to their dates of construction and it is unlikely that all included OWF would be able to pile at the same time as the Project due to the limited number of piling vessels currently available to undertake these works.

763. A second quantified assessment is presented in **Table 12-87** for harbour porpoise, bottlenose dolphin, minke whale, harbour and grey seal. This assessment uses the population modelling results (from **Section 12.8.3.1.2.3**) instead of quantified assessment numbers from piling at the Project and other OWFs to provide a more realistic overall prediction of effect.

764. Under the quantitative assessment (**Table 12-86**), for harbour porpoise and bottlenose dolphin there is the potential for a **high** magnitude of effect, if all included activities were to take place at the same time. For harbour porpoise and bottlenose dolphin in the GNS MU, the potential for a **high** magnitude of effect remains, regardless of whether the indicative activities are included. However, for bottlenose dolphin in the CES MU, the potential impact is reduced to **low** if the indicative activities are excluded. The results of the assessments with the population modelling results reduces the magnitude of effect for both harbour porpoise and bottlenose dolphin to **low** (**Table 12-87**).

765. For white-beaked dolphin, the results of the quantitative assessment show there is the potential for a **medium** magnitude of effect, either with or without the indicative activities (**Table 12-86**).

766. For common dolphin, the magnitude of effect is **low** with all included activities, and negligible if the indicative activities are not considered (**Table 12-86**).

767. For minke whale, the magnitude of effect is **low** under the quantitative assessment (**Table 12-86**) and under the population modelling (with or without indicative activities), the magnitude of effect is **high** (**Table 12-87**).

768. For grey seal and harbour seal, the quantitative assessment shows the potential for a **high** magnitude of effect, with or without indicative activities (**Table 12-86**). Under the population modelling, this is reduced to a magnitude of **medium** or **high** for all activities (for grey seal and harbour seal respectively), and **low** or **medium** without indicative activities (for grey seal and harbour seal respectively) (**Table 12-87**).

12.8.3.1.4.2 Cumulative Effect Significance 1c) Piling with Other Industries and Activities

769. As it has been highlighted in **Volume 2, Appendix 12.5 Cumulative Assessment Screening**, some projects and activities included in the cumulative disturbance assessment are based on speculative assessments, as there are no current licenses or pending applications to confirm timing or specifics. However, the likelihood of these activities occurring and overlapping with Project piling is low. For example, there are no current licences or licence applications for seismic surveys, so they have been included for informational purposes only. It is very unlikely that all activities would occur on the same day or in the same season, making this assessment an over-precautionary and worst-case estimate of the marine mammals potentially at risk of disturbance during the five-year offshore construction period of the Project.

770. The results of the quantified disturbance assessment highlighted significant effects on the populations of harbour porpoise, bottlenose dolphin, white-beaked dolphin, grey seal and harbour seal (see **Section 12.8.3.1.3.1**). As a result, population modelling was conducted for these species (excluding white-beaked dolphin), as well as minke whale, for which the necessary modelling parameters are available.

771. A summary of the magnitudes and resulting effect significances is provided in **Table 12-88**, based on both the overall quantitative disturbance assessment, and the overall assessment that includes the population modelling results.

772. All marine mammal species have a sensitivity of **medium** as a result of disturbance from underwater noise.

773. For harbour porpoise and bottlenose dolphin, under the overall quantitative assessment, the overall effect significance is **major adverse** which **is significant** in EIA terms, while the overall assessment (with the inclusion of population modelling) identified a **minor adverse** effect which **is not significant** in EIA terms (**Table 12-88**).

774. For common dolphin, the overall quantitative assessment resulted in a magnitude of **low**, therefore the effect significance is **minor adverse** overall which **is not significant** in EIA terms. For white-beaked dolphin, the overall quantitative assessment resulted in a magnitude of **medium**, therefore the effect significance is **moderate adverse** overall which **is significant** in EIA terms (**Table 12-88**).

775. For minke whale, the overall quantitative assessment resulted in a magnitude of **low**, therefore the effect significance is **minor adverse** overall which **is not significant** in EIA terms, while the overall assessment (with the inclusion of the population modelling results) identified a **major adverse** effect which **is significant** in EIA terms (**Table 12-88**).

Table 12-87 Quantified Assessment of Disturbance Including Population Modelling for All Potential Noisy Sources Occurring Simultaneously with Piling at the Project and other OWFs (activities in grey are indicative only; no formal application has been made; green shades are to help with visual presentation only))

Impact	**Number of Individuals**				
	Harbour porpoise	Bottlenose dolphin – GNS	Minke whale	Grey seal	Harbour seal
Disturbance from The Project and other OWFs through Population modelling (following the first six years)	*<2%*	*<1%*	*19%*	*<1%*	*7.5%*
Geophysical surveys	*1,225*	*3*	*5*	*214*	*30*
Aggregates and dredging	4.4	0.01	0.05	1.9	0.3
Seismic surveys	*3,230*	*19.7*	*30*	*2,169.2*	*301*
UXO clearance	*1,398*	*8.1*	*285.5*	*462.6*	*64.2*
Sub-sea Cables	28	0	0.3	12	2
Total number of individuals	**5,885**	**31**	**321**	**2,860**	**397**
(without indicative activities)	32	0.2	0.4	14	2
Percentage of MU	**3.7%**	**2.5%**	**20.6%**	**6.1%**	**15.5%**
(without indicative activities)	2.01%	1.01%	19.00%	1.03%	7.54%
Magnitude of cumulative effect	**Low**	**Low**	**High**	**Medium**	**High**
(without indicative activities)	Low	Low	High	Low	Medium

Table 12-88 Assessment of Effect Significance for Cumulative Disturbance of Marine Mammals from Underwater Noise During Piling at the Project and at all Other Noisy Projects and Activities (N/A = Not Applicable)

Species / receptor	Impact	Sensitivity	Magnitude	Effect significance	Additional mitigation measures proposed	Residual effect
Harbour porpoise	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**	Additional management measures to be considered prior to DCO submission. See **Section 12.1.1.1.1** below.	**Significant (major adverse)**
	iPCoD modelling		**Low**	**Not Significant (minor adverse)**		**Not Significant (minor adverse)**
Bottlenose dolphin	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**		**Significant (major adverse)**
	iPCoD modelling		**Low**	**Not Significant (minor adverse)**		**Not Significant (minor adverse)**
Common dolphin	Quantitative assessment	**Medium**	**Low**	**Not Significant (minor adverse)**		**Not Significant (minor adverse)**
White-beaked dolphin	Quantitative assessment	**Medium**	**Medium**	**Significant (moderate adverse)**		**Significant (moderate adverse)**
Minke whale	Quantitative assessment	**Medium**	**Low**	**Not Significant (minor adverse)**		**Not Significant (minor adverse)**
	iPCoD modelling		**High**	**Significant (major adverse)**		**Significant (major adverse)**
Grey seal	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**		**Significant (major adverse)**
	iPCoD modelling		**Medium**	**Significant (moderate adverse)**		**Significant (moderate adverse)**
Harbour seal	Quantitative assessment	**Medium**	**High**	**Significant (major adverse)**		**Significant (major adverse)**
	iPCoD modelling		**High**	**Significant (major adverse)**		**Significant (major adverse)**

776. For grey seal and harbour seal, the overall quantitative assessment resulted in a magnitude of **high**, therefore the effect significance is **major adverse** overall which **is significant** in EIA terms. The overall assessment (with the inclusion of the population modelling results) identified a **major adverse** effect for grey seal, and a **moderate adverse** effect for harbour seal which **is significant** in EIA terms (**Table 12-88**).

777. Therefore, as shown in **Table 12-88**, all marine mammal species (with the exception of common dolphin) have the potential for significant effect which will require management.

778. The confidence in this overall CEA is considered medium, as it was deemed sufficiently precautionary to comfortably encompass the likely uncertainty and variability. Throughout the assessment, it has been clearly indicated where multiple and compounding precautionary assumptions have been made. Where possible, uncertainties in the data, typically used to inform CEAs, and the quantification of impacts (when based on published ESs) have been removed. Where such data was lacking, a standard impact range for disturbance and the same source for density estimates (e.g. Waggitt *et al (*2019) over the IAMMWG MUs (2023) and Carter *et al (*2022) seal-at sea density estimates) has been used when calculating effects for each given impact. However, consideration has been given to a number of plans or projects / activities and the likelihood of temporal overlap of all these activities is low.

12.8.3.1.4.3 Additional Mitigation and Residual Effect

779. As set out in **Table 12-7**, the **Outline MMMP** (document reference 8.1) the MMMP will include information on additional mitigation measure options for potential noise reduction methods in line with the latest guidance and advice. The assessments of effect for disturbance from piling at the Project will be undertaken again for the ES, assuming the use of noise reduction technology, with the expectation that monopiles may remain within the project design and a significant effect is predicted. Updated guidelines will be taken into account regarding the use of noise reduction at the time of DCO submission.

780. The UK Government and Defra (2025) have released a policy paper in January 2025 on marine noise and "*expect that all offshore wind pile driving activity across all English waters will be required to demonstrate that they have utilised best endeavours to deliver noise reductions through the use of primary and/or secondary noise reduction methods in the first instance*". With respect to this policy paper and the effect it will have on commitments to NAS, the Project will investigate and consider the requirement for the use of NAS prior to DCO submission.

781. Note that while the Project will further investigate the requirement for the use of NAS prior to DCO submission, the potential for any cumulative effects to be effectively managed may rely on other OWFs also committing to the use of noise reduction, as DBD reducing noise at source alone may not sufficiently reduce the potential for a significant disturbance effect for all species.

12.8.3.2 Cumulative Impact 2: Behavioural Impacts Resulting from Vessel Presence (MM-C-06 & MM-O-06)

782. There are 14 offshore wind farms (see **Table 12-65**) that overlap with the Project's offshore construction period. As piling is the worst-case disturbance effect for all OWFs, the presence of construction vessels at these 14 OWFs would not cause a greater disturbance effect than what has already been considered in **Section 12.8.3.1.2**. Therefore, these 14 OWFs with potentially overlapping construction periods are not considered further in the following assessment.

783. As discussed in **Volume 2, Appendix 12.5 Cumulative Assessment Screening Section 12.5.4**, the cumulative effect of underwater noise from operational wind turbines was screened out based on the minimal impact ranges modelled. Additionally, as discussed in **Section 12.7.2.2**, the behavioural effects caused by underwater noise from operational wind turbines are considered to be **negligible** for the Project alone.

784. However, the presence of vessels during the Project's construction period, in addition to the O&M vessels at other OWFs (see **Table 12-65**) could lead to a potential significant effect in regard to disturbance to marine mammals.

12.8.3.2.1 Receptor Sensitivity

785. The sensitivity for all marine mammals species is considered to be **medium** (see **Section 12.7.1.4.1)**.

12.8.3.2.2 Magnitude

786. While some published ESs exist for the overlapping projects, they vary in the type of data provided. Some ESs estimate the number of vessels that could be on site at any given time, while others report the total number of return trips in a year. Consequently, the exact number of vessels present at all wind farm sites during their operation remains unknown. For projects with available data, the number of vessels on site could range from six to 26, with annual return trips ranging from 1,433 to 2,885.

787. If the response to vessels is displacement from the area, marine mammals will return once the vessel has passed, and therefore any impacts from vessel presence will be both localised and temporary. As outlined in **Section 12.7.2.4**, the disturbance from vessels during O&M is considered a long-term impact, and as such there is a repetitive exposure to vessel disturbance over the lifetime of the induvial projects.

788. Currently available monitoring studies for operational wind farms suggests that marine mammals are not significantly disturbed, and that any impact is localised and temporary (e.g. Diederichs *et al.,* 2008; Teilmann *et al.,* 2006; McConnell *et al.,* 2012). Harbour porpoise and seals have also been found to continue to forage within operational wind farm sites (Lindeboom *et al.,* 2011; Russell *et al.,* 2014; Leemans & Fijn, 2023). These monitoring studies suggest that there is no significant disturbance from operational wind farms, which may have a number of vessels present at any one time.

789. Vessels associated with operational OWFs are likely to undertake similar activities to those for construction, albeit with much lower frequency. Russell (2016) found that harbour seal foraged within an area undergoing OWF construction. Benhemma-Le Gall *et al (*2021) found that harbour porpoise could be disturbed up to 4km from construction related vessels, although a higher proportion are disturbed at 2km. It is expected that the vessel movements to an operational OWF, and from any port, will be incorporated within existing vessel routes and therefore to areas where marine mammals may already be accustomed to their presence.

790. The increase in vessel presence from operational OWFs is expected to be relatively small compared to the baseline of vessel movements in the area. Best practice measures, as implemented for the Project (see **Section 12.7.1.7.4**), are expected to be in place for all operational OWFs, further reducing the potential for disturbance. Once on-site, vessels would either be stationary or slow moving while undertaking their activities, which would minimise further the potential for disturbance. However, in a worst-case scenario, the array areas could become sources of disturbance if multiple vessels were present simultaneously. This type of scenario is illustrated in **Figure 12-9** for construction vessels. It is not expected that disturbance would be greater than the array area itself as far fewer vessels would be present during operation than during construction. Furthermore, the space between the individual projects and corridors within the array sites would allow sufficient space for marine mammals to travel in between, reaching their foraging grounds, haul-out sites or migration routes.

791. The magnitude of impact is therefore considered to be **low** but it is considered to be a long-term effect due to its prolonged duration, despite the minimal intensity.

12.8.3.2.3 Cumulative Effect Significance

792. Overall, it is predicted that sensitivity is **medium** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which **is not significant** in EIA terms.

12.8.3.3 Cumulative Impact 3: Disturbance at Seal Haul-Out Sites (MM-C-08 & MM-O-08)

793. There is the potential for the number of overlapping projects to have a cumulative effect on seal haul-out sites in terms of behavioural effects caused by underwater noise from noisy activities and vessel presence.

12.8.3.3.1 Receptor Sensitivity

794. The sensitivity of grey seal and harbour seal is considered to be **low** (see **Section 12.7.1.6**).

12.8.3.3.2 Magnitude

795. The Project and all other piling overlapping OWFs are located over 100km from the coast. The cumulative impacts from piling disturbance would not affect coastal haul-out sites, as the known disturbance range for seals is 25km (Russell *et al.,* 2016).

796. Those projects that are within closer (<100km) distance to the coast are operational, and as assessed in **Section 12.7.2.4**, behavioural impacts from O&M activities in the cable corridors or the array sites would be limited as few vessels per year are in operation, and as such the effect from vessels conducting the noisy work would be temporary and localised.

797. As outlined in **Section 12.7.1.6**, seals in coastal areas are often already accustomed to high traffic levels. The increase in vessel traffic or maintenance activities would not cause a rise in levels of disturbance.

798. The magnitude of impact is therefore considered to be **low**.

12.8.3.3.3 Cumulative Effect Significance

799. Overall, it is predicted that sensitivity of seal is **low** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which **is not significant** in EIA terms.

800. Best practice measures would be implemented by the Project, such as reducing vessel transit speeds, wherever possible, and the avoidance of transiting within 1km (outside of established navigation routes) of any seal haul-out site.

801. It has been assumed that all other projects would follow the similar best practice measures with regards to avoiding disturbance at haul-out sites if deemed required, unless within an established navigation route where seal haul-out sites are near to a vessel corridor (where seals present in that area would be used to vessels transiting past the area).

12.8.3.4 Cumulative Impact 4: Vessel Interaction (Increased Risk in Collision (MM-C-09 & MM-O-09)

802. The potential for vessels interacting with marine mammals due to an increased risk in collision with construction or O&M vessels, as discussed in **Section 12.7.1.7** and **Section 12.7.2.7**, concluded a **minor adverse** significance, which **is not significant** in EIA terms. However, the cumulative volume of annual vessel transits as outlined in **Section 12.8.3.2** traveling from the ports to the array sites would potentially pose an increased risk to marine mammals in the array, considering the proximity of several projects in the area (**Table 12-65**).

12.8.3.4.1 Receptor Sensitivity

803. Detailed information regarding sensitivities is outlined in **Section 12.7.1.7**. The sensitivity of marine mammals is therefore considered to be **medium** for minke whale, and **low** for all other marine mammal receptors.

12.8.3.4.2 Magnitude

804. Vessels would be intermittently present throughout the lifetime of the Project. As vessel movements to and from any port would be incorporated within existing vessel routes as far as possible, there would be no increased collision risk, as the increase in the number of OWF vessels would be relatively small compared to the baseline levels of vessel movements in these areas. Once on-site, OWF vessels and other construction-related vessels would be stationary or slow-moving as they undertake their associated activities.

805. As detailed in **Section 12.7.1.7.4**, best practice measures would reduce the risk of collision further.

806. To minimise the risk of marine mammal collisions, vessel movements will be integrated into recognised routes where marine mammals are accustomed to vessels (where possible). The number of vessel movements will be kept to the necessary minimum, and speeds will be reduced where practicable during transit.

807. Vessel operators for the Project, North Falls (SSE & RWE, 2024), Sheringham Shoal and Dudgeon Extension (Equinor, 2022) are committed to following best practices outlined in the **Outline PEMP** (document reference 8.6) to further reduce collision risks. Hornsea Four (Orsted, 2021) and Outer Dowsing (Outer Dowsing Offshore Wind, 2024) have proposed to adopt a VMP to minimise the potential for any impact. West of Orkney (Offshore Wind Power Limited, 2023), Five Estuaries (Five Estuaries OWF Limited, 2024) and Rampion 2 (Rampion 2 Wind Farm, 2023) have proposed to adopt a best practice vessel handling protocols such as the WiSe Scheme[21] or Guide to Best Practice for Watching Marine Wildlife[22]. It is expected that other offshore projects and industries will adopt similar measures to mitigate the potential for marine mammal collisions, with Hornsea Three (Orsted, 2018), Dogger Bank A and B (Forewind, 2014) and DBS (East and West) (RWE, 2024) also committed to these practices.

808. 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 was considered to be extremely low or **negligible**. Increased collision risk from aggregate extraction and dredging has therefore been screened out from further consideration in the CEA.

809. The magnitude of impact is therefore considered to be **low**.

12.8.3.4.3 Cumulative Effect Significance

810. Overall, it is predicted that sensitivity of minke whale is **medium** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which **is not significant** in EIA terms.

811. Overall, it is predicted that sensitivity of the harbour porpoise, dolphins and seals is **low** and the magnitude of impact is **low**. The effect is therefore of **minor adverse** significance, which **is not significant** in EIA terms.

812. As vessel movements to and from any port would be incorporated within existing vessel routes as far as possible, there would be no increased collision risk as the increase in the number of OWF vessels would be relatively small compared to the baseline levels of vessel movements in these areas. Once on-site, OWF vessels and other construction related vessels would be stationary or slow moving, as they undertake the activity they are associated with.

12.8.3.5 Cumulative Impact 5: Changes to Prey Resource (MM-C-10 & MM-O-10)

813. There is the potential for impacts to prey species at other projects to cumulatively and indirectly effect marine mammal species.

[21] https://www.wisescheme.org/

[22] https://www.nature.scot/doc/guide-best-practice-watching-marine-wildlife-smwwc

12.8.3.5.1 Receptor Sensitivity

814. The sensitivity of harbour porpoise and minke whale is considered to be **low** to **medium,** and for seals and dolphins is **low** (see **Section 12.7.1.8**).

12.8.3.5.2 Magnitude

815. For any potential changes to prey resources, it has been assumed that any potential effects from underwater noise, including piling , on marine mammal prey species would be the same or less than those for marine mammals (see **Section 12.7.1.8**). Therefore, there would be no additional cumulative effects other than those assessed for marine mammals, i.e. if prey is disturbed from an area as a result of underwater noise, marine mammals could be disturbed from the same or greater area. As a result, any changes to prey resources would not affect marine mammals as they would already be disturbed from the area.

816. Any effects to prey species (such as seabed disturbance and associated suspended sediment concentrations) 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 for prey species in the surrounding area.

817. Based on the assessment for the Project-alone, and assuming similar effects from other projects and activities (assessed as minor adverse effects in the DBS OWF ES), along with the variety of prey species marine mammals rely on and the extent of their foraging ranges, there would be no potential for cumulative effects on marine mammal populations as a result of changes in prey resources.

818. The magnitude of impact is therefore considered to be **negligible**.

12.8.3.5.3 Cumulative Effect Significance

819. Overall, it is predicted that the sensitivity for dolphins and seals is **low**, and the magnitude of impact is **negligible** in all cases. Therefore, for dolphin and seal species, the overall effect is **negligible adverse** which is **not significant** in EIA terms.

820. For harbour porpoise and minke whale, the sensitivity is **low** to **medium** and the magnitude of impact is **negligible**. The effect is therefore of **negligible adverse** significance, which is **not significant** in EIA terms.

821. No additional mitigation has been identified as being required for the potential for cumulative effects to prey species.

12.9 Transboundary Effects

822. Due to the highly mobile nature of marine mammals included in this assessment, there is the potential for transboundary impacts. 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 part of a larger overall population). The MUs (and therefore reference populations) for each species extend beyond the UK (**Table 12-89**). This approach has been consistently applied across all assessments.

Table 12-89 Countries Considered in the Marine Mammal Assessments Through the Relevant MU Reference Population

<table>
<tr><th>Species</th><th>Countries</th><th>Inclusion within assessment</th></tr>
<tr><td>Harbour Porpoise</td><td rowspan="3">Germany
Netherlands
Belgium
France
Denmark
Sweden
Norway</td><td>Part of the North Sea MU (Gilles et al., 2023; see Volume 2, Appendix 12.2 Marine Mammals Technical Report).
CEA screening area (see Volume 2, Appendix 12.5 Cumulative Assessment Screening).</td></tr>
<tr><td>Bottlenose dolphin</td><td>Part of the GNS MU and CES MU (IAMMWG, 2023; see Volume 2, Appendix 12.2 Marine Mammals Technical Report).
CEA screening area (see Volume 2, Appendix 12.5 Cumulative Assessment Screening).</td></tr>
<tr><td>Common dolphin, white-beaked dolphin and minke whale</td><td>Part of the CGNS MU (IAMMWG, 2023; see Volume 2, Appendix 12.2 Marine Mammals Technical Report).
CEA screening area (see Volume 2, Appendix 12.5 Cumulative Assessment Screening).</td></tr>
<tr><td>Grey seal and harbour seal</td><td>None</td><td>Apart from the UK, countries bordering the North Sea are not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts on the same population as assessed for the Project.</td></tr>
</table>

823. There is a substantial level of marine development currently underway, or planned, by other countries (including Belgium, the Netherlands, Germany and Denmark) in the (southern) North Sea. Each of these countries have its own environmental assessment requirements and regulations. As noted above, because marine mammals are highly mobile, there is potential for transboundary impacts, particularly relating to noise. In addition, the potential for DBD to impact marine mammals from designated sites has been assessed in the **RIAA** (document reference 5.3).

12.10 Inter-Relationships and Effect Interactions

824. Inter-relationships are defined as effects arising from residual effects associated with different environmental topics acting together upon a single receptor or receptor group. Potential inter-relationships between marine mammals and other environmental topics have been considered, where relevant, within the PEIR. **Table 12-90** provides a summary of key inter-relationships and signposts to where they have been addressed in the relevant chapters.

Table 12-90 Marine Mammals – Inter-Relationships with Other Topics

Impact ID	Impact and Project Activity	Related EIA Topic	Where Assessed in the PEIR Chapter	Rationale
Construction				
MM-C-05	Underwater noise: physical and auditory injury resulting from noise associated with other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	**Chapter 15 Shipping and Navigation**	**Section 12.7.1.3**	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
MM-C-09	Vessel interaction (increase in risk of collision) – from vessel movement relating to all aspects of construction of the project	**Chapter 15 Shipping and Navigation**	**Section 12.7.1.7**	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
MM-C-10	Changes to prey resource – from construction of wind turbines, cables and foundations	**Chapter 11 Fish and Shellfish Ecology**	**Section 12.7.1.8**	Potential effects on fish species could affect the prey resource for marine mammals.
MM-C-12	Changes to water quality (sediment bound contaminants in the offshore ECC – from installation of cables and foundations	**Chapter 8 Marine Physical Processes** **Chapter 9 Marine Water and Sediment Quality**	**Section 506**	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Operation and Maintenance				
MM-O-05	Underwater noise: physical and auditory injury from noise associated with maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	**Chapter 15 Shipping and Navigation**	**Section 12.7.2.3**	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
MM-O-09	Vessel interaction (increase in risk of collision) – from all vessel movements relating to operation and maintenance activities	**Chapter 15 Shipping and Navigation**	**Section 12.7.2.7**	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
MM-O-10	Changes to prey resource – from presence of wind turbines, cables and foundations	**Chapter 11 Fish and Shellfish Ecology**	**Section 12.7.2.8**	Potential effects on fish species could affect the prey resource for marine mammals.
MM-O-12	Changes to water quality (sediment bound contaminants in the offshore ECC) – from presence of cables and foundations	**Chapter 8 Marine Physical Processes**	**Section 12.7.2.9**	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.

Impact ID	Impact and Project Activity	Related EIA Topic	Where Assessed in the PEIR Chapter	Rationale
Decommissioning				
MM-D-06	Underwater noise: behavioural impacts – decommissioning activities not yet defined.	**Chapter 15 Shipping and Navigation**	**Section 12.7.3**	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
MM-D-09	Vessel interaction (increase in risk of collision) – decommissioning activities not yet defined.	**Chapter 15 Shipping and Navigation**		Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
MM-D-12	Changes to water quality (Sediment bound contaminants in the offshore ECC) – decommissioning activities not yet defined.	**Chapter 8 Marine Physical Processes** **Chapter 9 Marine Water and Sediment Quality**		Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
MM-D-10	Changes to prey resource – decommissioning activities not yet defined.	**Chapter 11 Fish and Shellfish Ecology**		Potential effects on fish species could affect the prey resource for marine mammals.

825. The impacts identified and assessed in this chapter have the potential to interact with each other. Potential interactions between impacts are identified in **Table 12-91**. Where there is potential for interaction between impacts, these are assessed in **Table 12-90**Table 12-92 for each receptor or receptor group.

826. Interactions are assessed by development phase ("phase assessment") to see if multiple impacts could increase the overall effect significance experienced by a single receptor or receptor group during each phase. Following from this, a lifetime assessment is undertaken which considers the potential for multiple impacts to accumulate across the construction, operational and decommissioning phases and result in a greater effect on a single receptor or receptor group. When considering synergistic effects from interactions, it is assumed that the receptor sensitivity remains consistent, while the magnitude of different impacts is additive.

Table 12-91 Marine Mammals – Potential Interactions between Impacts

Construction and O&M																			
	MM-C-01	**MM-C-02**	**MM-C-05**	**MM-C-06**	**MM-C-07**	**MM-C-08**	**MM-C-09**	**MM-C-10**	**MM-C-12**	**MM-O-03**	**MM-O-04**	**MM-O-05**	**MM-O-06**	**MM-O-07**	**MM-O-08**	**MM-O-09**	**MM-O-10**	**MM-O-12**	**MM-O-13**
MM-C-01		Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MM-C-02	No		Yes	Yes	Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MM-C-05	Yes	Yes		Yes	Yes	No	No	Yes	No	No	No	No	No	No	No	No	No	No	No
MM-C-06	No	Yes	No		Yes	No	No	No	No	No	No	No	No	No	No	No	No	No	No
MM-C-07	No	Yes	Yes	Yes		No	No	No	No	No	No	No	No	No	No	No	No	No	No
MM-C-08	No	No	No	Yes	No		No	No	No	No	No	No	No	No	No	No	No	No	No
MM-C-09	No	No	No	No	No	No		No	No	No	No	No	No	No	No	No	No	No	No
MM-C-10	No	No	No	No	No	No	No		Yes	No	No	No	No	No	No	No	No	No	No
MM-C-12	No	No	No	No	No	No	No	Yes		No	No	No	No	No	No	No	No	No	No
MM-O-03	No	No	No	No	No	No	No	No	No		Yes	Yes	Yes	No	No	No	No	No	No
MM-O-04	No	No	No	No	No	No	No	No	No	No		Yes	Yes	Yes	No	No	No	No	No
MM-O-05	No	No	No	No	No	No	No	No	No	Yes	Yes		Yes	No	No	No	No	No	No
MM-O-06	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes		Yes	Yes	No	No	No	No
MM-O-07	No	No	No	No	No	No	No	No	No	No	Yes	No	Yes		No	No	No	No	No
MM-O-08	No	No	No	No	No	No	No	No	No	No	No	No	Yes	No		No	No	No	No
MM-O-09	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No		No	No	No
MM-O-10	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No		Yes	No
MM-O-12	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	Yes		No
MM-O-13	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No	

Decommissioning	
MM-D-05 MM-D-06 MM-D-07 MM-D-08 MM-D-09 MM-D-10 MM-D-12	The details and scope of offshore decommissioning works will be determined by the relevant regulations and guidance at the time of decommissioning and provided in the Offshore Decommissioning Plan (see Commitment ID CO21 in **Volume 2, Appendix 6.3 Commitments Register**). For this assessment, it is assumed that interactions during the decommissioning phase would be of similar nature to, and no worse than, those identified during the construction phase.

Table 12-92 Interaction Assessment – Phase and Lifetime Effects

Impact ID	Impact and Project Activity	Receptor	Highest Significance Level			Phase Assessment	Lifetime Assessment
			Construction	Operation and Maintenance	Decommissioning		
MM-C-01 MM-C-02 MM-C-05 MM-O-03 MM-O-04 MM-O-05 MM-O-06	Impacts relating to injury and disturbance effects from underwater noise related to the Project	Marine mammal species	**Major adverse**	**Minor adverse**	TBC – Assumed no greater than construction	**Construction:** No greater than individually assessed impact. Marine mammals that would receive the noise are also likely to be disturbed from the same noise. This effect of unmitigated piling has already been assessed as major adverse, representing the worst-case scenario for disturbance and noise. Therefore, the effect from both effects would not be greater than that. **Operation:** No greater than individually assessed impact. Marine mammals with varying levels of hearing sensitivity could be experiencing auditory injury or disturbance from the turbine noise and be further affected by ongoing maintenance activities and vessel presence. However, operational noise would be localised around the turbines and the infrequent maintenance activity or vessel presence would have no potential to interact with each other. **Decommissioning:** No greater than individually assessed impact. Although the exact removal techniques are unknown, it is expected that the effect would be similar to those assessed during construction (except for piling).	No greater than individually assessed impact. The greatest magnitude of impact would be the spatial footprint of construction noise (i.e. piling). Once this disturbance impact has ceased all further impact during construction and O&M would be small scale, highly localised and episodic. There is no evidence of long-term displacement of marine mammals from operational wind farms. It was therefore considered that over the Project lifetime these impacts would not combine and represent an increase in potential impacts relating to injury and disturbance effects from project related underwater noise.
MM-C-08 MM-C-06 MM-O-08 MM-O-06	Disturbance at seal haul-out sites from underwater noise related to the Project	Seals	**Minor adverse**	**Minor adverse**	TBC – Assumed no greater than construction	**Construction:** No greater than individually assessed impact. Given that the haul-out sites are not near the Array Area or offshore ECC, any disturbance to seals at their haul-out site is most likely to be caused by passing vessels rather than construction activities. The same applies to all phases. **Operation:** No greater than individually assessed impact. **Decommissioning:** No greater than individually assessed impact.	No greater than individually assessed impact.

12.11 Monitoring Measures

827. Further potential monitoring measures for marine mammals will be developed if required through the EIA process and identified in the ES.

12.12 Summary

828. The assessment has established that there will be some minor adverse residual effects during the construction, operation and decommissioning phases of the Project, which is considered **not significant** in EIA terms. While most effects are short-term and localised, disturbance effects to marine mammals can extend beyond the Project area. However, these effects are considered temporary and are recoverable over time. **Table 12-93** presents a summary of the preliminary results of the assessment of likely significant effects on marine mammals during the construction, operational and decommissioning of the Project.

12.13 Next Steps

829. Between the submission of the PEIR and the final ES as part of the DCO application, the following actions will be undertaken:

- **Updates to underwater noise modelling**: These updates will address non-material changes, requirement for NAS as per latest UK Government and Defra (2025) policy, and the anticipated Defra noise dB limit for piling operations will be in place by 2028. This will necessitate modelling with mitigation measures to adhere to new best practices;
- **Revisions to SCOS reports**: These revisions will involve recalculating seal densities and reference populations, followed by subsequent assessments;
- Potential publication of new harbour seal dose-responses using Whyte (2022) data;
- Potential publication of updated EDRs for harbour porpoise;
- **CEA**: Until 6 months prior to DCO submission, the list of plans and projects will be updated to the Planning Inspectorate status, and updates to the assessment will be made; and
- **Ongoing and regular consultation with stakeholders**: This will be conducted throughout 2025 via ETGs. A particular focus are the disturbance ranges for piling and UXO; and the CEA.

Table 12-93 Summary of Potential Effects Assessed for Marine Mammals

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
Construction									
MM-C-01	Underwater noise: physical and auditory injury – from impact piling during construction PTS single strike	CO22	All marine mammal species	**High**	**Negligible**	**Minor adverse (not significant)**	**Outline MMMP** (document reference 8.1) (CO22)	**Minor adverse (not significant)**	Monitoring of underwater piling noise
	Underwater noise: physical and auditory injury – from impact piling during construction PTS cumulative exposure – from sequential piling		Harbour porpoise		**Medium**	**Major adverse (significant)**		**Minor adverse (not significant)**	
			Bottlenose dolphin		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Minke whale		**Monopile: Medium** **Pin pile: Low**	**Monopile: Major adverse (significant)** **Pin pile: Moderate adverse (Significant)**		**Minor adverse (not significant)**	
			Common dolphin		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			White-beaked dolphin		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Grey seal		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Harbour seal		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
	Underwater noise: physical and auditory injury – from impact piling during construction PTS cumulative exposure – from concurrent piling		Harbour porpoise		**Medium**	**Major adverse (significant)**		**Minor adverse (not significant)**	
			Bottlenose dolphin		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Minke whale		**Medium**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Common dolphin		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
			White-beaked dolphin		**Negligible**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Grey seal		**Medium**	**Major adverse (significant)**		**Minor adverse (not significant)**	
			Harbour seal		**Medium**	**Major adverse (significant)**		**Minor adverse (not significant)**	
	Underwater noise: physical and auditory injury – from impact piling during construction TTS single strike	None	All marine mammal species	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
	Underwater noise: physical and auditory injury – from impact piling during construction TTS cumulative exposure from sequential piling		All marine mammal species		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
	Underwater noise: physical and auditory injury – from impact piling during construction TTS cumulative exposure from concurrent piling		Harbour porpoise		**Low**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
			Bottlenose dolphin		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			Minke whale		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			Common dolphin		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			White-beaked dolphin		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			Grey seal		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			Harbour seal		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
MM-C-02	Underwater noise: behavioural impacts – from impact piling during construction	None	Harbour porpoise and bottlenose dolphin	**Medium**	**Negligible to low**	**Negligible to Minor adverse (not Significant)**	N/A	**Negligible to Minor adverse (not Significant)**	None
			Common dolphin, white-beaked dolphin, and grey seal		**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			Minke whale and harbour seal		**Negligible**	**Negligible adverse (not significant)** **Minor adverse (not significant) under population modelling**		**Negligible to Minor adverse (not Significant)**	
MM-C-05	Underwater noise: physical and auditory injury resulting from noise associated with other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	CO18	All marine mammal species	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
MM-C-06	Underwater noise: behavioural impacts resulting from other construction activities- installation of offshore infrastructure, presence of vessels and vessel traffic	CO18	Harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
			Bottlenose dolphin	**Medium**	Other construction activities: **Negligible to low** **Vessels: Low**	**Other construction activities: Minor to Negligible adverse (not significant)** **Vessels: Minor adverse (not significant)**		**Negligible adverse (not significant)**	
MM-C-07	Barrier effects due to underwater noise – from piling activities and other construction activities, and presence of vessels offshore	None	All marine mammals	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
MM-C-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	CO18	Grey seal and harbour seal	**Medium**	**Negligible to low**	**Negligible to Minor adverse(not significant)**	Best practice measures (CO18; CO28)	**Negligible to Minor adverse(not significant)**	None
MM-C-09	Vessel interaction (increase in risk of collision) – from vessel movement relating to all aspects of construction of the project	CO18	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	**Low**	**Low**	**Minor adverse (not significant)**	Best practice measures (CO18; CO28)	**Minor adverse (not significant)**	None
			Minke whale	**Medium**	**Low**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
MM-C-10	Changes to prey resource – from construction of wind turbines, cables and foundations	CO25	Harbour porpoise and minke whale	**Low to Medium**	**Negligible to Low**	**Negligible to Minor adverse (not significant)**	N/A	**Negligible to Minor adverse (not significant)**	None
			Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	**Low**	**Negligible to Low**	**Negligible to Minor adverse (not significant)**		**Negligible to Minor adverse (not significant)**	
MM-C-12	Changes to water quality (sediment bound contaminants in the offshore ECC – from installation of cables and foundations	CO25	All marine mammal species	**Negligible**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
Operation and Maintenance									
MM-O-03	Underwater noise: physical and auditory injury – from operational and maintenance noise, operation of wind turbines	None	All marine mammal species	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
MM-O-04	Underwater noise: behavioural impacts – from operation of wind turbines	None	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	**Low**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
			Minke whale	**Medium**	**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
MM-O-05	Underwater noise: physical and auditory injury from noise associated with maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	None	All marine mammal species	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
MM-O-06	Underwater noise: behavioural impacts from maintenance activities -from maintenance of infrastructure, presence of vessels and vessel traffic	CO28	Harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
			Bottlenose dolphin	**Medium**	**Negligible to low**	**Negligible to Minor adverse (not significant)**		**Negligible to Minor adverse (not significant)**	
	Underwater noise: behavioural impacts – from vessel noise (including disturbance to foraging areas)		Harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	**Medium**	**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
			Bottlenose dolphin	**Medium**	**Negligible to low**	**Negligible to Minor adverse (not significant)**		**Negligible to Minor adverse (not significant)**	

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
MM-O-07	Barrier effects due to underwater noise – from underwater noise due to the operation of the wind turbines, as well as disturbance associated with underwater noise from O&M activities along with the presence of vessels offshore	None	All marine mammal species	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
MM-O-08	Disturbance at seal haul-out sites – from landfall works, and vessel transits to and from the Project and the local port	CO18 CO28	Grey seal and harbour seal	**Low**	**Low**	**Minor adverse (not significant)**	Best practice measures (CO18; CO28)	**Minor adverse (not significant)**	None
MM-O-09	Vessel interaction (increase in risk of collision) – from all vessel movements relating to operation and maintenance activities	CO18 CO28	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	**Low**	**Low**	**Minor adverse (not significant)**	Best practice measures (CO18; CO28)	**Minor adverse (not significant)**	None
			Minke whale	**Medium**	**Low**	**Minor adverse (not significant)**		**Minor adverse (not significant)**	
MM-O-10	Changes to prey resource – from presence of wind turbines, cables and foundations	CO25	Harbour porpoise and minke whale	**Low to Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
			Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	**Low**	**Negligible**	**Negligible adverse (not significant)**		**Negligible adverse (not significant)**	
MM-O-12	Changes to water quality (sediment bound contaminants in the offshore ECC) – from presence of cables and foundations	CO25	All marine mammal species	**Negligible**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None
MM-O-13	Physical Barrier Effect – from presence of wind farm infrastructure	None	All marine mammal species	**Medium**	**Negligible**	**Negligible adverse (not significant)**	N/A	**Negligible adverse (not significant)**	None

Impact ID	Impact and Project Activity	Embedded Mitigation Measures	Receptor	Receptor Sensitivity	Impact Magnitude	Effect Significance	Additional Mitigation Measures	Residual Effect	Monitoring Measures
Decommissioning									
MM-D-05	Underwater noise: physical and auditory injury – decommissioning activities not yet defined.	CO21	The details and scope of offshore decommissioning works will be determined by the relevant regulations and guidance at the time of decommissioning and provided in the Offshore Decommissioning Plan (see Commitment ID CO21 in **Volume 2, Appendix 6.3 Commitments Register**). This will include a detailed assessment of decommissioning impacts and appropriate mitigation measures to avoid significant effects. For this assessment, it is assumed that impacts during the decommissioning phase would be of similar nature to, and no worse than, those identified during the construction phase.						
MM-D-06	Underwater noise: behavioural impacts – decommissioning activities not yet defined.	CO21							
MM-D-07	Underwater noise: barrier effects – decommissioning activities not yet defined.	CO21							
MM-D-08	Disturbance at seal haul-out sites – decommissioning activities not yet defined.	CO21							
MM-D-09	Vessel interaction (increase in risk of collision) – decommissioning activities not yet defined.	CO21							
MM-D-10	Changes to prey resource – decommissioning activities not yet defined.	CO21							
MM-D-12	Changes to water quality (Sediment bound contaminants in the offshore ECC) – decommissioning activities not yet defined.	CO21							

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List of Acronyms

Acronym	Definition
ADD	Acoustic Deterrent Device
AIS	Automatic Identification System
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
AU	Assessment Unit
BAP	Biodiversity Action Plan
BEIS	Department for Business, Energy and Industrial Strategy [23]
BSH	Bundesamt fuer Seeschiffahrt und Hydrographie
BSI	British Standards Institution
CCW	Countryside Council for Wales
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture
CES	Coastal East Scotland
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CIEEM	Chartered Institute of Ecology and Environmental Management
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CL	Confidence Limit
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CPOD	Cetacean Porpoise Detector
CRA	Chemical Risk Assessment
CRoW	Countryside and Rights of Way Act
CRRU	Cetacean Research and Rescue Unit
CSIP	Cetacean Strandings Investigation Programme
CV	Coefficient of Variation
DAERA	Department of Agriculture, Environment and Rural Affairs
dB	decibel
DBD	Dogger Bank D
DBS	Dogger Bank South
DCO	Development Consent Order
DECC	Department of Energy and Climate Change [23]
Defra	Department for Environment, Food and Rural Affairs
DEP	Dudgeon Extension Project
DEPONS	Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea
DESNZ	Department for Energy Security and Net Zero
DOWL	Dudgeon OWF Limited
DRC	Dose-Response Curve
ECC	Export Cable Corridor
EDR	Effective Deterrence Radius
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field

[23] The DECC was merged with the BEIS in 2016. As of February 2023, BEIS is known as the DESNZ.

Acronym	Definition
EMODnet	European Marine Observation and Data Network
EPP	Evidence Plan Process
EPS	European Protected Species
ES	Environmental Statement
ETG	Expert Topic Groups
EU	European Union
FCS	Favourable Conservation Status
GNS	Greater North Sea
GPS	Global Positioning System
HDD	Horizontal Directional Drilling
HF	High Frequency
HM	His Majesty
HRA	Habitat Regulations Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
IFAW	International Fund for Animal Welfare
INSPIRE	Impulsive Noise Propagation and Impact Estimator
IPCC	Intergovernmental Panel on Climate Change
IPCOD	Interim Population Consequence of Disturbance
IUCN	International Union for Conservation of Nature
IWC	International Whaling Commission
JNCC	Joint Nature Conservation Committee
Kt	knots
LAT	Lowest Astronomical Tide
LF	Low Frequency

Acronym	Definition
MCRI	Marine Conservation Research International
MCZ	Marine Conservation Zone
MMObs	Marine Mammal Observers
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MPS	Marine Policy Statement
MRE	Marine Renewable Energy
MSFD	Marine Strategy Framework Directive
MU	Management Units
NAS	Noise Abatement Systems
NE	North-East
NI	Northern Ireland
NMFS	National Marine and Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NPS	National Policy Statement
NRW	Natural Resources Wales
NS	North Sea
NSIP	Nationally Significant Infrastructure Project
NW	North-west
O&M	Operation and Maintenance
OESEA	Offshore Energy Strategic Environmental Assessment
OP	Offshore Platform

Acronym	Definition
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment
ORJIP	Offshore Renewables Joint Industry Programme
OWF	Offshore Wind farm
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PEIR	Preliminary Environmental Information Report
PEMP	Project Environment Management Plan
PTS	Permanent Threshold Shift
QSR	Quality Status Report
RaDIN	Range Dependent Nature of Impulsive Noise
RIAA	Report to Inform Appropriate Assessment
RMS	Root Mean Square
RoC	Review of Consents
SAC	Special Area of Conservation
SBP	Sub-bottom Profiler
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SE	South-East
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level from cumulative exposure
SEL_{ss}	Sound Exposure Level from single strike
SEP	Sheringham Shoal Extension
SIP	In Principle Site Integrity Plan
SMRU	Sea Mammal Research Unit

Acronym	Definition
SNCBs	Statutory Nature Conservation Bodies
SNS	South North Sea
SPL	Sound Pressure Level
SPL_{peak}	Peak Sound Pressure Level
Spp.	Species plural
SW	South-west
SWF	SeaWatch Foundation
TTS	Temporary Threshold Shift
UK	United Kingdom
USBL	Ultra-Short Base Line
UXO	Unexploded Ordnance
VHF	Very High Frequency
VMP	Vessel Management Plan
WGMME	Working Group on Marine Mammal Ecology
WOZEP	Dutch Governmental Offshore Wind Ecological Programme
ZoI	Zone of Influence