RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Preliminary Environmental Information Report

Chapter 11 – Marine Mammals

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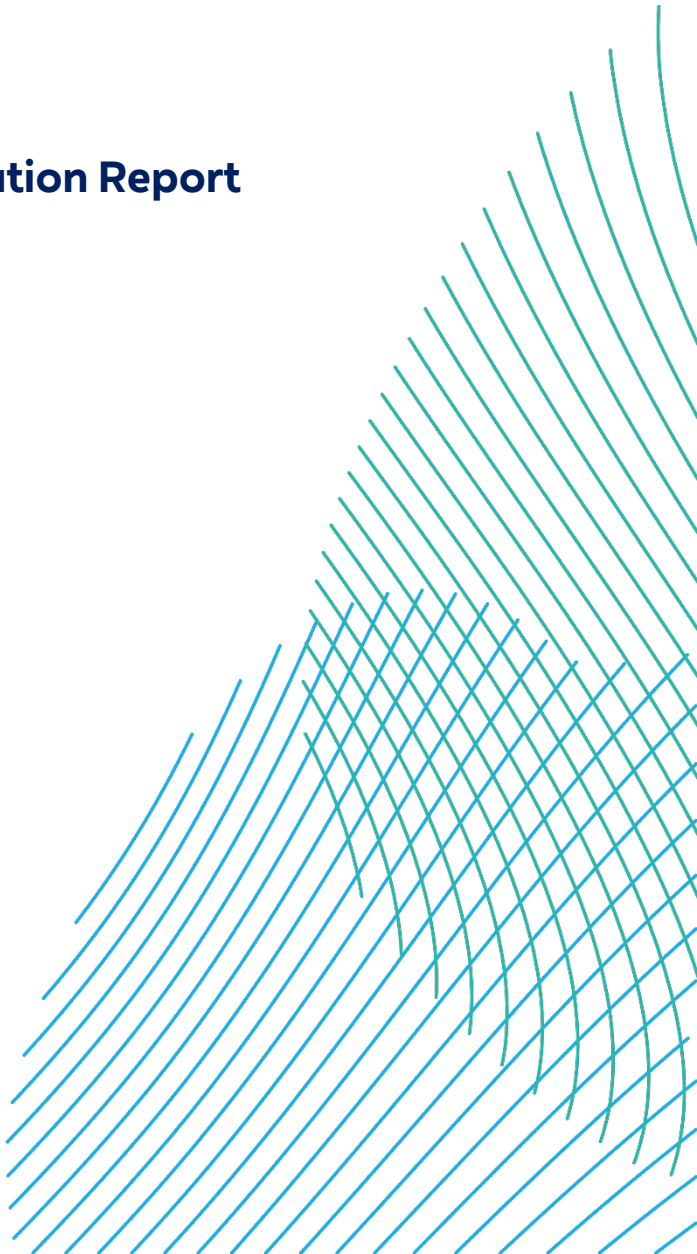

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Contents

Glossary 1
Acronyms 3
11 Marine Mammal Ecology 8
11.1 Introduction 8
11.2 Consultation 9
11.3 Scope 16
11.3.1 Study Area 17
11.3.2 Realistic Worst Case Scenario 18
11.3.2.1 General Approach 18
11.3.2.2 Development Scenarios 29
11.3.2.3 Construction Scenarios 29
11.3.2.4 Operation Scenarios 30
11.3.2.5 Decommissioning Scenarios 31
11.3.3 Mitigation Embedded in the Design 31
11.3.3.1 Other Mitigation 32
11.4 Assessment Methodology 34
11.4.1 Policy, Legislation and Guidance 34
11.4.1.1 National Policy Statements 34
11.4.1.2 National and Regional Marine Policies 41
11.4.1.3 National and International Legislation for Marine Mammals 41
11.4.1.4 Guidance Documents for Marine Mammals 42
11.4.1.5 Protected Species and Marine Wildlife Licence Guidance 43
11.4.1.6 Conservation Status of Marine Mammals 43
11.4.2 Data and Information Sources 45
11.4.2.1 Site Specific Surveys 45
11.4.2.2 Other available sources 46
11.4.3 Impact Assessment Methodology 49
11.4.3.1 Definitions 49
11.4.4 Cumulative Effect Assessment Methodology 55
11.4.5 Transboundary Effect Assessment Methodology 58
11.4.6 Assumptions and Limitations 58

11.5 Existing Environment 60
11.5.1 Harbour Porpoise 60
11.5.1.1 Results from the Site-Specific Surveys for Harbour Porpoise 61
11.5.1.2 Site-Specific Density estimates for Harbour Porpoise 61
11.5.1.3 Review of Abundance and Density Estimates for Harbour Porpoise 62
11.5.2 Bottlenose Dolphin 62
11.5.2.1 Desk-Based Review of Bottlenose Dolphin Presence 62
11.5.2.2 Results from the Site-Specific Surveys for Bottlenose Dolphin 63
11.5.2.3 Review of Abundance and Density Estimates for Bottlenose Dolphins 63
11.5.3 Common Dolphin 64
11.5.3.1 Desk-Based Review of Common Dolphin Presence 64
11.5.3.2 Results from the Site-Specific Surveys for Common Dolphin 64
11.5.3.3 Review of Abundance and Density estimates for Common Dolphin 64
11.5.4 White-Beaked Dolphin 65
11.5.4.1 Desk-Based Review of White-Beaked Dolphin Presence 65
11.5.4.2 Results from the Site-Specific Surveys for White-Beaked Dolphin 66
11.5.4.3 Review of Abundance and Density estimates for White-Beaked Dolphin. 66
11.5.5 Minke Whale 66
11.5.5.1 Desk-Based Review of Minke Whale Presence 66
11.5.5.2 Results from the Site-Specific Surveys for Minke Whale 67
11.5.5.3 Review of Abundance and Density Estimates for Minke Whale 68
11.5.6 Grey Seal 68
11.5.6.1 Desk-Based Review of Grey Seal Presence 68
11.5.6.2 Results from the Site-Specific Surveys for Grey Seal 69
11.5.6.3 Review of Abundance and Density Estimates for Grey Seal 69
11.5.7 Harbour seal 70
11.5.7.1 Desk-Based Review of Harbour Seal Presence 70
11.5.7.2 Results from the Site-Specific Surveys for Harbour Seals 71
11.5.7.3 Review of Abundance and Density Estimates for Harbour Seal 71
11.5.8 Summary of Marine Mammal Densities and Reference Populations for Assessments 72
11.5.9 Future Trends 74
11.6 Assessment of Significance 79

11.6.1 Potential Effects During Construction 79
11.6.1.1 Impact 1 Permanent and Temporary Auditory Injury from Underwater Noise During Piling 79
11.6.1.2 Impact 2 Disturbance or Behavioural Effects from Underwater Noise During Piling 119
11.6.1.3 Impact 3: TTS and Disturbance from Underwater Noise During Other Construction Activities 158
11.6.1.4 Impact 4 TTS and Disturbance from Underwater Noise due to the Presence of Vessels 179
11.6.1.5 Impact 5 Barrier Effects as A Result of Underwater Noise During Construction 202
11.6.1.6 Impact 6 Increased Collision Risk with Vessels During Construction 206
11.6.1.7 Impact 7 Changes to Prey Resources 218
11.6.1.8 Impact 8 Changes to Water Quality 229
11.6.1.9 Impact 9 Disturbance of Seals at Haul-Out Sites 231
11.6.2 Potential Effects During Operation 236
11.6.2.1 Impact 1 Impacts from Underwater Noise Associated with Operational Wind Turbines 236
11.6.2.2 Impact 2: Impacts from Underwater Noise Associated with Operation and Maintenance Activities 245
11.6.2.3 Impact 3 Impacts from Underwater Noise due to the Presence of Vessels 249
11.6.2.4 Impact 4 Barrier Effects 255
11.6.2.5 Impact 5 Increased Collision Risk with Vessels During Operation and Maintenance 256
11.6.2.6 Impact 6 Changes to Prey 261
11.6.2.7 Impact 7 Changes to Water Quality 269
11.6.2.8 Impact 8 Disturbance at seal haul-out sites 270
11.6.3 Potential Effects During Decommissioning 273
11.7 Preliminary Assessment of Cumulative Effect 274
11.7.1 Initial Screening for Cumulative Effects 274
11.7.2 Plans/Projects Considered for Cumulative Impacts 281
11.8 Potential Monitoring and Mitigation Requirements 283
11.9 Transboundary Effects 285
11.10 Interactions 288

11.11 Inter-relationships 297
11.12 Marine Wildlife Licence Application 299
11.13 Summary 299
References 316

Tables

Table 11-1 Consultation Responses 9
Table 11-2 Realistic Worst Case Design Parameters 19
Table 11-3 Embedded Mitigation Measures 31
Table 11-4 Additional Mitigation Measures 33
Table 11-5 NPS Assessment Requirements 34
Table 11-6 Conservation Status of Marine Mammal Species Occurring in UK and Adjacent Waters, Relevant to The Projects (JNCC, 2019) 44
Table 11-7 Global IUCN Red List of Threatened Species Assessments for Marine Mammal Species Relevant to The Project 44
Table 11-8: APEM Surveys Species Counts for DBS East; DBS West And 4km Buffer (March 2021 to February 2022) 45
Table 11-9 Other Available Data and Information Sources 46
Table 11-10 Definition of Sensitivity for A Marine Mammal Receptor 50
Table 11-11 Definition of Value for A Marine Mammal Receptor 51
Table 11-12 Definition of Magnitude of Impacts 52
Table 11-13 Marine Mammal Significance of Effect Matrix 54
Table 11-14 Definition of Effect Significance 54
Table 11-15 Tiers in Relation to Project Category Which Have Been Screened Into the CEA 57
Table 11-16 Seasonal Density Estimates for Harbour Porpoise Form APEM Ltd Survey 61
Table 11-17 Grey Seal Count Population Estimates 70
Table 11-18 Summary of Marine Mammal Reference Populations Used in the Impact Assessments 72
Table 11-19 Summary of Marine Mammal Density Estimates Used in the Impact Assessments 73
Table 11-20 The Predicted Effect Ranges for PTS in all Marine Mammal Species, at the Worst Case Modelling Location, for the Maximum Hammer Energies of Both Monopiles and Pin Piles 81

Table 11-21 Assessment of the Potential for Instantaneous PTS Due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile 82

Table 11-22 The Predicted Effect Ranges for PTS in all Marine Mammal Species, at the Worst Case Modelling Location, for the Cumulative Exposure of both Monopiles and Pin Piles 85

Table 11-23 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period 87

Table 11-24 Assessment of the Potential for Instantaneous PTS due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile at DBS East and DBS West Together 90

Table 11-25 The Predicted Effect Ranges for PTS in all Marine Mammal Species at the Combined Modelling Locations, for the Cumulative Exposure of Multiple Monopiles and Pin Pile Installations at the Same Time (Effect Areas In Bold Used Within the Assessments for Sequential Piling) 92

Table 11-26 Assessment of the Potential for PTS due to the Cumulative Exposure of Simultaneous Monopiles or Jacket Pin Piles at the Same Time 94

Table 11-27 Predicted Effect Ranges for TTS in All Marine Mammal Species, at the Worst Case Modelling Location, for the Maximum Hammer Energies of Both Monopiles and Pin Piles 95

Table 11-28 Assessment of the Potential for Instantaneous TTS Due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile 96

Table 11-29 Predicted Effect Ranges for TTS in All Marine Mammal Species, at the Worst Case Modelling Location, for the Cumulative Exposure of both Monopiles and Pin Piles 99

Table 11-30 Assessment of the Potential for TTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period 102

Table 11-31 Assessment of the Potential for Instantaneous TTS due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile at DBS East and DBS West Together 105

Table 11-32 Predicted Effect Ranges for TTS in all Marine Mammal Species at the Combined Modelling Locations, for the Cumulative Exposure of Multiple Monopiles and Pin Pile Installations at the Same Time (Effect Areas in Bold Used Within the Assessments for Sequential Piling) 107

Table 11-33 Assessment of the Potential for TTS due to the Cumulative Exposure of Simultaneous Monopiles or Jacket Pin Piles at the Same Time 109

Table 11-34 Assessment of Significance of Effect for the Potential for PTS for DBS East and DBS West in Isolation due to Piling of Monopiles and Jacket Pin Piles 112

Table 11-35 Assessment of Significance of Effect for the Potential for TTS for DBS East or DBS West in Isolation due to Piling of Monopiles and Jacket Pin Piles 113

Table 11-36 Assessment of Significance of Effect for the Potential for PTS for DBS East and DBS West Together due to Piling of Monopiles and Jacket Pin Piles 115

Table 11-37 Assessment of Significance of Effect for the Potential for TTS for DBS East or DBS West in Isolation due to Piling of Monopiles and Jacket Pin Piles 116

Table 11-38 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for both a Single and Two Simultaneous Piling Events at DBS East or DBS West 130

Table 11-39 Assessment of the Potential for Disturbance to Grey Seal and Harbour Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East or DBS West 132

Table 11-40 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East or DBS West in Isolation Based on the Dose-Response Approach 136

Table 11-41 Assessment of the Potential for Disturbance due to ADD Activation Based on the Worst Case 80 minute Duration for Monopile at DBS East or DBS West in Isolation ... 138

Table 11-42 Maximum Duration of Piling and ADD activation at each Array Area, Based on Worst Case Scenarios, Including Soft-Start, and ADD Activation 140

Table 11-43 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for Both a Single and Two Simultaneous Piling Events 144

Table 11-44 Assessment of the Potential for Disturbance to Grey Seal and Harbour Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East and DBS West Together 145

Table 11-45 Number of Individuals (and % of Reference Population) That Could be Disturbed During Piling at DBS East and DBS West Together Based on the Dose-Response Approach 147

Table 11-46 Assessment of the Potential for Disturbance Due to ADD Activation Based on the Worst Case 80 Minute Duration for Monopile at DBS East and DBS West Together .. 148

Table 11-47 Maximum Duration of Piling and ADD activation at DBS Project Areas Together, based on Worst Case Scenarios, Including Soft-Start, and ADD Activation 149

Table 11-48 Assessment of Significance of Effect for the Potential for Disturbance from Monopiles and Jacket Pin Piles for DBS East or DBS West in Isolation 153

Table 11-49 Assessment of Significance of Effect for the Potential for Disturbance from Monopiles and Jacket Pin Piles for DBS East and DBS West Together 156

Table 11-50: Predicted Impact Ranges (and Areas) For TTS From 24 Hour Cumulative Exposure During Other Construction Activities 161

Table 11-51: Maximum Number of Individuals (and % Of Reference Population) That Could Be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for Each Individual Activity And For All Activities At The Same Time At DBS East or DBS West 163

Table 11-52: Maximum Number of Individuals (And % Of Reference Population) That Could Be Impacted as A Result of Underwater Noise Associated with Non-Piling Construction

Activities Based on Underwater Noise Modelling for All Activities at The Same Time at The Projects 167

Table 11-53 Assessment of The Potential for Disturbance Due to Other Construction Activities, for One and Multiple Activity Taking Place at Any One Time Either DSB East or DBS West in Isolation 172

Table 11-54 Assessment of The Potential for Disturbance Due to Other Construction Activities Taking Place at Any One Time at DBS East and DBS West Together 176

Table 11-55 Assessment of Significance of Effect for the Potential for Underwater Effects Due to Other Construction Activities at DBS East or DBS West in Isolation 178

Table 11-56 Assessment of Significance of Effect for the Potential for Underwater Effects Due to Other Construction Activities at DBS East or DBS West in Isolation 179

Table 11-57 Predicted Impact Ranges (and Areas) For TTS From 24 Hour Cumulative Exposure for Construction Vessels 181

Table 11-58 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 DBS East or DBS West in Isolation 183

Table 11-59 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 DBS East or DBS West Together 186

Table 11-60 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in Isolation 191

Table 11-61 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East and DBS West Together 197

Table 11-62 Assessment of Significance of Effect for the Potential for Disturbance Due to Construction Vessels at DBS East or DBS West in Isolation 201

Table 11-63 Assessment of Significance of Effect for the Potential for Disturbance Due To Construction Vessels at DBS East and DBS West Together 202

Table 11-64 Assessment of Significance of Effect for Any Potential Barrier Effects from Underwater Noise during Construction at DBS East or DBS West 205

Table 11-65 Assessment of Significance of Effect for Any Potential Barrier Effects from Underwater Noise during Construction at DBS East and DBS West Together 205

Table 11-66 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collision With a Vessel 208

Table 11-67 Predicted Number of Marine Mammals at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (Magnitude of Impact Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West in Isolation 210

Table 11-68 Predicted Number of Marine Mammals at risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (Magnitude of Impact Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West Together 214

Table 11-69 Assessment of Significance of Effect for Increased Collision Risk with Vessels during Construction for DBS East and West in Isolation and Together 217

Table 11-70 Magnitude of Potential Changes to Prey Resources During Construction, Based on Assessments in Chapter 10 Fish and Shellfish Ecology 225

Table 11-71 Assessment of Significance of Effect for the Potential of an Indirect Effect to Marine Mammals Through Changes to Prey Resources During Construction 228

Table 11-72 Assessment of Significance of Effect for any Changes in Water Quality during Construction at DBS East or DBS West 230

Table 11-73 Assessment of significance of effect for Disturbance at Seal Haul-Out Sites During Construction 235

Table 11-74 Predicted Impact Ranges (And Areas) for PTS of TTS from 24 hour Cumulative Exposure of Underwater Noise From Operational Turbines 238

Table 11-75 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TSS as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East and DBS West in Isolation 239

Table 11-76 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TSS as a Result of Underwater Noise Associated with Operational Turbines at DBS East and DBS West Together 241

Table 11-77 Assessment of Significance of Effect for the Potential for Disturbance Due to Operational Wind Turbines at DBS East and DBS West in isolation 244

Table 11-78 Assessment of Significance Of Effect for the Potential for Disturbance Due To Operational Wind Turbines at DBS East and DBS West Together 245

Table 11-79 Assessment of Significance of Effect for TTS or Disturbance from Underwater Noise During Maintenance Activities at the DBS East and DBS West Array Areas 248

Table 11-80 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TTS as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation 250

Table 11-81 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TTS as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East and DBS West Together 252

Table 11-82 Assessment of Significance of Effect for the Potential for Disturbance from Vessels During Operation and Maintenance at DBS East and DBS West in Isolation or Together 254

Table 11-83 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels at DBS East and DBS West in Isolation 257

Table 11-84 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels at DBS East and DBS West Together 259

Table 11-85 Assessment of Significance of Effect for Increased Collision Risk with Vessels During Operation and Maintenance 260

Table 11-86 Magnitude of Potential Changes to Prey Resources During Operation, Based on Assessments in **Chapter 10 Fish and Shellfish Ecology** 265

Table 11-87 Assessment of Significance of Effect for the Potential of an Indirect Effect to Marine Mammals Through Changes to Prey Resources During Operation and Maintenance 267

Table 11-88 Assessment of Significance of Effect for Disturbance at Seal Haul-Out Sites During Operation and Maintenance 272

Table 11-89 Potential Cumulative Effects 275

Table 11-90 Additional Mitigation 284

Table 11-91 Other Countries Considered in the Marine Mammal Assessments Through the Relevant MU Reference Populations 285

Table 11-92 Interactions Between Impacts - Screening 290

Table 11-93 Interaction Between Impacts - Phase and Lifetime Assessment 294

Table 11-94 Marine Mammal Inter-Relationships 297

Table 11-95 Summary of Potential Likely Significant Effects on Marine Mammals 300

Volume 2 - Figures

Figure 11-1: Marine Mammal Study Area

Volume 3 – Appendices

Appendix 11-1: Marine Mammal Information Report

Appendix 11-2: Underwater Noise Modelling Report

Appendix 11-3: Underwater Noise Impact Assessment

Glossary

Term	Definition
Accommodation Platform	An offshore platform (situated within either the DBS East or DBS West array area) that will provide accommodation and mess facilities for staff when carrying out maintenance activities for the Projects.
Array Areas	The DBS East and DBS West offshore array areas, where the wind turbines and array cables will be located. The array areas do not include the offshore export cable corridor.
Array Cables	Cables which link the wind turbine generators to the offshore substation/converter/collector platform(s).
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Electrical Switching Platform (ESP)	The electrical switching platform (if required) will provide a link to a co-ordinated east coast transmission system which is planned to run from Scotland to England, as per National Grid ESO's Holistic Design Network. This platform may be located either within one of the array areas (alongside a converter station) or mid-way along the export cable corridor (likely next to the Reactive Compensation Platform if required).
Inter-Platform Cables	Cables linking offshore platforms.
Offshore Converter Platforms (OCPs)	Offshore Converter Platforms (OCPs) will be required for the HVDC option. The OCPs are fixed structures located within the array area that collect the AC power generated by the wind turbines and convert the power to DC, before transmission through the offshore export cables to the Project's onshore grid connection points.
Offshore Development Area	The Offshore Development Area encompasses the wind farm site and the options for the offshore transmission works.

Term	Definition
Offshore Export Cable Corridor	This is the area which will contain the offshore export cables (and potentially the ESP and / or RCP) between the offshore substation/converter platforms and Transition Joint Bays at the landfall.
Offshore Substation Platforms (OSPs)	Offshore Substation Platforms (OSPs) will be required for the HVAC option. These are fixed structures located within the array areas that contain electrical equipment to aggregate the power from the wind turbines, followed by conversion into a more suitable voltage for transmission through the offshore export cables to the Project's onshore grid connection points.
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South offshore wind farms).
Reactive Compensation Platform (RCP)	A Reactive Compensation Platform (RCP) will be required for a HVAC solution. The RCP will host the shunt reactors required to provide reactive compensation, in order to limit the electrical losses which occur with HVAC transmission over long distances.
Safety Zones	A statutory marine zone demarcated for the purposes of safety around a possibly hazardous installation or works/construction area.
Scoping Report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Scoping Opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.

Acronyms

Term	Definition
ADD	Acoustic Deterrent Device
AIS	Automatic Identification System
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BAP	Biodiversity Action Plan
BEIS	Department of Business, Energy and Industrial Strategy
BSI	British Standards Institution
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CPOD	Cetacean Porpoise Detector
CSIP	Cetacean Strandings Investigation Programme
CV	Coefficient of Variation
DAERA	Department of Agriculture, Environment and Rural Affairs
DBS	Dogger Bank South
DCO	Development Consent Order

Term	Definition
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DEPONS	Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea
ECC	Export Cable Corridor
EDR	Effective Deterrence Range
EEA	European Economic Area
EEZ	European Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EPP	Evidence Plan Process
EPS	European Protected Species
ES	Environmental Statement
ETG	Expert Topic Groups
FCS	Favourable Conservation Status
GNS	Greater North Sea
HDD	Horizontal Directional Drilling
HF	High Frequency
HRA	Habitat Regulations Assessment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
IPC	Infrastructure Planning Commission (now PINS and SoS)

Term	Definition
IPMP	In Principle Monitoring Plan
IUCN	International Union for Conservation of Nature
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
km	Kilometres
LAT	Lowest Astronomical Tide
LF	Low Frequency
MCZ	Marine Conservation Zone
ML	Marine Licence
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MPS	Marine Policy Statement
MU	Management Unit
NE	North East
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine and Fisheries Service
NPS	National Policy Statements
NS	North Sea
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and Maintenance
OESEA	Offshore Energy Strategic Environmental Assessment
OSP	Offshore Substation Platform
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment

Term	Definition
OWF	Offshore Wind Farm
PCW	Phocid in Water
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
RMS	Root Mean Square
SAC	Special Area of Conservation
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
SIP	Site Integrity Plan
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNS	Southern North Sea
SoS	Secretary of State
SPL	Sound Pressure Level
SPL_{peak}	peak Sound Pressure Level
SSC	Suspended Sediment Concentration
TTS	Temporary Threshold Shift

Term	Definition
UK	United Kingdom
UXO	Unexploded Ordnance
VHF	Very High Frequency
WBD	White-beaked dolphin

11 Marine Mammal Ecology

11.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) considers the likely significant effects of the Projects on marine mammal ecology. The chapter provides an overview of the existing environment for the proposed Offshore Development Area, followed by an assessment of likely significant effects for the construction, operation, and decommissioning phases of the Projects.
2. The assessment should be read in conjunction with the following linked chapters:
   - **Chapter 8 Marine Physical Environment** (assessments inform this chapter due to indirect effects);
   - **Chapter 9 Benthic Ecology** (assessments inform this chapter due to indirect effects on prey species);
   - **Chapter 10 Fish and Shellfish Ecology** (assessments inform this chapter due to indirect effects on prey species);
   - **Chapter 13 Commercial Fisheries** (assessments inform this chapter due to indirect effects on prey species); and
   - **Chapter 14 Shipping and Navigation** (assessments inform this chapter due to collision risk effects).
3. Additional information to support the marine mammal assessment include:
   - **Appendix 11-1**: Marine Mammal Information Report
   - **Appendix 11-2**: Underwater Noise Modelling Report
   - **Appendix 11-3**: Underwater Noise Impact Assessment

11.2 Consultation

4. Consultation with regard to marine mammal ecology has been undertaken in line with the general process described in **Chapter 6 EIA Methodology**. The key elements of consultation to date have included scoping and the ongoing Evidence Plan Process (EPP) via the marine mammal Expert Topic Group (ETG).

5. The first ETG meeting was held in September 2021, with attendees at some or all of the meetings including Natural England, The Wildlife Trusts and the Marine Management Organisation (MMO).

6. The feedback received has been considered in preparing the PEIR. **Table 11-1** provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

7. This chapter will be updated following consultation on PEIR in order to produce the final assessment that will be submitted with the Development Consent Order (DCO) application. Full details of the consultation process will also be presented in the Consultation Report alongside the DCO application.

Table 11-1 Consultation Responses

Comment	Project Response
The Planning Inspectorate (PINS) Scoping Responses 02/09/2022	
Increased disturbance at seal haul out sites (all phases). This matter is proposed to be scoped out due to the distance of known haul-out sites from the Proposed Development. It is not clear if this reasoning includes landfall activities, particularly in relation to construction which the Inspectorate considers could give rise to significant effects. Paragraph 306 discusses the location of haul out sites briefly, stating that the Proposed Development is 60km from Donna Nook (grey seal), but no figures showing them in relation to the Proposed Development or detail on other sites is provided. Paragraph 322 states that this matter has been scoped out for operation but provides no reasoning for this conclusion. In the absence relevant baseline information and explanation of the anticipated extent of impacts from construction and operation activities, the Inspectorate cannot agree to scope this matter out. The Inspectorate expects the ES to provide an assessment of impacts and resulting effects on seal	Assessment of potential disturbance at seal haul-out sites is provided in section 11.6.1.9 and 11.6.2.8, based on current information and worst-case scenario for port options available at this time.

Comment	Project Response
haul-out sites, or robust evidence to support the conclusion that significant effects are unlikely. The Applicant should make effort to agree the evidence required in the Environmental Statement (ES) with relevant consultation bodies.	
Changes in water quality (all phases). The Inspectorate draws the Applicant's attention to the comments above relating to remobilisation of contaminants and changes to sediment concentrations. The ES should assess the potential impacts on marine mammals or provide adequate evidence to demonstrate that significant effects are unlikely.	The potential changes to water quality are assessed in section 11.6.1.8 and 11.6.2.7 This includes suspended sediments and the remobilisation of contaminants.
Barrier effects from the physical presence of the wind farm (all phases – applicable to operation only). Taking into account the information in Paragraph 323 the Inspectorate agrees that barrier effects the from physical presence of the Proposed Development are unlikely to give rise to significant effects. This matter can be scoped out of the ES subject to site-specific information on marine mammal movements and discussions with the relevant consultees.	Noted, and therefore not considered further in this chapter. Further information for the scoping out of barrier effects from the physical presence has been included in **Appendix 11-1**
Effects from Electromagnetic fields (EMF) (all project phases -applicable to operation only, see above). Paragraph 324 states that the potential for impacts from EMF has been scoped out, citing consistency with scoping opinions related to other wind farm projects. The evidence submitted into scoping for these previous wind farm projects is not presented in the Scoping Report. Nevertheless, the Inspectorate is aware of evidence from recent scoping exercises that the species known in the Proposed Development area are not sensitive to EMF. On this basis, the Inspectorate agrees to scope effects from EMFs on marine mammals. However, the Inspectorate would expect the Applicant to ensure that the need to consider EMF sensitive species is ruled out in consultation with the relevant stakeholders.	Noted, and therefore not considered further in this chapter. Further agreement was received to this approach in Natural England's scoping responses (02/09/2022).
Physical and auditory injury resulting from underwater noise during operation.	A separate Marine Licence (ML) application for UXO clearance will

Comment	Project Response
No discussion of the need for unexpected/ emergency Unexploded Ordinance (UXO) clearance during operation and the potential for effects on marine mammals is provided. The Inspectorate advises that the ES should provide an assessment of the likely significant effects which could arise, including details of any mitigation or control measures proposed to manage the risks to marine mammals from unexpected UXO clearance and how these are to be secured.	be submitted post-consent once detailed information on the locations and extent of UXO required to be cleared is known. An initial assessment of the potential impacts from UXO clearance at the Projects will be provided during the ES, for information purposes only. The potential cumulative effects from UXO clearance during construction will also be taken in to account during the ES.
Project-specific surveys and data analysis. The Scoping Report does not explain if the proposed surveys will cover the export cable corridor area, and what rationale has been applied to the survey area chosen. The Inspectorate advises that the ES describes how the approach to data collection has been discussed with stakeholders and to what extent survey effort and methodologies for data analysis have been discussed and agreed. The Inspectorate understands that the completion of the aerial surveys (February 2023) may coincide or immediately precede the statutory consultation on the PEIR. This is likely to be an important consideration in ensuring that information is available to all relevant stakeholders so that their views can be captured in preparation of the ES. The ES should explain how stakeholder views have informed the project-specific surveys undertaken. This comment applies to all chapters where aerial surveys are noted as being required.	An overview of the site-specific surveys is provided in section 11.4.2.1 and 11.5, with further information in **Appendix 11-1.** The scope of the aerial surveys was discussed with consultees during the EPP which presented the DBS Projects array areas including a buffer. The approach to data collection was agreed by the MMO, NE and The Wildlife Trusts. Densities for the export cable corridor area have been calculated from the most up to date available data (see section 11.5) and will be applied to the assessment where appropriate.

Comment	Project Response
Baseline characterisation, and connectivity with designations. The Applicant should make effort to agree the geographical context and population context of the marine mammal assessment with relevant consultation bodies, including any assumptions made in relation to connectivity to designated sites. The Inspectorate advises that connectivity to designations including the Southern North Sea SAC is relevant to the assessment in the ES as well as the HRA screening process as stated in Paragraph 313.	Information on the study area for marine mammals, including relevant MUs is provided in section 11.5, with further information in **Appendix 11-1.** This has been presented, discussed and agreed at the Marine Mammal ETG meetings by the MMO, NE and The Wildlife Trusts.
Cumulative effects. The Scoping Report indicates that only displacement effects due to underwater noise, operational displacement from vessels, and impacts on prey species will be considered cumulatively but does not provide any rationale for this approach as it relates to the scope of the cumulative assessment. The Inspectorate expects the Applicant to consider cumulative effects for all the potential impacts which may combine with those from other development, and which may result in significant effects.	The approach to the cumulative effects assessment is given in 11.7 of this PEIR. A draft CEA for marine mammals will be submitted for consultation post the PEIR submission and prior to the ES being undertaken.
MMO. Scoping Responses 02/09/2022	
It is expected that the six most commonly occurring species within the Offshore Study Area, and therefore taken forward for assessment, will be the harbour porpoise, white-beaked dolphin; bottlenose dolphin; minke whale; grey seal; and harbour seal.	A desk-based review of marine mammals presence in the Project area has been conducted in section 11.5, with further information in **Appendix 11-1.**
The MMO expect any underwater UXO surveys to be completed before a marine licence application for the UXO disposal campaign is submitted.	A separate ML application for UXO clearance will be submitted post-consent once detailed information on the locations and extent of UXO required to be cleared is known.
The MMO expects the following impacts to be scoped into the EIA: Auditory injury resulting from piling and UXO clearance (during construction) and Behavioural and disturbance impacts resulting from noise including vessels (during construction and operation)	Noted. For the PEIR assessments have been undertaken for: • Piling of foundations for turbines and substations;

Comment	Project Response
	• Other construction activities and maintenance activities, including seabed preparation (dredging), cable laying, trenching and rock placement; • Vessels; and • Operational turbine noise. The potential effects of underwater noise on marine mammals is assessed for noise sources and vessels during construction (section 11.6.1) and operation and maintenance (section 11.6.2). An indicative assessment of potential impacts for UXO clearance will be undertaken in a supporting appendix at the ES stage. Potential UXO clearance from other developments will be considered for the Cumulative Effects Assessment.
The MMO recommends that the risk of auditory injury (i.e. PTS and TTS) is also considered, using appropriate noise exposure criteria where relevant.	The potential effects of underwater noise on marine mammals is assessed in section 11.6.1.1; 11.6.1.2; 11.6.1.3; 11.6.2.1; 11.6.2.2 and 11.6.2.3.1 based on the latest guidance, research, and criteria from Southall *et al.* (2019) and National Oceanic and Atmospheric Administration (NOAA) (National Marine and Fisheries Service (NMFS), 2018).

Comment	Project Response
The CEA will consider displacement due to cumulative underwater noise and impacts on prey species. The assessment will also consider displacement due to the presence of offshore vessels and maintenance activities during the operational phase. The MMO expects the potential for auditory injury to also be considered.	The approach to the cumulative effects assessment is given in section 11.4.4 of this PEIR. A draft CEA for marine mammals will be submitted for consultation post the PEIR submission and prior to the ES being undertaken.
Natural England. Scoping Responses 02/09/2022	
Natural England's comments provided in Annex C still stand.	Noted
Natural England are in agreement with the information presented here to characterise the existing environment, but would expect a more thorough and complete assessment in the PEIR/ES.	A desk-based review of marine mammals presence in the Project areas has been conducted in section 11.5, with further information in **Appendix 11-1.**
Natural England is broadly in agreement with the potential impacts identified and is in agreement that EMF can be scoped out for marine mammals. However, barrier effects from physical presence should be considered further in the context of what is known about animal movements and activities in and around the array areas, such as telemetry data that may show seals transit through the area when foraging, before it is scoped in or out.	Barrier effects has been considered further in **Appendix 11.1**. Addition information has been provided to support scoping out of the impact.
Natural England are in agreement with the proposed approach to assessment presented here but would expect a more thorough approach to assessment to be outlined within the PEIR/ES.	The full approach to assessment is given in section 11.4 and **Chapter 6 EIA Methodology.**
Marine Mammal Ecology ETG Responses – Pre-Scoping 17/09/2021	
Natural England is keen to ensure that UXO impacts are included in the ES but agrees with the approach that a separate ML would be applied for to cover the UXO clearance activities, post-consent.	An indicative assessment of potential impacts for UXO clearance will be undertaken in a supporting appendix at the ES stage. Potential UXO clearance from other developments will be considered for the Cumulative Effects Assessment.

Comment	Project Response
Marine Mammals ETG Responses – Pre-PEIR 201/02/2023	
The current best practice advice guidance states that the Wadden Sea MU shouldn't be used unless the population is included for seal density estimates.	Noted – population estimates for seals are based on the relevant UK MUs with connectivity.
Natural England will confirm if the proposed approach of using the Greater North Sea MU in relation to bottlenose dolphin density estimates for the PIER is acceptable.	In response to Natural England's comments to the HRA Screening report we will assess the Moray Firth SAC based on the Coastal East Scotland (CES) MU which will be used for population estimates. The use of the CES MU for the impact assessment will be considered during the ES for potential impacts in the coastal region such as works in the Export Cable Corridor after Natural England's review of the current approach.

11.3 Scope

8. Site characterisation has been undertaken using site specific data for Dogger Bank South (DBS) East and DBS West offshore wind farms, collectively known as DBS offshore wind farms ('the Projects'), as well as existing data from other offshore wind farms in the area and other available information for the region (see **Appendix 11-1**). The key species, and therefore the focus of the assessments, are:

- Harbour porpoise, *Phocoena phocoena;*
  - Present throughout the year, although there may be variations in seasonal occurrence.
- Bottlenose dolphin, *Tursiops truncatus;*
  - Historically not common in the Offshore Development Area, with limited data, however, with a recent increase in sightings along the coast, the species has been included on a precautionary basis.
- Common dolphin, *Delphinus delphis*;
  - Seasonal occurrence in low numbers.
- White-beaked dolphin, *Lagenorhynchus albirostris*;
  - Seasonal occurrence in low numbers.
- Minke whale, *Balaenoptera acutorostrata*;
  - Seasonal occurrence in low numbers.
- Grey seal, *Halichoerus grypus*;
  - Present throughout the year.
- Harbour seal, *Phoca vitulina*;
  - Present throughout the year.

11.3.1 Study Area

9. The study area for marine mammals has been defined on the basis that marine mammals are highly mobile and transitory in nature. It is, therefore, necessary to examine species occurrence not only within the DBS East and DBS West array areas and offshore export cable corridor (ECC), but also over the wider area.

10. For the marine mammal species in the assessments, the following study areas have been defined, based on the relevant Management Units (MUs) (Inter-Agency Marine Mammal Working Group (IAMMWG) 2022), current knowledge and understanding of the biology of each species (see **Figure 11-1** and **Appendix 11-1**):

    - Harbour porpoise: North Sea (NS) MU.
    - Bottlenose dolphin: Greater North Sea (GNS) MU.
    - Common dolphin: Celtic and Greater North Seas (CGNS) MU.
    - White-beaked dolphin: CGNS MU.
    - Minke whale: CGNS MU.
    - Grey seal: South-east (SE) England and North-east (NE) England Sea region.
    - Harbour seal: SE England MU.

11. The status and activity of marine mammals known to occur within or adjacent to the Projects are considered in the context of regional population dynamics at the scale of the wider North Sea, depending on the data available for each species and the extent of the agreed reference population.

12. The DBS West array area is located approximately 100km from the shore (at its closest point), with DBS East approximately 122km from shore. The minimum and maximum water depths within the array areas at the time of the site-specific geophysical survey ranged from 12m to 40m below the lowest astronomical tide (LAT).

13. There is the potential for seals from haul-out sites to move along the coast and to forage in and around the proposed offshore sites. Key haul-out sites for both seal species within the vicinity of the Projects sites include:

- Filey Brigg (located 28km from the landfall location at the closest point).
- Other haul-out sites are located at Ravenscar (52km at closest point), Donna Nook (62km at closest point), the Tees (93km at closest point) and the Wash (108km at closest point) (see section 11.5 for further details).

14. Further seal haul-out sites located in the wider seal MUs are listed in **Appendix 11-1**.

11.3.2 Realistic Worst Case Scenario

11.3.2.1 General Approach

15. The realistic worst case design parameters for likely significant effects scoped into the EIA for the marine mammal assessment are summarised in **Table 11-2**. These are based on the project parameters described in **Chapter 5 Project Description**, which provides further details regarding specific activities and their durations.

16. In addition to the design parameters set out in **Table 11-2**, consideration is also given to the different development scenarios still under consideration and the possible phasing of the construction as set out in sections 11.3.2.2 to 11.3.2.5.

Table 11-2 Realistic Worst Case Design Parameters

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Construction				
Construction will take approximately five years per site and if the Projects are built concurrently. If built sequentially, with a two year lag between construction starting it would take approximately seven years to construct DBS East and DBS West.				
Impact 1 and 2: Underwater noise and vibration from piling	**Array Area** • 494.5km^2 • Up to 100 turbines • Four offshore converter platforms, plus one accommodation platform **Offshore Export Cable Corridor** • One Electrical Switching Platform (ESP)	**Array Area** • 494.5km^2 • Up to 100 turbines • Four offshore substation platforms, plus one accommodation platform **Offshore Export Cable Corridor** • One Reactive Compensation Platform (RCP)	**Array Areas** • 989km^2 • Up to 200 turbines • Eight offshore substation/converter/collector platforms, plus one accommodation platform **Offshore Export Cable Corridor** • One ESP and RCP	Two of the platforms (ESP & RCP) could be located on the export cable corridor, not in the array area.
	Foundations Options for wind turbine piled foundations:	**Foundations** Options for wind turbine piled foundations:	**Foundations** Options for wind turbine piled foundations:	

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	• one monopile per wind turbine foundation; • four pin piles per wind turbine foundation. Options for platforms piled foundations: • one monopile per platform; or • Up to eight pin piles per platform.	• one monopile per wind turbine foundation; • four pin piles per wind turbine foundation. Options for platforms piled foundations: • one monopile per platform; or • Up to eight pin piles per platform.	• one monopile per wind turbine foundation; • four pin piles per wind turbine foundation. Options for platforms piled foundations: • one monopile per platform; or • Up to eight pin piles per platform.	
	Piling *Monopile* Max piles per day - 3 (2 turbines and 1 platform) Diameter -17m Hammer energy – 7,000kJ hammer Duration per monopile – 320 minutes	**Piling** *Monopile* Max piles per day - 3 (2 turbines and 1 platform) Diameter -17m Hammer energy – 7,000kJ hammer Duration per monopile – 320 minutes	**Piling** *Monopile* Max piles per day - 5 (4 turbines per array area and 1 platform) Diameter -17m Hammer energy – 7,000kJ hammer Duration per monopile – 320 minutes	In sequential scenario, max piles per day is identical to DBS East or DBS West in isolation, just spread over a longer time period. Max piles per day assumes three vessels on site at one time.

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Jacket pin pile Max piles per day - 12 (3 turbines, with 4 pin piles per foundation) Diameter - 4.2m Hammer energy – 3,000kJ hammer Duration per jacket pile - 190 minutes	*Jacket pin pile* Max piles per day - 12 (3 turbines, with 4 pin piles per foundation) Diameter - 4.2m Hammer energy – 3,000kJ hammer Duration per jacket pile - 190 minutes	*Jacket pin pile* Max piles per day - 12 (3 turbines, with 4 pin piles per foundation) Diameter - 4.2m Hammer energy – 3,000kJ hammer Duration per jacket pile - 190 minutes	
Impact 3: Underwater noise from other construction activities	Up to 5% of the wind turbine locations could need drilling i.e., likely minimum of two for each of DBS East and DBS West.			Drilling produces low frequency, low intensity noise, noise form the vessel will be a higher impact.
	Sea bed clearance methods: Pre-lay grapnel run, boulder clearance, sand wave levelling, dredging			
	Cable installation methods: Jet-trenching / ploughing / dredging / mechanical trenching / mass flow excavation / rock cutting / burial sledge			

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Underwater noise modelling for all construction activities			See **Appendix 11-2**
	Maximum number of export cables: 2 Maximum length of export cable: 396km	Maximum number of export cables: 4 Maximum length of export cable: 632km	Maximum number of export cables: 6 Maximum length of export cable: 1,028km	
Impact 4 and 6: Underwater noise and disturbance from vessels, and vessel collision risk	Maximum number of construction vessels on site at any one time: up to 66 vessels and up to 5,745 round trips to port.	Maximum number of construction vessels on site at any one time: up to 66 vessels and up to 5,745 round trips to port	Maximum number of construction vessels on site at any one time: up to 132 vessels and up to 11,489 round trips to port.	
Impact 5: Barrier effect from underwater noise	As described for **Impact 1** above.			The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier impact.

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Impact 7: Changes to prey resources	Impacts to prey species and habitat as described in **Chapter 10 Fish and Shellfish Ecology**			
	Total habitat loss within the array area – 3,667,330m² Total habitat loss within the offshore export cable corridor – 1,268,681m²	Total habitat loss within the array area – 3,813,562m² Total habitat loss within the offshore export cable corridor – 1,993,549m²	Total habitat loss within the array area – 8,171,853m² Total habitat loss within the offshore export cable corridor – 3,255,261m²	
	Total disturbance within Array Areas – 8,804,077m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 9,206,411m²	Total disturbance within Array Areas – 9,706,077m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 15,523,443m²	Total disturbance within Array Areas – 23,236,305m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 24,729,838m²	

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Total habitat loss and disturbance within offshore development area - 22,946,499m²	Total habitat loss and disturbance within offshore development area - 31,036,631m²	Total habitat loss and disturbance within offshore development area - 59,393,257m²	
	Increase in suspended sediment concentrations due to drill arisings Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum percentage of locations using drilling – 5% Max volume of arisings (48 wind turbines) – 42,751m³	**Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum percentage of locations using drilling – 5% Max volume of arisings (48 wind turbines) – 42,751m³	**Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum % of locations using drilling – 5% Max volume of arisings (95 turbines) – 84,611m³	
Impact 8: Changes to water quality	Impacts to water quality as described in **Chapter 8 Marine Physical Environment** See worst case for temporary increases in SSC and re-mobilisation of contaminated sediments as described.			

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Impact 9: Disturbance at seal haul-out sites	122km from coast at closest point. For distances of seal haul out sites refer to **Marine Mammal Appendix 11-1**	100km from coast at closest point. For distances of seal haul out sites refer **Marine Mammal Appendix 11-1**	122km closest point for DBS East and 100km closest point for DBS West. For distances of seal haul out sites refer to **Marine Mammal Appendix 11-1**	Construction port/s will not be confirmed until nearer the start of construction. There are well known seal-haul out sites along the coast, distances recorded from landfall area are: North of Skipsea: Filey Brigg 27km Ravenscar 50km Tess 95km South of Skipsea: Donna Nook 62km The Wash 118km

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Operation and Maintenance				
Impact 1: Underwater noise from operational turbines	Up to 100 wind turbines Turbine diameter 17m	Up to 100 wind turbines Turbine diameter 17m	Up to 200 wind turbines Turbine diameter 17m	Underwater noise modelling for operational turbines.
	Underwater noise parameters described in Underwater Noise Modelling Report **Appendix 11-2.**			Worst case assessment will be made based on the underwater noise modelling results.
Impact 2: Underwater noise from maintenance activities	Estimated timeframe for any cable repair, replacement or reburial works:			For short cables, replacements are a more likely option.
	• One export cable repair every 10 years • One inter-platform cable repair every 10 years • Two array cable repairs every 10 years	• One export cable repair every 10 years • One inter-platform cable repair every 10 years • Two array cable repair every 10 years	• Two export cable repairs every 10 years • Two inter-platform cable repairs every 10 years • Four array cable repairs every 10 years	
Impact 3 and 5: Underwater noise	Maximum number of vessels on site at any one time: 11	Maximum number of vessels on site at any one time: 11	Maximum number of vessels on site at any one time: 21	

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
from vessel and vessel collision	Up to 237 annual round trips to port.	Up to 237 annual round trips to port.	Up to 473 annual round trips to port	
Impact 4: Barrier effects from underwater noise	Maximum impact ranges from operation and maintenance phase underwater noise assessments (as above).			The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier impact.
Impact 6: Changes to prey resources	Impacts to prey species and habitat as described in **Chapter 10 Fish and Shellfish Ecology and Chapter 9 Benthic Habitats**.			The worst case scenario for maximum area of habitat loss / disturbance of seabed from jack-up vessel deployments, cable repair,
	Total habitat loss within the array area – 3,667,330m² Total habitat loss within the offshore export cable corridor – 1,268,681m²	Total habitat loss within the array area – 3,813,562m² Total habitat loss within the offshore export cable corridor – 1,993,549m²	Total habitat loss within the array area – 8,171,853m² Total habitat loss within the offshore export cable corridor – 3,255,261m²	
	Displaced sediment during cable trenching:	Displaced sediment during cable trenching:	Displaced sediment during cable trenching:	

Impact	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Array 325,000m³ Offshore export cable corridor - 396,000m³	Array 325,000m³ Offshore export cable corridor - 632,000m³	Array 325,000m³ Offshore export cable corridor - 1,028,000m³	replacement and reburial footprint.
	See Operation Impact in **Chapter 9 Benthic Habitats**			
Impact 7: Changes to water quality	Impacts to water quality (as described in **Chapter 8 Marine Physical Environment**). Temporary increases in SSC and any deterioration in water quality through the resuspension of contaminated sediment due to maintenance activities could result from periodic jack-up vessel deployment, and cable repair, replacement and reburial activities – same as temporary habitat loss / disturbance for prey above.			
Impact 8: Disturbance at seal haul-out sites	See above **Disturbance to seal haul-out sites**			
	O&M base location: Final decision to be made post-consent but could be located at the Grimsby port.			
Decommissioning				
No final decision regarding the final decommissioning policy for the onshore project infrastructure including landfall, onshore cable route and onshore substation has yet been made. It is also recognised that legislation and industry best practice change over time. However, it is likely that offshore project infrastructure will be removed above the seabed and reused or recycled where practicable. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the worst case scenario, the impacts will be no greater than those identified for the construction phase.			

11.3.2.2 Development Scenarios

17. There are currently two possible electrical solutions being considered for DBS West, HVAC or HVDC. Due to the distance of the array area offshore DBS East will be an HVDC project. Therefore, there are two possible electrical solutions for the Projects:

- One HVDC project and one HVAC project; or
- Two HVDC projects.

18. Offshore the most significant difference between an HVAC solution and an HVDC solution is that if an HVAC electrical solution is used an additional platform will be required along the offshore export cable. In additional, a HVAC solution will require two additional cables offshore, over and above the four cables that would be required for two HVDC projects.

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

11.3.2.3 Construction Scenarios

20. The following principles set out the framework for how the Projects may be constructed (relating to both onshore and offshore works):

- DBS West and DBS East may be constructed at the same time, or at different times;
- If built concurrently, both Projects could be constructed in five years;
- If built non-concurrently, either Project could be built first;
- If built non-concurrently, each Project would require a five year period of construction;
- If built non-concurrently, it is anticipated that there would be up to a two year lag between the start of construction for the first project and the start of construction for the second project; ; and
- Assuming a maximum construction period per Project of five years, and taking the above into account, the maximum construction period over which the construction of both Projects could take place is seven years.

21. In order to determine which construction scenario presents the realistic worst case for each receptor and impact, the assessment considers both maximum duration effects and maximum peak effects, in addition to each Project being developed in isolation, drawing out any differences between each of the two Projects.

22. The three construction scenarios considered by the marine mammal assessment are therefore:

- Build DBS East or build DBS West in isolation;
- Build DBS East and DBS West concurrently – reflecting the maximum peak effects; and
- Build the Projects sequentially with a lag of up to two years – reflecting the maximum duration of effects.

23. The individual, concurrent and sequential construction scenarios all allow for flexibility to build out the Projects using a phased approach. This will allow the Projects to adapt to National Grid Electricity Transmission Operator's development plans for the onshore grid connection points. Under a phased approach the maximum timescales for individual elements of the construction have been assessed.

24. Any differences between the Projects, or differences that could result from the manner in which the first and the second Projects are built (concurrent or sequential and the length of any gap) are identified and discussed where relevant in section 11.6. For each potential impact, only the worst case construction scenario for two Projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst case is provided, where necessary, in section 11.6.

11.3.2.4 Operation Scenarios

25. Operation scenarios are described in detail in **Chapter 5 Project Description**. The assessment considers the following scenarios:

- Only DBS East in operation;
- Only DBS West in operation; and
- The two projects operating concurrently, with a lag of two years between each Project commencing operation.

26. If the Projects are built out using a phased approach, there would also be a phased approach to starting the operational stage. The worst case scenario for the operational phases for the Projects have been assessed. See section 5.1.1 of Chapter 5 Project Description for further information on phasing scenarios for the Projects.

27. The operations lifetime of each Project is expected to be 30 years.

11.3.2.5 Decommissioning Scenarios

28. Decommissioning scenarios are described in **Chapter 5 Project Description**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction, however for the purpose of this assessment it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

11.3.3 Mitigation Embedded in the Design

29. This section outlines the embedded mitigation relevant to the marine mammal assessment, which has been incorporated into the design of the Projects (**Table 11-3**). Where other mitigation measures are proposed, these are detailed in the impact assessment (section 11.6).

Table 11-3 Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
Underwater Noise	
Soft-start and ramp-up (part of Marine Mammal Mitigation Protocol (MMMP) for piling activities)	Each piling event would commence with a soft-start at a lower hammer energy followed by a gradual ramp-up for at least 20 minutes to the maximum hammer energy required (the maximum hammer energy is only likely to be required at a few of the piling installation locations). This would be secured through the DCO.
Vessel collision risk	
Best practice to reduce vessel collision risk	Vessel movements, where possible, will follow set vessel routes and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. An outline Project Environmental Management Plan (PEMP) will be submitted alongside the DCO application to set out the details of the measures that will be taken in relation to collision risk, as required. The final PEMP will include the RWE 'Working in Proximity to Wildlife in the Marine Environment Code of Conduct' which all operational sites are required to follow. It sets out guidelines for working in proximity to wildlife, following best practice guidelines to reduce and minimise injury and collision to wildlife. This would be secured through the DCO.
Water Quality	
Pollution Prevention Measures	Due to the presence and movements of construction and operation and maintenance vessels/equipment there is the potential for spills and leaks which could result in changes to

Parameter	Mitigation Measures Embedded into the Project Design
	water quality. All vessels involved will be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. An outline Pollution Environmental Management Plan (PEMP) will also be produced and implemented to cover the construction and, operation and maintenance and decommissioning phases of the Project. This will set out all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed during construction and, operation and maintenance and decommissioning phases to minimise the risk of, and effects in the event of an accidental spill. The PEMP will identify all potential sources and types of accidental pollution for all project phases and set out the proposed mitigation measures and will be developed in consultation with key stakeholders for approval by the MMO. This would be secured through the DCO.

11.3.3.1 Other Mitigation

30. In addition to the embedded mitigation as outlined above, the Applicant has also committed to the following measures (**Table 11-4**).

Table 11-4 Additional Mitigation Measures

Parameter	Additional Mitigation Measures
MMMP for Piling Activities	
MMMP for piling activities	The MMMP for piling will be developed in the pre-construction period and based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will be developed in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs) and the MMO, detailing the proposed mitigation to reduce the risk of any physical or permanent auditory injury (Permanent Threshold Shift (PTS)) to marine mammals during all piling operations. This will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the proposed mitigation zone and any additional mitigation measures required in order to minimise potential impacts of any physical or PTS, for example, the activation of an ADD prior to the soft-start. A Draft MMMP will be submitted with the DCO application.
Site Integrity Plan (SIP)	
Southern North Sea Special Area of Conservation (SAC) SIP	In addition to the MMMPs for piling and UXO clearance, a Southern North Sea SAC SIP will be developed. The SIP will set out the approach to deliver any project mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the Southern North Sea SAC conservation objectives. The SIP will be an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the Southern North Sea SAC. The SIP will be developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and MMO.

11.4 Assessment Methodology

11.4.1 Policy, Legislation and Guidance

11.4.1.1 National Policy Statements

31. The assessment of potential impacts upon marine mammals has been made with specific reference to the relevant National Policy Statements (NPS). The specific assessment requirements for marine mammal ecology, as details in the NPS, are summarised in **Table 11-5.**

32. It is noted that the NPS for Energy (EN-1) and the NPS for Renewable Energy Infrastructure (EN-3) are in the process of being revised. Draft versions were published for consultation in September 2021 (Department for Business Energy and Industrial Strategy (BEIS)[1], 2021a and BEIS, 2021b, respectively). A review of these draft versions has been undertaken in the context of this PEIR chapter.

33. **Table 11-5** includes sections of the draft versions of the NPS (EN-1 and EN-3) in which relevant additional NPS requirements that are not presented within the current NPS (EN-1 and EN-3) have been included. Minor wording changes within the draft version which do not materially influence the NPS (EN-1 and EN-3) requirements have not been reflected in **Table 11-5**.

34. Following the consultation in 2021 on the draft energy NPS, a new consultation opened on the 30 March 2023 on revised drafts of the energy NPSs, including EN1, EN3 and EN5. Due to the timing of this consultation, and finalisation of this PEIR we have been unable to review and take these revised draft NPS into account within these documents. However, these will be reviewed and incorporated into the final ES where relevant.

Table 11-5 NPS Assessment Requirements

NPS Requirement	NPS Reference	PEIR Section Reference
NPS for Renewable Energy Infrastructure (EN-3)		
There are specific considerations from piling noise which apply to offshore wind energy infrastructure proposals with regard to marine mammals, including cetaceans and seals, which have statutory protection.	2.6.90-2.6.91 See updated wording in draft EN-3 paragraph 2.28.1 and 2.28.2 (BEIS, 2021b) below.	Section 11.3.2 provides an overview of the worst-case scenario for possible piling works. Sections 11.6.1.1 and 11.6.1.2 provides an assessment of pile driving

[1] BEIS is now known as the Department for Energy Security and Net Zero as of the 8th February 2023

NPS Requirement	NPS Reference	PEIR Section Reference
		(including noise modelling results). It is anticipated that an application for a Wildlife Licence will be submitted post-consent.
Where necessary, assessment of the effects on marine mammals should include details of: • Likely feeding areas; • Known birthing areas / haul out sites; • Nursery grounds; • Known migration or commuting routes; • Duration of the potentially disturbing activity including cumulative / in-combination effects with other plans or projects; • Baseline noise levels; • Predicted noise levels in relation to mortality, PTS and Temporary Threshold Shift (TTS); • Soft-start noise levels according to proposed hammer and pile design; and • Operational noise.	2.6.92 See updated wording in draft EN-3 paragraph 2.28.3 (BEIS, 2021b) below.	Section 11.5 and **Appendix 11-1** provide a description of the existing environment. Section 11.6.1 details the assessment of impacts during construction, including pile driving. Section 11.6.2 provides the assessment of operational noise. Cumulative effects are considered in section 11.7. Potential effects on protected sites will be assessed in the Report to Inform Appropriate Assessment (RIAA) during the ES.
The applicant should discuss any proposed piling activities with the relevant body. Where assessment shows that noise from offshore piling may reach noise levels likely to lead to an offence [as described above], the applicant should look at possible alternatives or appropriate mitigation before applying for a licence.	2.6.93 See updated wording in draft EN-3 paragraph 2.28.1 and 2.28.5 (BEIS, 2021b) below.	Section 11.6.1 details the assessment of impacts during construction, including pile driving and mitigation measures. The Applicant has discussed proposed piling activities with Natural England (**Table 11-1**) through the EPP as outlined in section 11.2.

NPS Requirement	NPS Reference	PEIR Section Reference
The IPC (Infrastructure Planning Commission) [now the PINS and 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 so as to reasonably minimise significant disturbance effects on marine mammals. Unless suitable noise mitigation measures can be imposed by requirements to any development consent the IPC [now SoS] may refuse the application. The conservation status of marine European Protected Species and seals are of relevance to the IPC [now SoS]. IPC [now SoS] should take into account the views of the relevant statutory advisors. Fixed submerged structures such as foundations are likely to pose little collision risk for marine mammals and the IPC [now SoS] is not likely to have to refuse to grant consent for a development on the grounds that offshore windfarm foundations pose a collision risk to marine mammals.	P2.6.94 to 2.6.96 See updated wording in draft EN-3 paragraph 2.28.9 and 2.28.10 (BEIS, 2021b) below.	**Chapter 5 Project Description** describes the foundation options under consideration. Section 11.3.2 describes the worst-case scenario for marine mammals.
Monitoring of the surrounding area before and during the piling procedure can be undertaken. During construction, 24-hour working practices may be employed so that the overall construction programme and the potential for impacts to marine mammal communities are reduced in time. Soft start procedures during pile driving may be implemented. This	2.6.97 to 2.6.99 See updated wording in draft EN-3 paragraph 2.28.6 and 2.28.7 (BEIS, 2021b) below.	An **Offshore In Principle Monitoring Plan** (**IPMP**) and draft MMMP will be submitted with the DCO application. These plans will be developed in consultation with the relevant SNCBs and approved by the MMO post-consent and will identify any necessary monitoring requirements.

NPS Requirement	NPS Reference	PEIR Section Reference
enables marine mammals in the area disturbed by the sound levels to move away from the piling before significant adverse impacts are caused.		
The conservation status of marine European Protected Species and seals are of relevance to the IPC [now SoS].	2.6.95	The conservation status of relevant marine mammal species is included in section 11.4.1.6.
Monitoring of the surrounding area before and during the piling procedure can be undertaken.	2.6.97	A draft MMMP will be submitted with the DCO application which will detail the marine mammal monitoring requirements during piling.
During construction, 24-hour working practices may be employed so that the overall construction programme and the potential for impacts to marine mammal communities is reduced in time.	2.6.98	Details on the construction programme are provided in **Chapter 5 Project Description.**
The applicant should discuss any proposed piling activities with the relevant body. Where assessment shows that noise from offshore piling may reach noise levels likely to lead to an offence [as described above], the applicant should look at possible alternatives or appropriate mitigation before applying for a licence.	2.6.93 See updated wording in draft EN-3 paragraph 2.28.1 and 2.28.5 (BEIS, 2021b) below.	Section 11.7 details the assessment of impacts during construction, including pile driving and mitigation measures. The Project has discussed proposed piling activities consulted with Natural England (**Table 11-1**) through the EPP as outlined in in section 11.2.
Draft EN-3 NPS for Renewable Energy Infrastructure		
Construction activities, including installing wind turbine foundations by pile driving, geophysical surveys, and clearing the site and cable route of unexploded ordinance (UXOs) may reach noise levels which are high enough to cause disturbance, injury, or even death to marine mammals. All marine mammals are protected under Part 3 of the	2.28.1	Section 11.7provides 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.

NPS Requirement	NPS Reference	PEIR Section Reference
Habitats Regulations. In addition, whales, dolphins and porpoises (collectively known as cetaceans) are legally protected species. Therefore, if construction and associated noise levels are likely to lead to an offence under Part 3 of the Habitats Regulations (which would include deliberately disturbing, injuring or killing), an application will have to be made for a wildlife licence to allow the activity to take place.		
The development of offshore wind farms can also impact fish species, which can have indirect impacts on marine mammals if those fish are prey species. There is also the risk of collision with construction and maintenance vessels.	2.28.2	Section 11.6 provides an assessment of the potential impacts from any indirect effects as a result of impacts on prey species and the risk of collision with construction and maintenance vessels.
Applicant's assessment Where necessary, assessment of the effects on marine mammals should include details of: • likely feeding areas and impacts on prey species and prey habitat; • known birthing areas / haul out sites for breeding and pupping; • migration routes; • protected areas (e.g. SACs); • baseline noise levels; • predicted construction and soft start noise levels in relation to mortality, PTS and TTS and disturbance; • operational noise;	2.28.3	Section 11.5 and **Appendix 11-1** provide a description of the existing environment, including likely feeding areas and prey, seal haul-out sites, migration routes and protected areas. Section 11.6 details the assessment of impacts for PTS, TTS and disturbance from underwater noise, including during construction from pile driving and soft-start noise levels. Sections 11.6.2 provides the assessment of operational noise. Sections 11.6.1 and 11.6.2 details the assessment of collision risk with vessels during

NPS Requirement	NPS Reference	PEIR Section Reference
• duration and spatial extent of the impacting activities including cu-mulative / in-combination effects with other plans or projects; • collision risk; and • barrier risk.		construction, operation and maintenance. Sections 11.6.1 and 11.6.2 detail the assessment of potential barrier effects from underwater noise or physical presence of the offshore wind farm.
The scope, effort and methods required for marine mammal surveys should be discussed with the relevant statutory nature conservation body.	2.28.4	The requirements of the marine mammal surveys were discussed with the relevant SNCBs as part of the EPP, as outlined in section 11.2.
The applicant should discuss any proposed noisy activities with the relevant body and must reference the JNCC underwater noise guidance (JNCC *et al.*.2020) in relation to noisy activities (alone and in-combination with other plans or projects) within HRA sites. Where assessment shows that noise from construction and UXO clearance may reach noise levels likely to lead to noise thresholds being exceeded (as detailed in the JNCC guidance) or an offence as described in paragraph 2.28.1 above, the applicant should look at possible alternatives or appropriate mitigation (detailed below).	2.28.5	The Applicant has discussed noisy activities through the EPP as outlined in section 11.2. Reference will be included 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 Report to Inform Appropriate Assessment (RIAA). This will be provided to stakeholders following consultation on PEIR.
Mitigation Monitoring of the surrounding area before and during the piling procedure can be undertaken by various methods including marine mammal observers and passive acoustic monitoring. Active displacement of marine mammals outside potential injury zones can be	2.28.6	The proposed mitigation is outlined in section 11.3.3 and the proposed monitoring is outlined in section 11.8

NPS Requirement	NPS Reference	PEIR Section Reference
undertaken using equipment such as acoustic deterrent devices.		
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.	2.28.7	Soft-start procedures are included in the embedded mitigation as outlined in section 11.3.3.
Where noise impacts cannot be reduced to acceptable levels, other mitigation should be considered, including spatial/temporal restrictions on noisy activities, alternative foundation types, alternative installation methods and noise abatement technology. Review of up-to-date research should be undertaken and all potential mitigation options presented.	2.28.8	Mitigation to reduce the impacts from underwater noise are provided in the draft MMMP. As outlined in section 11.3.3 the MMMPs and the mitigation measures required will be developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and MMO.
Secretary of State decision making The Secretary of State 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 Secretary of State may refuse the application.	2.28.9	As outlined in section 11.3.3 selection of the types of foundations, construction methods and mitigation measures are designed to reasonably minimise significant impacts on marine mammals.

NPS Requirement	NPS Reference	PEIR Section Reference
The conservation status of cetaceans and seals are of relevance and the Secretary of State should be satisfied that cumulative and in-combination impacts on marine mammals have been considered.	2.28.10	The conservation status of relevant marine mammal species is included in section 11.4.1.6. The cumulative and in-combination effects on marine mammals are assessed in section 11.7and will be included in the RIAA.

11.4.1.2 National and Regional Marine Policies

35. In addition to the NPS, 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 (United Kingdom (UK) Government, 2010).
- Policy:
  - The Marine Policy Statement (MPS) (HM Government, 2011); and
  - 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).

36. Further detail is provided in **Appendix 11-1** and **Chapter 3 Policy and Legislative Context**.

11.4.1.3 National and International Legislation for Marine Mammals

37. **Appendix 11-1** provides an overview of national and international legislation in relation to marine mammals.

11.4.1.4 Guidance Documents for Marine Mammals

38. The principal guidance documents used to inform the assessment of potential impacts on marine mammals include, but are not limited to:

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

11.4.1.5 Protected Species and Marine Wildlife Licence Guidance

39. All cetacean species are listed as EPS under Annex IV of the Habitats Directive and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Within the UK, The Habitats Directive is enacted through The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017. Under these 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.

40. Grey and harbour seal are also protected under the Conservation of Habitats and Species Regulations 2017 and The Conservation of Offshore Marine Habitats and Species Regulations 2017, as well as Conservation of Seals Act 1970. Further information is provided in **Appendix 11-1**.

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

11.4.1.6 Conservation Status of Marine Mammals

42. **Table 11-6** provides the current conservation status of marine mammal species occurring in UK and adjacent waters, based on the most recent 2013-2018 reporting by JNCC in 2019.

Table 11-6 Conservation Status of Marine Mammal Species Occurring in UK and Adjacent Waters, Relevant to The Projects (JNCC, 2019)

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

43. The International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species provides assessments of the conservation status of animals evaluated at a global scale using the IUCN Red List Categories and Criteria, with the aim of determining their relative risk of extinction. Assessments are updated periodically to reflect new information. Where sufficient information exists, the majority of marine mammal species occurring in UK waters fall into the lowest category of 'least concern' (**Table 11-7**).

Table 11-7 Global IUCN Red List of Threatened Species Assessments for Marine Mammal Species Relevant to The Project

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

11.4.2 Data and Information Sources

11.4.2.1 Site Specific Surveys

44. In order to provide site specific and up to date information on which to base the impact assessment, a site-specific digital aerial survey was conducted for both marine mammals and seabirds. APEM Ltd collected high resolution digital aerial still imagery for marine megafauna (combined with ornithology surveys) over both DBS East and DBS West, including a 4km buffer (the Survey Area; **Appendix 11-1**).

45. **Table 11-8** shows the numbers of marine mammals recorded during the digital aerial surveys in the Projects from March 2021 to February 2022. The results indicate that harbour porpoise is present in the highest numbers, followed by dolphin/porpoise species which for a worst case scenario can be considered as harbour porpoises. These numbers are the raw count, therefore only present a relative abundance and not total abundances.

46. The site specific surveys finished in February 2023, providing two years' worth of data. The full data will be presented to stakeholders through the ETGs and will be included in the final assessment in the ES.

Table 11-8: APEM Surveys Species Counts for DBS East; DBS West And 4km Buffer (March 2021 to February 2022)

Species	DBS East	DBS West	Total
Harbour porpoise	276	334	610
Common dolphin	-	2	2
White-beaked dolphin	8	12	20
Dolphin / porpoise species	35	34	69
Dolphin species	1	2	3
Minke whale	1	-	1
Grey seal	11	31	42
Seal species	25	34	59
Marine mammal species	4	16	20

11.4.2.2 Other available sources

47. Other sources that have been used to inform the assessment are listed in **Table 11-9.**

Table 11-9 Other Available Data and Information Sources

Data Set	Spatial Coverage	Year	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond *et al.* 2021)	North Sea and European Atlantic waters	Summer 2016	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2016, including the offshore Project areas.
Management Units (MUs) for cetaceans in UK waters (IAMMWG 2022)	UK waters	2022	Provides information on MU for the offshore project areas.
Offshore Energy Strategic Environmental Assessment (OESEA) (including relevant appendices and technical reports) (OESEA 3 (DECC (2016); OESEA 4 (BEIS 2022a and 2022b)).	UK waters	2016 2022	Provides information on marine mammals in UK waters.
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov 2015)	UK waters	1994-2011	Data was used to determine UK harbour porpoise SAC sites.
Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (Paxton *et al.*.2016)	UK EEZ	1994-2011	Provides information on cetaceans in UK waters.
Seasonal habitat-based density models for a marine top predator, the harbour porpoise, in a dynamic environment (Gilles *et al.*2016)	UK (SCANS II, Dogger Bank), Belgium, the Netherlands, Germany, and Denmark	2005-2013	Provides information for central and southern North Sea.

Data Set	Spatial Coverage	Year	Notes
Distribution and abundance maps for cetacean species around Europe (Waggitt *et al.*2019).	North-east Atlantic	1980-2018	Provides information on cetacean species in the North Sea and UK waters.
Distribution of marine mammals recorded from Digital Aerial survey (HiDef)	Dogger Bank Zone and Tranche C site	2013	Provides information on cetacean species in the Dogger Bank Project Areas.
Distribution of marine mammals recorded from Digital Aerial survey (HiDef)	Dogger Bank Zone 3	April 2010 to May 2012	Provides information on cetacean species in the Dogger Bank Zone 3 area.
Marine mammal surveys	Forewind Dogger bank offshore wind farm	January 2012 to June 2012	Provides information on cetacean species in the Forewind Dogger Bank project area.
Distribution of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008 (The Wildfowl and Wetlands Trust 2009)	UK areas of the North Sea	2001-2008	Provides information on species in the North Sea.
MARINElife surveys from ferry routes across the southern North Sea area (MARINElife 2022)	Southern North Sea	2017-2019	Provides information on species in the southern North Sea.
Sea Watch Foundation volunteer sightings off eastern England (Sea Watch Foundation 2023)	East coast of England	2019-2020	Provides information on species sighted along east coast of England.
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (Carter *et al.*2020 and 2022)	North Sea	1991-2019	Provides information on abundance and absolute density estimates (i.e. number of seals) for seal species.

Data Set	Spatial Coverage	Year	Notes
Seal telemetry data (e.g. Russell and McConnell, 2014; Russell 2016a; Carter *et al.*.2020)	North Sea	1988-2010; 2015	Provides information on movements and distribution of seal species.
Special Committee on Seals (SCOS) annual reporting of scientific advice on matters related to the management of seal populations (SCOS 2020; SCOS 2021).	North Sea	2019 & 2020	Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles

11.4.3 Impact Assessment Methodology

48. **Chapter 6 EIA Methodology** provides a summary of the general impact assessment methodology applied. The following sections describe the methods used to assess the likely significant effects on marine mammals.

49. A matrix approach is used to guide the assessment of impacts following best practice, EIA guidance and the approach outlined in the Projects Scoping Report. An explanation of how this is applied within the marine mammal assessment is set out below.

50. In order to enable and facilitate a consistency of approach a matrix of definitions will be employed to structure the expertise and evidence led assessment of impacts. Receptor sensitivity for each marine mammal species have been defined within the PEIR, following the definitions set out in section 11.4.3.1.

11.4.3.1 Definitions

51. For each potential impact, the assessment identifies receptors sensitive to that impact and implements a systematic approach to understanding the impact pathways and the level of impacts (i.e. magnitude) on given receptors. The definitions of sensitivity and magnitude for the purpose of the marine mammal assessment are provided in **Table 11-10** and **Table 11-11**.

11.4.3.1.1 Sensitivity

52. The sensitivity of a receptor is determined through its ability to accommodate change and on its ability to recover if it is affected (**Table 11-10**). 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 effect;
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect;
- Recoverability – The temporal scale over and extent to which a receptor will recover following an effect; and
- Value – A measure of the receptor importance, rarity and worth.

Table 11-10 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.

11.4.3.1.2 Value

53. 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.

54. 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.

55. 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.

56. **Table 11-11** 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 11-11 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 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.

11.4.3.1.3 Magnitude

57. 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 JNCC *et al.* (2010) draft guidance on disturbance to EPS species. The JNCC *et al.* (2010) EPS draft guidance suggests definitions for a 'significant group' of individuals or proportion of the population for EPS species. As such this guidance has been considered in defining the thresholds for magnitude of impact (**Table 11-12**).

58. 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 favourable conservation status. The JNCC *et al.* (2010) draft guidance also provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement.

59. 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.

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

Table 11-12 Definition of Magnitude of Impacts

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

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

11.4.3.1.4 Significance of Effect

61. 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 **Chapter 6 EIA Methodology**. Definitions of each level of significance are provided in **Table 11-13**. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIA terms, whether this be adverse or beneficial. Any effect that has a significance of minor or negligible is not significant.

Table 11-13 Marine Mammal Significance of Effect Matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	**Medium**	**Low**	**Negligible**	**Negligible**	**Low**	**Medium**	**High**
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 11-14 Definition of Effect Significance

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

11.4.4 Cumulative Effect Assessment Methodology

62. The cumulative effect assessment (CEA) considers other plans and projects that may result in cumulation with the Projects. **Chapter 6 EIA Methodology** provides details of the general framework and approach to the CEA that will be undertaken for the Projects.

63. The final assessment of cumulative effects will be undertaken during the later stages of the EIA, once further information is available on a number of projects such as the Outer Dowsing Offshore Wind Farm, Hornsea Project Four decision and the Sheringham Shoal and Dudgeon Extension Projects examination. However, for the purposes of the PEIR, it is possible to identify a number of projects and plans which are likely to feature in that assessment and consider the extent to which cumulative effects might arise. Section 11.7 presents the following preliminary information regarding cumulative effects:

- Screening for cumulative effects; and
- A preliminary short list of plans and projects considered for CEA, including a brief description as to how projects have been screened in and the initial tier level they have been assigned.

64. The marine mammal assessment will present relevant cumulative effects of projects based on their stage of development using the tiered approach as devised by Natural England and Defra (2022), as follows:

- Tier 1: built and operational projects;
- Tier 2: projects under construction;
- Tier 3: projects that have been consented (but construction has not yet commenced);
- Tier 4: projects that have an application submitted to the appropriate regulatory body that have not yet been determined;
- Tier 5: projects that have produced a PEIR and have characterisation data within the public domain;
- Tier 6: projects that the regulatory body are expecting to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects); and
- Tier 7: projects that have been identified in relevant strategic plans or programmes.

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

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

- Other OWFs;
- Other marine renewables (wave and tidal) developments;
- Aggregate extraction and dredging;
- Licenced disposal sites;
- Construction of subsea cables and pipelines;
- Oil and gas development and decommissioning, including seismic surveys;
- Coastal developments;
- UXO clearance;
- Commercial fisheries; and
- Shipping.

67. The CEA is a two-part process in which an initial list of potential projects is identified with the potential to interact with the proposed projects based on the mechanism of interaction and spatial extent of the reference population for each marine mammal species. Following a tiered approach, the list of projects is then refined based on the level of information available for this list of projects to enable further assessment.

68. The CEA will consider projects, plans and activities which have sufficient information available to undertake the assessment. Insufficient information will preclude a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances.

69. Given the fast-moving nature of offshore development, it is likely that new projects relevant to the assessment will arise throughout the pre-application period. In order to finalise an assessment, it will be necessary to have a cut-off period after which no more projects will be included.

70. The project tiers considered in the CEA for marine mammals are outlined in **Table 11-15** and the appropriate CEA screening will be provided.

Table 11-15 Tiers in Relation to Project Category Which Have Been Screened Into the CEA

Project Category	UK	Other
Other OWFs	Tier 1, 2, 3, 4, 5	Tier 1, 2, 3, 4, 5
Other renewable developments (tidal and wave)	Tier 1, 2, 3, 4, 5	Tier 1, 2, 3
Aggregate extraction and dredging	Tier 1, 2, 3, 4	Screened out
Oil and gas installations and decommissioning	Tier 1, 2, 3, 4	Screened out
Shipping	Tier 1, 2, 3	Screened out
Planned construction of subsea cables and pipelines	Tier 1, 2, 3, 4, 5	Screened out
Gas storage, offshore mines, and carbon capture projects	Tier 1, 2, 3, 4, 5	Screened out
Coastal developments	Tier 1, 2, 3, 4, 5	Screened out
Commercial fisheries	Tier 1, 2, 3	Screened out
Seismic and geophysical surveys	Tier 1, 2, 3, 4	Screened out

11.4.5 Transboundary Effect Assessment Methodology

71. The transboundary assessment considers the potential for transboundary effects to occur on marine mammal receptors as a result of DBS; either those that might arise within the UK EEZ of European Economic Area (EEA) states or arising on the interests of EEA states e.g. a non UK fishing vessel. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the assessment of the transboundary effects.

72. For marine mammals, the potential for transboundary impacts has been addressed by considering the reference MUs and potential linkages to other countries (for example, as identified through seal telemetry studies).

73. The assessment of effects on transboundary designated sites will be presented in the draft RIAA which will be consulted on following PEIR.

11.4.6 Assumptions and Limitations

74. This preliminary assessment is considered to be an interim stage in the EIA process. The results presented in the following sections are based on early design assumptions and initial assessments which will be refined and presented in the final Environmental Statement (ES) to be submitted as part of the DCO application.

75. Due to the large amount of data that has been collected for this and other nearby OWFs, as well as other available data for marine mammals within the region, there is a good understanding of the existing environment. There are, however, some limitations to data collected by marine mammal surveys, primarily due to the highly mobile nature of marine mammals and therefore the potential variability in usage of the site; each survey provides only a snapshot. The majority of the surveys, such as SCANS, are typically carried out in summer months which can result in seasonal gaps. However, the site specific surveys were conducted every month during the two year survey period (**Appendix 11-1**). However, the surveys in the study area over the last decade show relatively consistent results and taking into account the site-specific survey and data from other surveys, such as nearby OWFs for different months, seasons and years, there is good coverage to provide information on the species likely to be present in the area.

76. There are also limitations in the detectability of marine mammals from aerial surveys, such as not being to detect those individuals that are submerged. As a precautionary approach, density estimates for each marine mammal species used in the assessments are based on the highest for the area, see section 11.5. These limitations will be addressed by estimating a correction factor in order to determine estimated absolute density estimates from the site specific aerial surveys once the full two years' worth of data is available.

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

11.5 Existing Environment

11.5.1 Harbour Porpoise

78. Within the North Sea area, harbour porpoise are the most common marine mammal species. Heinänen and Skov (2015) identified one area of high harbour porpoise density in the summer period; from the western slopes of Dogger Bank south along a 30m depth contour towards an area off the Norfolk coast. High densities in winter were also identified in the southern North Sea, within an area between Flamborough Head and the outer Thames Estuary.

79. Distribution and abundance maps were developed by Waggitt *et al.* (2019) for cetacean species around Europe. For harbour porpoise, the distribution maps show a clear pattern of high harbour porpoise density in the southern North Sea, and the coasts of south-east England, for both January and July (See **Appendix 11-1**; Waggitt *et al.* 2019). Interrogation of these data[2], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

- 0.59 individuals per km^2 for the DBS East array area;
- 0.58 individuals per km^2 for the DBS West array area;
- 0.56 individuals per km^2 for the offshore export cable corridor; and
- 0.415 individuals per km^2 for the total Offshore Development Area.

80. Within the impact assessments for harbour porpoise, and in addition to the site specific density estimates for harbour porpoise, density estimates from the SCANS-III surveys (Hammond *et al.* 2021) will also be used to provide context for the wider area. The DBS sites are both in SCANS-III survey blocks O (See **Appendix 11-1**):

- Abundance = 53,485 harbour porpoise (coefficient of variation (CV) = 0.209; 95% confidence intervals (CI) = 37,413-81,695)
- Density = 0.888 harbour porpoise/km^2 (CV=0.209)

[2] Available from: https:// doi.org/10.5061/dryad.mw6m905sz

11.5.1.1 Results from the Site-Specific Surveys for Harbour Porpoise

81. Harbour porpoise was the most commonly sighted marine mammal species during the surveys, with a total of 276 individuals recorded through the 12 survey dates within the DBS East Survey Area and 344 individuals recorded through the 12 survey dates within the DBS West Survey Area. Totalling 620 individuals at the DBS array sites including the 4km buffer.

82. The distribution of harbour porpoise within DBS East and DBS West survey areas varied, with no evident pattern of harbour porpoise distribution within the Survey Area and no indication of a particular area of importance.

11.5.1.2 Site-Specific Density estimates for Harbour Porpoise

83. Density estimates of animals/km^2 have been calculated from the raw data counts for (i) harbour porpoise and (ii) dolphin/porpoise species and are set out in **Appendix 11-1**. These abundance and densities are for the entire Survey Area, plus 4km buffer for DBS East No correction factor has been used to count for diving porpoises, therefore the abundance and density estimates are the absolute minimum.

84. The average of the winter months, summer months, and annual density has then been calculated based on the maximum calculated for each month. **Table 11-16** shows the densities for harbour porpoise, based on all individuals that have the potential to be harbour porpoise (see **Appendix 11-1** for more information on how these density estimates were derived). The density estimates are higher in the summer months.

Table 11-16 Seasonal Density Estimates for Harbour Porpoise Form APEM Ltd Survey

Season	DBS East absolute density estimates	DBS West absolute density estimates
Summer average	0.275	0.427
Winter average	0.17	0.058
Yearly average	0.223	0.243

11.5.1.3 Review of Abundance and Density Estimates for Harbour Porpoise

85. Within the impact assessments for harbour porpoise, and in addition to the site specific density estimates for harbour porpoise, density estimates from the SCANS-III surveys (Hammond *et al.* 2021) will be used to provide context for the wider area. The DBS sites are both in SCANS-III survey blocks O (See **Appendix 11-1**):

- Density = 0.888 harbour porpoise/km^2

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

87. The estimate of harbour porpoise abundance in the North Sea MU is 346,601 (CV = 0.09; 95%; CI = 289,498 – 419,967 IAMMWG 2022). This is the reference population for harbour porpoise, of which any potential impacts will be assessed against.

11.5.2 Bottlenose Dolphin

11.5.2.1 Desk-Based Review of Bottlenose Dolphin Presence

88. For bottlenose dolphin, the distribution maps (developed by Waggitt *et al.* 2019) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay (See **Appendix 11-1** for further information). Densities of bottlenose dolphin in the North Sea are very low in comparison.

89. A resident population of bottlenose dolphin is present in the Moray Firth, with an estimated 224 individuals (95% CI 213 – 234; IAMMWG 2022). Historically, very few sightings of bottlenose dolphin were recorded further south on the east coast of the UK. In recent years an increase in bottlenose dolphins along the coastline of north-east England have been reported (Aynsley 2017; Hacket 2022). They have been recorded approximately 300 miles outside of what would be considered their 'normal' home range (Cheney *et al.* 2018), with one individual from the Moray Firth population being recorded as far south and east as The Netherlands (Aynsley 2017). Whilst bottlenose dolphin presence has been increasing in north-east England in recent years, they appear to be a coastal population at present (Hacket 2022).

90. The SCANS-III survey shows a similar distribution pattern, with no bottlenose dolphin identified within the southern North Sea survey block L or the more northerly block O, and higher densities with block R, for the east coast of Scotland (See **Appendix 11-1**).

91. As sightings of bottlenose dolphin have been increasingly reported along the north-east coast of England, they have also been included in the assessment. For the entire SCANS-III survey area, bottlenose dolphin abundance in the summer of 2016 was estimated to be 19,201, with an overall estimated density of 0.00159/km^2 (CV = 0.242; 95% CI = 11,404-29,670; Hammond *et al.* 2021).

11.5.2.2 Results from the Site-Specific Surveys for Bottlenose Dolphin

92. During the site specific digital aerial surveys of both DBS East and DBS West, no bottlenose dolphin were recorded. However, one sighting was recorded as unidentified dolphin, which could be attributed to bottlenose dolphin.

11.5.2.3 Review of Abundance and Density Estimates for Bottlenose Dolphins

93. There is currently no SCANs density estimate for bottlenose dolphin in and around the Projects. With no confirmed detections in the site specific surveys, density estimates from the Waggitt *et al.* (2019) data will be used for the impact assessments which are:

- 0.00014 individuals per km^2 for the DBS East Site;
- 0.00025 individuals per km^2 for the DBS West Site;
- 0.0013 individuals per km^2 for the offshore export cable corridor; and
- 0.0014 individuals per km^2 for the total Offshore Development Area.

94. The estimate of bottlenose abundance in the GNS MU is 2,022 (95% CI = 548 – 7,453; IAMMWG 2022). This is the reference population for bottlenose dolphin for which any potential impacts will be assessed against.

11.5.3 Common Dolphin

11.5.3.1 Desk-Based Review of Common Dolphin Presence

95. The short-beaked common dolphin is a widespread species of common dolphin occurring in warm-temperate oceans. Being one of the most abundant species of cetacean, the common dolphin has a global population estimated to be around six million (Hammond *et al.*.2008). 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). 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).

96. No common dolphins were recorded in survey block O (in which the Project is located) or any of the blocks in the North Sea during the SCANS -III survey (See **Appendix 11-1**, Hammond *et al.* 2021).

11.5.3.2 Results from the Site-Specific Surveys for Common Dolphin

97. During the site specific digital aerial surveys of the Projects, undertaken from March 2021 to February 2022, one sighting of two individuals was recorded in the DBS West site.

98. In additional to the common dolphins, there was one sighting recorded as unidentified dolphin, which could have been attributed to common dolphin.

11.5.3.3 Review of Abundance and Density estimates for Common Dolphin

99. For the SCANS-III surveys, there are no abundance or density estimates for common dolphin in the North Sea (Hammond *et al.* 2021).

100. Therefore, within the impact assessments for common dolphin, density estimates from Waggitt *et al.* 2019 data will be used:

- 0.037 individuals per km^2 for the DBS East Site;
- 0.041 individuals per km^2 for the DBS West Site;
- 0.073 individuals per km^2 for the offshore export cable corridor; and
- 0.038 individuals per km^2 for the total ODA.

101. As for the density estimate, the CGNS MU (See **Appendix 11-1**), in which sits the Projects, has a population estimate for the common dolphin of 102,656 (95% CI = 58,932 – 178,822; IAMMWG 2022).

11.5.4 White-Beaked Dolphin

11.5.4.1 Desk-Based Review of White-Beaked Dolphin Presence

102. White-beaked dolphin are widely distributed within the central North Sea, however, very few sightings are recorded along the east coast of England, with a small number of sightings in offshore waters within the shallow waters near the North Norfolk Sandbanks and Dogger Bank areas (Gilles *et al.* 2012; DECC 2016). The occurrence of white-beaked dolphin in the southern North Sea is relatively low (Reid *et al.* 2003; Hammond *et al.* 2013; 2021).

103. SCANS-III identified that for white-beaked dolphin, densities are low across much of UK waters, with higher densities shown to be in the Hebrides and the northern North Sea, with no white-beaked dolphin identified within the southern North Sea survey block L, and low but increasing densities with the more northerly North Sea survey blocks (blocks O and R) (Hammond *et al.* 2021).

104. For the entire SCANS-III survey area, white-beaked dolphin abundance in the summer of 2016 was estimated to be 36,287 with an overall estimated density of 0.030/km^2 (CV = 0.29; 95% CI = 18,694-61,869; Hammond *et al.* 2021). DBS offshore wind farms are located in SCANS-III survey block O (Hammond *et al.* 2021):

- Abundance = 143 white-beaked dolphin (CV=0.97; 95% CI= 0-490)
- Density = 0.002 white-beaked dolphin/km^2 (CV=0.97)

105. For white-beaked dolphin, the distribution maps developed by Waggitt *et al.* (2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (**Appendix 11-1**; Waggitt *et al.*2019). DBS East and DBS West are located to the southern end of the area with relatively higher densities, where there appears an increase in densities during the summer months within this area. For white-beaked dolphin the highest density estimate was from the distribution maps developed by Waggitt *et al.* (2019), with a project wide (for DBS) density estimate of 0.006 individuals per km^2.

11.5.4.2 Results from the Site-Specific Surveys for White-Beaked Dolphin

106. During the site-specific aerial surveys of both DBS East and DBS West, eight white-beaked dolphins were recorded in the DBS East survey area during one survey in March 2021 and 12 individuals in the DBS West survey area during two surveys occurring in April and June (four and eight individuals respectively). However, several sightings were recorded as unidentified dolphin, dolphin/porpoise species and marine mammal species, some of which could have been white-beaked dolphin.

11.5.4.3 Review of Abundance and Density estimates for White-Beaked Dolphin

107. Within the impact assessments for white-beaked dolphin, the worse-case density estimates for the offshore sites will be used. Therefore, the density estimates from Waggitt *et al.* (2019) data will be used:

- 0.0055 individuals per km^2 for the DBS East Site;
- 0.011 individuals per km^2 for the DBS West Site;
- 0.046 individuals per km^2 for the offshore export cable corridor; and
- 0.017 individuals per km^2 for the total Offshore Development Area.

108. The single MU for white-beaked dolphin, the CGNS MU, comprises all UK waters. The reference population for white-beaked dolphin in the CGNS MU is 43,951 animals (CV=0.22; 95% CI= 28,439 – 67,924; IAMMWG 2022).

11.5.5 Minke Whale

11.5.5.1 Desk-Based Review of Minke Whale Presence

109. Minke whales 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). DECC (2016) support this, stating that sightings rarely extend past Dogger Bank, but that occasional sightings of minke whale are made as far south as Flamborough Head and the north Humberside coastlines between July and October (DECC 2016).

110. For minke whale, the distribution maps developed by Waggitt *et al.* 2019 show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the CIS, with decreasing densities southwards of Scotland along the east coast of England. There is a clear seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (**Appendix 11-1;** Waggitt *et al.* 2019). The Projects are located to the very southern end of the area with relatively higher densities, and there appears to be a slight difference in their seasonal distributions with higher densities in this area during the summer months. Interrogation of this data[3], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

- 0.0025 individuals per km^2 for the DBS East Site;
- 0.0034 individuals per km^2 for the DBS West Site; and
- 0.0073 individuals per km^2 for the offshore export cable corridor; and
- 0.0075 individuals per km^2 for the total Offshore Development Area.

111. For the entire SCANS-III survey area, minke whale abundance in the summer of 2016 was estimated to be 13,101 with an overall estimated density of 0.01/km^2 (CV = 0.345; 95% CI = 7,050-26,721; Hammond *et al.*.2021).

- Abundance = 603 minke whale (CV=0.62; 95% CI=109-1,670)
- Density = 0.01 minke whale/km^2 (CV=0.621)

11.5.5.2 Results from the Site-Specific Surveys for Minke Whale

112. During the DBS East and DBS West site specific digital aerial surveys a single minke whale was positively identified in September inside the DBS East site. The individual minke recorded, resulted in a relative density estimate of 0.01 individuals per km^2.

[3] Available from: https:// doi.org/10.5061/dryad.mw6m905sz

11.5.5.3 Review of Abundance and Density Estimates for Minke Whale

113. Within the impact assessments for minke whale, the worst case density estimates from the SCANS-III surveys will be used. The Projects are located in SCANS-III survey block O with a density estimate of (Hammond *et al.* 2021):

- 0.010 minke whale/km^2 (CV=0.621)

114. The single MU for minke whale is the CGNS covering all UK waters (IAMMWG 2022 See **Appendix 11-1**). The reference population for minke whales in the CGNS MU is 20,118 animals (CV = 0.18; 95% CI = 14,061 – 28,786; IAMMWG 2022).

11.5.6 Grey Seal

11.5.6.1 Desk-Based Review of Grey Seal Presence

115. Grey seal only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in north-west Europe (SCOS 2020).

116. Approximately 36% of the world's grey seals breed in the UK, and 81% of these breeds at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in south-west England and Wales (SCOS 2020).

117. The relative seals at-sea density maps have been used to calculate grey seal density estimates for DBS East and DBS West. The Carter *et al.* (2022) density maps include updated tagging studies (See **Appendix 11-1**). These density maps only include tagging studies from the UK.

118. The grey seal density estimates for DBS East and DBS West have been calculated from the seal at sea usage maps (Carter *et al.* 2022) based on the 5km x 5km grids that overlap with the Projects. The total grey seal population in the British Isles, at sea, is approximately 159,175 individuals, based on the corrected values and most recent haul-out counts for the UK (SCOS 2020). This is the population estimate used with the Carter *et al.* (2022) data to calculate density estimates for DBS East and DBS West array sites.

11.5.6.2 Results from the Site-Specific Surveys for Grey Seal

119. From March 2021 to February 2022, 11 grey seals were recorded in DBS East on seven surveys and 31 individuals in DBS West during eight surveys. However, a number of sightings were recorded as 'seal species', at DBS East (n=25), DBS West (n=34) and 'marine mammal species' DBS West (n=14), some of which could have been grey seals.

120. The number of grey seals peaked in the summer months but unidentified seal sightings where higher in the winter.

11.5.6.3 Review of Abundance and Density Estimates for Grey Seal

121. Within the impact assessments for grey seal, density estimates for DBS East and DBS West calculated from the seal at sea usage maps (Carter *et al.* 2022) will be used (see **Appendix 11-1**).

122. The mean at sea relative density estimates for these areas have been calculated from Carter *et al.* (2022);

- 0.181 individuals per km^2 for the DBS East;
- 0.260 individuals per km^2 for the DBS West;
- 0.531 individuals per km^2 for the Offshore export cable corridor; and
- 0.386 individuals per km^2 for the total Offshore Development Area.

123. In accordance with the agreed approach for other OWFs, the reference population extent for grey seal incorporates the SE England MU and the NE England MU (IAMMWG 2013; SCOS 2020) to take into account the wide-ranging movement of grey seal as indicated by tagging studies.

124. These have also been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.2515 grey seals are available to count within the August surveys (i.e. are hauled-out), and therefore this has been used as a correction factor, to derive total grey seal numbers within each MU, rather than the number counted within each MU.

125. The reference population for grey seal is therefore currently based on the most recent estimates as shown in **Table 11-17.**

Table 11-17 Grey Seal Count Population Estimates

Population area	Grey seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Grey seal total population
SE England MU	8,667	SCOS 2020	0.2515	34,461
NE England MU	6,501	SCOS 2020	0.2515	25,849
Total wider reference population	15,168	-	0.2515	60,310

126. The total reference population for the assessment is 60,310 grey seal. Assessments are in the context of the nearest MU (of 34,461) as well as the wider reference population (of 60,310). As a worst case it is assumed that all seals are from the nearest MU, the south-east England MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

11.5.7 Harbour seal

11.5.7.1 Desk-Based Review of Harbour Seal Presence

127. 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 vitulina* (SCOS 2021).

128. 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 2021).

129. Harbour seal come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. Harbour seal regularly haul-out on land in a pattern that is often related to the tidal cycle (SCOS 2021). Harbour seal give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS 2021). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS 2021).

130. DBS East is located approximately 100km offshore (at the closest point) and DBS West is located approximately 122km offshore (at the closest point).

131. The Carter *et al.* (2022) density maps include updated tagging studies (See **Appendix 11-1**). These density maps only include tagging studies from the UK.

132. The harbour seal density estimates for DBS East and DBS West have been calculated from the seal at sea usage maps (Carter *et al.* 2022) based on the 5km x 5km grids that overlap with the Projects. The total harbour seal population in the British Isles, at sea, is approximately 40,600 individuals, based on the corrected values and most recent haul-out counts for the UK (SCOS 2021). This is the population estimate used with the Carter *et al.* (2022) data to calculate density estimates for DBS East and DBS West array sites

11.5.7.2 Results from the Site-Specific Surveys for Harbour Seals

133. During the site specific digital aerial surveys of both DBS East and DBS West, no harbour seals were recorded. However, several sightings were recorded as unidentified seals, some of which could be attributed to harbour seals as well as grey seals (see **Appendix 11-1**).

11.5.7.3 Review of Abundance and Density Estimates for Harbour Seal

134. The relative seals at-sea density maps (Carter *et al.* 2022; **Appendix 11-1**) have been used to calculate harbour seal density estimates for DBS East and DBS West array sites.

135. The harbour seal density estimates for the Projects have been calculated from the latest seal at sea maps produced by SMRU (Carter *et al.* 2022), based on the grids that overlap with each area (see **Appendix 11-1**). This is the population estimate used with the Carter *et al.* (2022) data to calculate density estimates for the Projects.

136. The mean at sea density estimates for these areas have been used in the assessment:

- 0.0017 individuals per km^2 for the DBS East;
- 0.0010 individuals per km^2 for the DBS West;
- 0.0017 individuals per km^2 for the offshore export cable corridor; and
- 0.0015 individuals per km^2 for the total Offshore Development Area.

137. In accordance with the agreed approach for other OWFs, the reference population extent for harbour seal will incorporate the SE England MU (IAMMWG 2013; SCOS 2021).

138. These have also been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.72 harbour seals (Lonergan *et al.* 2013) are available to count within the August surveys (i.e. are hauled-out), and therefore this has been used as a correction factor, to derive total harbour seal numbers within each MU, rather than the number counted within each MU. The reference population for harbour seal is therefore currently based on the most recent estimates of 4,853.

139. As a worst case it is assumed that all seals are from the nearest MU, the south-east England MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

11.5.8 Summary of Marine Mammal Densities and Reference Populations for Assessments

140. **Table 11-18** and **Table 11-19** provide a summary of the reference populations and the density estimates for the marine mammal species used in the impact assessment.

141. To determine the magnitude of an impact the number of individuals that could be impacted is put into the context of the relevant reference population (see **Table 11-12** for definitions of magnitude).

Table 11-18 Summary of Marine Mammal Reference Populations Used in the Impact Assessments

Species	Reference population extent	Population	Source
Harbour porpoise	NS MU	346,601	IAMMWG (2022)
Bottlenose dolphin	GNS MU	2,022	IAMMWG (2022)
Common dolphin	CGNS MU	102,656	IAMMWG (2022)
White-beaked dolphin	CGNS MU	43,951	IAMMWG (2022)
Minke whale	CGNS MU	20,118	IAMMWG (2022)
Grey seal	SE England MU	34,461	Corrected from haul-out count in SCOS (2020)
	Wider reference population = (SE England MU; NE England MU)	60,310 (34,461; 25,849)	Corrected from haul-out counts in SCOS (2020)
Harbour seal	SE England MU	4,853	Corrected from haul-out counts in SCOS (2021)

Table 11-19 Summary of Marine Mammal Density Estimates Used in the Impact Assessments

Species	Area of density estimate	Density estimate (individuals per km²)	Source
Harbour porpoise	SCANS III Block O	0.888	Hammond *et al.* (2021)
Bottlenose dolphin	DBS East (summer season as worst case)	0.00014	Waggitt *et al.* (2019)
	DBS West (summer season as worst case)	0.00025	
	Offshore ECC (summer season as worst case)	0.0013	
	Offshore Development Area (Average annual estimate)	0.0016	
Common dolphin	DBS East (summer season as worst case)	0.037	Waggitt *et al.* (2019)
	DBS West (summer season as worst case)	0.041	
	Offshore ECC (summer season as worst case)	0.073	
	Offshore Development Area (Average annual estimate)	0.038	
White-beaked dolphin	DBS East (summer season as worst case)	0.0055	Waggitt *et al.* (2019)
	DBS West (summer season as worst case)	0.012	
	Offshore ECC (summer season as worst case)	0.046	
	Offshore Development Area (Average annual estimate)	0.017	
Minke whale	SCANS III Block O	0.010	Hammond *et al.* (2021)
Grey seal	DBS East (average density)	0.181	Carter *et al.* (2022)
	DBS West (average density)	0.260	
	Offshore ECC	0.531	
	Offshore Development Area	0.386	
Harbour seal	DBS East (average density)	0.0017	

Species	Area of density estimate	Density estimate (individuals per km²)	Source
	DBS West (average density)	0.001	
	Offshore ECC	0.0017	
	Offshore Development Area	0.0015	

11.5.9 Future Trends

142. In the event that the Projects are not developed, an assessment of future conditions for marine mammals has been carried out and is described within this section.

143. The existing baseline conditions for marine mammals are considered to be relatively stable for most species. The baseline environment of the southern North Sea has been influenced by the oil and gas industry since the 1960s, fishing by various methods for hundreds of years and the construction and operation of OWFs for over ten years (Kentish Flats in 2005; Lynn and Inner Dowsing in 2009). The baseline will continue to evolve as a result of global trends which include the effects of climate change.

144. The potential impacts of climate change on marine mammals can be direct, such as the effects of rising sea levels on seal haul-out sites, or species tracking a specific range of water temperatures in which they can physically survive. Indirect effects of climate change include changes in prey resources affecting distribution, abundance and migration patterns, community structure, susceptibility to disease and contaminants. Ultimately, these can impact on the reproductive success and survival of marine mammals and, hence, have consequences for populations (Learmonth *et al.* 2006).

145. Indirect effects of climate change include changes in prey resources affecting distribution, abundance and migration patterns, community structure, susceptibility to disease and contaminants. Ultimately, these can impact on the reproductive success and survival of marine mammals and, hence, have consequences for populations (Learmonth *et al.* 2006; Evans and Waggitt 2020).

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

147. For harbour porpoise in the North Sea, the latest SCANS-III survey results show no evidence for trends in abundance since the mid-1990s (Hammond *et al.* 2021).

148. Despite no overall change in population size, large scale changes in the distribution of harbour porpoise were observed between SCANS-I in 1994 and SCANS-II in 2005, with the main concentration shifting from north-eastern UK and Denmark to the southern North Sea. Such large-scale changes in the distribution of harbour porpoise are likely the result of changes to the resources of their principal prey species, such as sandeel, within the North Sea (SCANS-II 2008).

149. The observed distribution of harbour porpoises from the SCANS-III survey in summer 2016 was similar to that observed in SCANS-II in 2005 (Hammond *et al.* 2013). Although, one notable difference is that more sightings were made throughout the English Channel (block C) in 2016 than previous surveys (Hammond *et al.* 2021). The progressive spread of sightings into most of the Channel over the past two 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 (Hammond *et al.* 2021).

150. 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 resources, and therefore a change in prey range has the potential to cause a change in the distribution of harbour porpoise (Evans and Bjorge 2013; Ransijn *et al.* 2019). As outlined above, a shift southward of harbour porpoise has been noted within the North Sea (Hammond *et al.*.2021), and it is possible that this was due to a loss of sandeel resources in the northern parts of the North Sea (Evans and Bjorge 2013).

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

152. In SCANS-III there was an increase in predicted densities of bottlenose dolphin off the southwest coast of Britain and northwest 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.

153. The Moray Firth population is a regular visitor to the east coast of England during the summer months; however bottlenose dolphin has recently been recorded to be resident the coast off Yorkshire permanently all year (The Telegraph 2022). The Wildlife Trust said the shift is most likely due to change in prey distribution.

154. SCANS III predicted high densities of common dolphin in the Celtic Sea in 2016, focused on shelf waters off the southwest of England and northwest coast of Spain, and this species is regularly seen around coastal regions of Cornwall. The estimated density areas have shifted northwards over time, with high numbers expected within the offshore development area in 2016 compared to 2005 (Hammond *et al.* 2013, 2021). Between 1994 and 2010 the population in the UK has remained relatively stable. However, there are noted fluctuations on approximately decadal time scales (Paxton *et al.* 2016). Common dolphins prefer a warm temperate or tropical environment (thermophilic) and are noted as having a flexible diet (Marcalo *et al.* 2018). Therefore, it may be expected that this species will move into more northerly regions as sea temperatures rise and prey availability changes at the same time (Williamson *et al.* 2021).

155. The observed distribution of white-beaked dolphin in 2016 (SCANS-III) is similar to that observed in SCANS-II in 2005 and in SCANS-I in 1994 (Hammond *et al.* 2002, 2013, 2021). The estimate of abundance of white-beaked dolphin in 2016 is very similar to the revised estimate from SCANS-II in 2005, but higher than the revised estimate from SCANS-I in 1994 (Hammond *et al.* 2021).

156. SCANS found no evidence of a trend in abundance of white-beaked dolphin in the North Sea since the mid-1990s (Hammond *et al.* 2021). 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 south-western 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.

157. Around north-west Scotland in the period 1992 to 2003, the relative frequency of stranding 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 show that the relative occurrence and abundance of white-beaked dolphins have declined and common dolphins increased in comparison to previous studies. These observations are consistent with changes in the local cetacean community being driven by increases in local water temperature (MacLeod *et al.* 2005).

158. SCANS found no evidence of a trend in abundance of minke whale in the North Sea since the mid-1990s (Hammond *et al.* 2021). 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).

159. There has been a continual increase in the total UK grey seal pup production since regular surveys began in the 1960s (SCOS 2020). Grey seal pup production at colonies in the North Sea increased rapidly up to 2016, with an annual increase of 7.5% per year from 2014 to 2018, slightly lower than the 11.5% growth between 2010 and 2016 (SCOS 2020). 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).

160. 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 management units, with general declines in counts of harbour seals in several regions around Scotland and more recently in the South-east. Recent trends, i.e. those that incorporate the last 10 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). The 2019 decrease follows a period when growth rates had decreased to zero, possibly indicating that the population in SE England MU was approaching its carrying capacity, meaning that it may be the first indication of a population decline. Additional surveys in 2020 and 2021 confirmed the decrease (SCOS 2021).

161. 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. 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).

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

11.6 Assessment of Significance

11.6.1 Potential Effects During Construction

163. The potential effects during construction assessed for marine mammals are:

- Impact 1: Permanent and temporary auditory injury from underwater noise during piling;
- Impact 2: Disturbance or behavioural effects from underwater noise during piling;
- Impact 3: TTS and disturbance from underwater noise during other construction activities, including seabed preparations, cable installation and rock placement;
- Impact 4: TTS and disturbance from underwater noise and presence of vessels;
- Impact 5: Barrier effects as a result of underwater noise during construction;
- Impact 6: Increased collision risk with vessels during construction;
- Impact 7: Changes to prey resources;
- Impact 8: Changes to water quality; and
- Impact 9: Disturbance of seals at haul-out sites.

164. The realistic worst-case scenarios on which the assessments are based are outlined in **Table 11-2.**

11.6.1.1 Impact 1 Permanent and Temporary Auditory Injury from Underwater Noise During Piling

165. A range of foundation options are being considered for the DBS Projects, including monopiles, jackets (with pin piles), suction bucket jackets and gravity base for platforms (see section 11.3.2 and **Chapter 5 Project Description**). Of these, monopiles and jackets (with pin piles) may require piling. As a worst case scenario for underwater noise, it has been assumed that all foundations would be piled, although drive-drill-drive or alternative installation may be used.

166. Impact piling is a source of high-level underwater noise, which can cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) effects on marine mammals.

167. Should a marine mammal be very close to the source, the high peak pressure sound levels have the potential to cause death or physical injury, with any severe injury potentially leading to death, if no adequate mitigation is in place. High exposure levels from underwater noise sources can cause auditory injury or hearing impairment, taking the form of a permanent loss of hearing sensitivity (PTS), or a temporary loss in hearing sensitivity (TTS). The potential for auditory injury is not just related to the level of the underwater sound and its frequency relative to the hearing bandwidth of the animal, but is also influenced by the duration of exposure. The level of impact on an individual is a function of the Sound Exposure Level (SEL) that an individual receives as a result of underwater noise.

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

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

11.6.1.1.1 Underwater Noise Modelling

169. Underwater noise modelling was undertaken by Subacoustech Environmental Ltd to estimate the noise levels likely to arise during noisy activities (see **Appendix 11-2**) and determine the potential effects on marine mammals. Key information on the methodology of underwater noise modelling, and the full results of the assessments for marine mammals, is provided in **Appendix 11-3**.

170. Underwater noise modelling was undertaken against the currently recommended marine mammal injury thresholds presented in Southall *et al.* (2019).

11.6.1.1.2 Impact 1a: Permanent auditory injury (PTS) due to impact piling

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

11.6.1.1.3 Magnitude of Impact – DBS East or DBS West in Isolation

11.6.1.1.3.1 PTS from a single strike

172. The assessments are provided in **Appendix 11-3** for the potential for PTS due to a single strike at the maximum hammer energy.

173. The potential for PTS due to a single strike at the starting hammer energy (of 1,050kJ) will be provided in the ES, and will inform the in-principle MMMP for piling which will be submitted with the DCO application.

174. **Table 11-20** present the underwater noise modelling results for the predicted effect ranges and areas for PTS from a single strike of the maximum hammer energy for the worst case location at each Project. The potential effect range for PTS is highest for harbour porpoise for both monopiles and jacket pin piles, with a maximum potential PTS range of 770m and 610m respectively for DBS West.

Table 11-20 The Predicted Effect Ranges for PTS in all Marine Mammal Species, at the Worst Case Modelling Location, for the Maximum Hammer Energies of Both Monopiles and Pin Piles

Marine mammal species	**Location**	**Potential effect ranges (and areas) for PTS at the maximum hammer energy**	
		Monopile (7,000kJ)	**Jacket pin pile (3,000kJ)**
Harbour porpoise	DBS East	760m (1.80km^2)	600m (1.1km^2)
	DBS West	770m (1.80km^2)	610m (1.2km^2)
Dolphin species	DBS East	<50m (0.01km^2)	<50m (<0.01km^2)
	DBS West		
Minke whale	DBS East	50m (0.01km^2)	<50m (<0.01km^2)
	DBS West		
Seal species	DBS East	60m (0.01km^2)	<50m (<0.01km^2)
	DBS West		

175. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS, due to a single strike at the maximum hammer energy, for both monopiles and jacket pin piles, is presented in **Table 11-21**. Densities used in **Table 11-21** are based on the worst case for each species from across the Project array areas and Offshore Development Area; the assessment against all marine mammal densities is provided in **Appendix 11-3**.

176. The magnitude of the potential impact is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-21**).

Table 11-21 Assessment of the Potential for Instantaneous PTS Due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	1.61 (0.00046% of the NS MU reference population)	Negligible
	DBS West		
Bottlenose dolphin	DBS East	0.000001 (0.00000005% of the GNS MU reference population)	Negligible
	DBS West	0.000002 (0.00000005% of the GNS MU reference population)	
Common dolphin	DBS East	0.0003 (0.0000003% of the CGNS MU reference population)	Negligible
	DBS West	0.0003 (0.0000003% of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.00004 (0.0000001% of the CGNS MU reference population)	Negligible
	DBS West	0.00009 (0.00000021% of the CGNS MU reference population)	
Minke whale	DBS East	0.00008 (0.0000004% of the CGNS MU reference population)	Negligible
	DBS West		
Grey seal	DBS East	0.002 (0.000006% of the SE England MU and 0.000007% of the wider reference population)	Negligible (negligible)

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
	DBS West	0.003 (0.000009% of the SE England MU reference population and 0.000005% of the wider reference population)	
Harbour seal	DBS East	0.000019 (0.0000004% of the SE England MU reference population)	Negligible
	DBS West	0.000011 (0.0000002% of the SE England MU reference population)	
PTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	1.0 (0.0003% of the NS MU reference population)	Negligible
	DBS West		
Bottlenose dolphin	DBS East	0.0000011 (0.00000005% of the GNS MU reference population)	Negligible
	DBS West	0.000002 (0.0000001% of the GNS MU reference population)	
Common dolphin	DBS East	0.0003 (0.00000029% of the CGNS MU reference population)	Negligible
	DBS West	0.0003 (0.00000031% of the CGNS MU reference population)	

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
White-beaked dolphin	DBS East	0.00004 (0.0000001% of the CGNS MU reference population)	Negligible
	DBS West	0.00009 (0.00000021% of the CGNS MU reference population)	
Minke whale	DBS East	0.00008 (0.0000004% of the CGNS MU reference population)	Negligible
	DBS West		
Grey seal	DBS East	0.001 (0.000004% of the SE England MU and 0.000002% of the wider reference population)	Negligible (negligible)
	DBS West	0.002 (0.000006% of the SE England MU and 0.000003% of the wider reference population)	
Harbour seal	DBS East	0.000013 (0.0000003% of the SE England MU reference population)	Negligible
	DBS West	0.000008 (0.0000002% of the SE England MU reference population)	

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.3.2 PTS from cumulative exposure from a single piling location

177. The SEL_{cum} is a measure of the total received noise over the whole piling operation. The SEL_{cum} range indicates the distance from the piling location that if the receptor were to start fleeing in a straight line from the noise source starting at a range closer than the modelled range it would receive a noise exposure in excess of the criteria threshold, and if the receptor were to start fleeing from a range further than the modelled range it would receive a noise exposure below the criteria threshold (see **Appendix 11-2** and **Appendix 11-3** for further details).

178. **Table 11-22** presents the underwater noise modelling results for the predicted effect ranges and areas for PTS due to the cumulative exposure of monopiles and jacket pin piles at the worst case location. The potential effect range for PTS is highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative PTS range of 20km and 14km respectively for the DBS West array, for multiple piles in a 24 hour period.

179. It is important to note that assessment for PTS from cumulative exposure is highly precautionary. There is a lot of variation in the potential effect ranges for SEL_{cum} at each location and between locations (see **Appendix 11-2**). In addition, the maximum hammer energy is only likely to be required at a few of the piling installation locations and for shorter periods of time.

Table 11-22 The Predicted Effect Ranges for PTS in all Marine Mammal Species, at the Worst Case Modelling Location, for the Cumulative Exposure of both Monopiles and Pin Piles

Marine mammal species	**Location**	**Potential effect ranges (and areas) for PTS due to cumulative exposure**	
		Monopile (7,000kJ)	**Jacket pin pile (3,000kJ)**
Single pile installation in 24 hours		**One monopile**	**One jacket pin pile**
Harbour porpoise	DBS East	11km (270km^2)	7.2km (130km^2)
	DBS West	11km (270km^2)	7.1km (130km^2)
Dolphin species	DBS East	< 0.1km (0.1km^2)	< 0.1km (0.1km^2)
	DBS West	< 0.1km (0.1km^2)	< 0.1km (0.1km^2)
Minke whale	DBS East	19km (610km^2)	13km (290km^2)
	DBS West	19km (690km^2)	13km (310km^2)

Marine mammal species	Location	Potential effect ranges (and areas) for PTS due to cumulative exposure	
		Monopile (7,000kJ)	**Jacket pin pile (3,000kJ)**
Seal species	DBS East	1.7km (7.2km^2)	0.75km (1.4km^2)
	DBS West	1.8km (8.6km^2)	0.8km (1.7km^2)
Multiple sequential pile installations in 24 hours		**Two sequential monopiles**	**Four sequential jacket pin piles**
Harbour porpoise	DBS East	11km (270km^2)	7.9km (140km^2)
	DBS West	11km (280km^2)	8.0km (150km^2)
Dolphin species	DBS East	< 0.1km (0.1km^2)	< 0.1km (0.1km^2)
	DBS West	< 0.1km (0.1km^2)	< 0.1km (0.1km^2)
Minke whale	DBS East	19km (620km^2)	13km (310km^2)
	DBS West	20km (700km^2)	14km (330km^2)
Seal species	DBS East	1.8km (7.6km^2)	0.88km (1.7km^2)
	DBS West	1.8km (8.6km^2)	0.95km (2.1km^2)

180. An assessment of the maximum number of individuals that could be at risk of cumulative PTS, for both sequential monopiles and jacket pin piles, is presented in **Table 11-23**, based on the effect areas as presented in **Table 11-22**. An assessment against all marine mammal densities is provided in **Appendix 11-3**.

181. The magnitude of the potential impact (without any mitigation) is assessed as for either DBS East or DBS West was negligible for bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal for both monopiles and jacket pin piles, low for grey seal, and medium for minke whale and harbour porpoise due to four sequential monopiles and jacket pin piles (**Table 11-23**).

Table 11-23 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
PTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum})			
Harbour porpoise	DBS East	239.76 (0.07% of the NS MU reference population)	Medium
	DBS West	248.64 (0.07% of the NS MU reference population)	
Bottlenose dolphin	DBS East	0.000014 (0.0000007% of the GNS MU reference population)	Negligible
	DBS West	0.00003 (0.0000012% of the GNS MU reference population)	
Common dolphin	DBS East	0.004 (0.000004% of the CGNS MU reference population)	Negligible
	DBS West	0.004 (0.000004% of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.001 (0.000001% of the CGNS MU reference population)	Negligible
	DBS West	0.001 (0.000003% of the CGNS MU reference population)	
Minke whale	DBS East	6.2 (0.031% of the CGNS MU reference population)	Medium
	DBS West	7.0 (0.035% of the CGNS MU reference population)	
Grey seal	DBS East	1.38 (0.004% of the SE England MU or 0.002% of the wider reference population).	Low (low)
	DBS West	2.24 (0.006% of the SE England MU or 0.004% of the wider reference population reference population)	
Harbour seal	DBS East	0.013 (0.0003% of the SE England MU reference population)	Negligible
	DBS West	0.009 (0.0002% of the SE England MU reference population)	
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})			

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
Harbour porpoise	DBS East	124.3 (0.04% of the NS MU reference population)	Medium
	DBS West	133.2 (0.04% of the NS MU reference population)	
Bottlenose dolphin	DBS East	0.00001 (0.0000007% of the GNS MU reference population)	Negligible
	DBS West	0.00003 (0.0000012% of the GNS MU reference population)	
Common dolphin	DBS East	0.004 (0.000004% of the CGNS MU reference population)	Negligible
	DBS West	0.003 (0.000003%of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.00055 (0.000001% of the CGNS MU reference population)	Negligible
	DBS West	0.0012 (0.000003% of the CGNS MU reference population)	
Minke whale	DBS East	3.1 (0.02% of the CGNS MU reference population)	Medium
	DBS West	3.3 (0.02% of the CGNS MU reference population)	
Grey seal	DBS East	0.31 (0.001% of the SE England MU or 0.002% of the wider reference population).	Low (low to negligible)
	DBS West	0.55 (0.002% of the SE England MU or 0.0009% of the wider reference population)	
Harbour seal	DBS East	0.003 (0.0001% of the SE England MU reference population)	Negligible
	DBS West	0.002 (0.000043% of the SE England MU reference population)	

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.4 Magnitude of Impact – DBS East and DBS West Together

182. As outlined in section 11.3.2.3, there is the potential that the Projects could be constructed concurrently. Therefore, the worst-case for the Projects being developed at the same time has been assessed, based on simultaneous piling at the two sites and a central location at the same time.

11.6.1.1.4.1 PTS from a Single Strike

183. 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 1.53km for harbour porpoise for the monopile worst-case with a maximum hammer energy of 7,000kJ (**Table 11-20**). Therefore, there would be minimal overlap between the two Projects due to turbine spacing and the assessments for the DBS Projects in isolation are appropriate. As a worst-case the maximum number of marine mammals from each Project have been assessed to indicate the maximum number of marine mammals that could be impacted from DBS East and West together, if they are developed concurrently (**Table 11-24**).

184. The magnitude of the potential impact for instantaneous PTS from single strike of the maximum hammer energy without any mitigation at DBS East and West together is assessed as negligible for harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 0.001% or less of the relevant reference populations anticipated to be exposed to any permanent effect (**Table 11-24**).

Table 11-24 Assessment of the Potential for Instantaneous PTS due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile at DBS East and DBS West Together

Marine mammal species	Assessment of effect	Magnitude of impact*
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})		
Harbour porpoise	3.2 (0.0009% of the NS MU reference population)	Negligible
Bottlenose dolphin	0.000003 (0.0000001% of the GNS MU reference population)	Negligible
Common dolphin	0.0006 (0.0000006% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.00013 (0.00000031% of the CGNS MU reference population)	Negligible
Minke whale	0.00016 (0.0000008% of the CGNS MU reference population)	Negligible
Grey seal	0.005 (0.000015% of the SE England MU or 0.000012% of the wider reference population).	Negligible (negligible)
Harbour seal	0.00003 (0.0000006% of the SE England MU reference population)	Negligible
PTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})		
Harbour porpoise	2.0 (0.0006% of the NS MU reference population)	Negligible
Bottlenose dolphin	0.0000031 (0.00000015% of the GNS MU reference population)	Negligible
Common dolphin	0.0006 (0000006% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.00013 (0.00000031% of the CGNS MU reference population)	Negligible
Minke whale	0.00016 (0.0000008% of the CGNS MU reference population)	Negligible
Grey seal	0.003 (0.00001% of the SE England MU or 0.000005% of the wider reference population).	Negligible (negligible)
Harbour seal	0.000021 (0.0000005% of the SE England MU reference population)	Negligible

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.4.2 PTS from cumulative exposure from multiple piling locations

185. The simultaneous piling scenario assumes that animals are within potential effect ranges for a much longer period (i.e. they would be travelling from one pile location to another while piling is ongoing), and therefore cumulative effect ranges are much larger than for the cumulative exposure ranges of one pile at a time. See **Appendix 11-2** and **Appendix 11-3** for further information.

186. The potential effect ranges are not possible to model under this scenario, as there are two starting points for receptors, and it is not possible to determine the potential range at which they need to be in order to not be at risk of effect. Therefore, the following assessment is based on the potential areas of effect only.

187. Where the potential effect areas are not large enough to interact with each other (i.e. they do not meet), the results for the respective locations and scenarios are used (the results of the modelling for the DBS East and DBS West and centre locations are used to inform the assessment, to align with the modelling locations used for the simultaneous modelling).

188. **Table 11-25** presents the underwater noise modelling results for the predicted effect ranges and areas for PTS due to the cumulative exposure of simultaneous monopiles and jacket pin piles at the DBS East and DBS West and centre modelling locations. These locations were chosen as the have the potential for the largest 'spread' in terms of underwater noise propagation (as they are the two furthest apart locations). The modelling includes two monopiles being installed sequentially at DBS East and DBS West at each location and a single monopile at the centre location at the same time, and four jacket pin piles being installed sequentially at each of the three locations at the same time.

189. The potential effect range for PTS is highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative PTS effect area of 3,000km^2 and 2,200km^2 respectively, for multiple simultaneous piles. For harbour porpoise and minke whale, the cumulative PTS is significantly higher for simultaneous piling that it is for a single piling location at any one time, however, for dolphin and seal species, the potential PTS ranges are significantly smaller, and do not interact with each other where there are simultaneous piling events at the same time (**Table 11-25**). For harbour porpoise and minke whale, the results of the modelling for simultaneous piling for both monopiles and jacket pin piles are used in the assessments, while for both dolphin and seal species, the assessments for sequential piling are based on the results of the modelling at the three locations, summed together.

Table 11-25 The Predicted Effect Ranges for PTS in all Marine Mammal Species at the Combined Modelling Locations, for the Cumulative Exposure of Multiple Monopiles and Pin Pile Installations at the Same Time (Effect Areas In Bold Used Within the Assessments for Sequential Piling)

Marine mammal species	**Potential effect areas for PTS due to cumulative exposure of simultaneous pile installations**	
	Monopile (7,000kJ)	**Jacket pin pile (3,000kJ)**
	Two sequential monopiles at the DSB East location and two sequential monopile at the DSB West location and one monopile at the centre location	Four sequential jacket pin piles at the DSB East location and four sequential jacket pin piles at the DSB West location and one monopile at the centre location
Harbour porpoise	DSB East = 270km^2 DBS West = 280km^2 DBS Central = 32km^2 Total together = 582km^2	DSB East = 140km^2 DBS West = 150km^2 DBS Central = 11km^2 Total together = 301km^2
Dolphin species	DSB East = <0.1km^2 DBS West = <0.1km^2 DBS Central = <0.1km^2 **Total together = 0.3km^2**	DSB East = <0.1km^2 DBS West = <0.1km^2 DBS Central = <0.1km^2 **Total together = 0.3km^2**
Minke whale	DSB East = 620km^2 DBS West = 720km^2 DBS Central = 36km^2 Total together = 1,376km^2	DSB East = 310km^2 DBS West = 330km^2 DBS Central = 5.5km^2 Total together = 645.5km^2
Seal species	DSB East = 7.6km^2 DBS West = 8.6km^2 DBS Central = <0.1km^2 **Total together = 16.3km^2**	DSB East = 1.7km^2 DBS West = 2.1km^2 DBS Central = <0.1km^2 **Total together = 3.9km^2**
	Multiple simultaneous monopiles (two sequential monopiles at each Project location, and one in the centre at the same time)	Multiple simultaneous jacket pin piles (four sequential jacket pin piles at each location, at the same time)
Harbour porpoise	**1,800km^2**	**1,400km^2**
Minke whale	**3,000km^2**	**2,200km^2**
Dolphin species	No interaction	No interaction
Seal species		

190. An assessment of the maximum number of individuals that could be at risk of cumulative PTS, for simultaneous monopiles and jacket pin piles is presented in **Table 11-26**, based on the effect areas as presented in **Table 11-23**. An assessment against all marine mammal densities is provided in **Appendix 11-3**, the assessment for the worst case density for each species from DBS East, West or the Offshore Development Area has been provided here.

191. The magnitude of the potential impact (without any mitigation) is assessed as high for minke whale and harbour porpoise and negligible for bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal for both monopiles and jacket pin piles, due to simultaneous monopiles and jacket pin pile installations. For grey seals the magnitude of the potential impact is medium (medium) for monopiles and low (low) for jacket pin piles respectively (**Table 11-26**).

Table 11-26 Assessment of the Potential for PTS due to the Cumulative Exposure of Simultaneous Monopiles or Jacket Pin Piles at the Same Time

Marine mammal species	Assessment of effect	Magnitude of impact*
PTS due to the cumulative exposure of simultaneous monopile installations (SEL_{cum})		
Harbour porpoise	1598.4 (0.46% of the NS MU reference population)	High
Bottlenose dolphin	0.00048 (0.000024% of the GNS MU reference population)	Negligible
Common dolphin	0.0123 (0.000012% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.0051 (0.000012% of the CGNS MU reference population)	Negligible
Minke whale	30.0 (0.15% of the CGNS MU reference population)	High
Grey seal	6.29 (0.02% of the SE England MU or 0.01% of the wider reference population).	Medium (medium)
Harbour seal	0.03 (0.0006% of the SE England MU reference population)	Negligible
PTS due to the cumulative exposure of simultaneous jacket pin pile installations (SEL_{cum})		
Harbour porpoise	1243.2 (0.36% of the NS MU reference population)	High
Bottlenose dolphin	0.00048 (0.000024% of the GNS MU reference population)	Negligible
Common dolphin	0.0123 (0.000012% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.0051 (0.000012% of the CGNS MU reference population)	Negligible
Minke whale	22.0 (0.11% of the CGNS MU reference population)	High
Grey seal	1.5 (0.0044% of the SE England MU or 0.0025 of the wider reference population)	Low (low)
Harbour seal	0.0066 (0.0001% of the SE England MU reference population)	Negligible

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.5 Impact 1b: Temporary auditory injury (TTS) due to impact piling

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

11.6.1.1.6 Magnitude of Impact – DBS East or DBS West in Isolation

11.6.1.1.6.1 TTS from a single strike

193. **Table 11-27** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS from a single strike of the maximum hammer energy for the worst case location, for both monopiles and jacket pin piles. The potential effect range for TTS is highest for harbour porpoise for both monopiles and jacket pin piles, with a potential TTS range of 1.9km and 1.6km respectively for DBS West.

Table 11-27 Predicted Effect Ranges for TTS in All Marine Mammal Species, at the Worst Case Modelling Location, for the Maximum Hammer Energies of Both Monopiles and Pin Piles

Marine mammal species	Location	Potential effect ranges (and areas) for TTS at the maximum hammer energy	
		Monopile (7,000kJ)	Jacket pin pile (3,000kJ)
Harbour porpoise	DBS East	1.9km (11km^2)	1.5km (7.1km^2)
	DBS West	1.9km (12km^2)	1.6km (7.5km^2)
Dolphin species	DBS East	<0.05km (0.01km^2)	<0.05km (<0.01km^2)
	DBS West		
Minke whale	DBS East	0.13km (0.05km^2)	0.1km (0.03km^2)
	DBS West	0.13km (0.06km^2)	
Seal species	DBS East	0.16m (0.07km^2)	0.12km (0.05km^2)
	DBS West	0.16m (0.08km^2)	

194. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS, due to a single strike at the maximum hammer energy, for both monopiles and jacket pin piles, is presented in **Table 11-28**, based on the effect areas as presented in **Table 11-27**. Densities used in **Table 11-28** are based on the worst case for each species from across the Project array areas and Offshore Development Area; the assessment against all marine mammal densities is provided in **Appendix 11-3**.

195. The magnitude of the potential impact (without any mitigation) is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-28**).

Table 11-28 Assessment of the Potential for Instantaneous TTS Due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
TTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	10.07 (0.003% of the NS MU reference population)	Negligible
	DBS West	10.66 (0.003% of the NS MU reference population)	
Bottlenose dolphin	DBS East	0.0000011 (0.00000005% of the GNS MU reference population)	Negligible
	DBS West	0.000002 (0.0000001% of the GNS MU reference population)	
Common dolphin	DBS East	0.0003 (0.0000003% of the CGNS MU reference population)	Negligible
	DBS West	0.0003 (0.0000003% of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.00004 (0.0000001% of the CGNS MU reference population)	Negligible
	DBS West	0.00009 (0.0000002% of the CGNS MU reference population)	
Minke whale	DBS East	0.0005 (0.0000026% of the CGNS MU reference population)	Negligible
	DBS West	0.0006 (0.000003% of the CGNS MU reference population)	
Grey seal	DBS East	0.01 (0.000037% of the SE England MU) and 0.000021% of the wider reference population)	Negligible (negligible)

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
	DBS West	0.02 (0.00006% of the SE England MU and 0.00003% of the wider reference population)	
Harbour seal	DBS East	0.0001 (0.000002% of the SE England MU reference population)	Negligible
	DBS West	0.00008 (0.000002% of the SE England MU reference population)	
TTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	6.3 (0.002% of the NS MU reference population)	Negligible
	DBS West	6.7 (0.002% of the NS MU reference population)	
Bottlenose dolphin	DBS East	0.0000014 (0.00000007% of the GNS MU reference population)	Negligible
	DBS West	0.000002 (0.0000001% of the GNS MU reference population)	
Common dolphin	DBS East	0.0004 (0.0000004% of the CGNS MU reference population)	Negligible
	DBS West	0.0003 (0.0000003% of the CGNS MU reference population)	

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
White-beaked dolphin	DBS East	0.00006 (0.00000013% of the CGNS MU reference population)	Negligible
	DBS West	0.00009 (0.0000002% of the CGNS MU reference population)	
Minke whale	DBS East	0.0003 (0.0000015% of the CGNS MU reference population)	Negligible
	DBS West		
Grey seal	DBS East	0.01 (0.000026% of the SE England MU and 0.000015% of the wider reference population)	Negligible (negligible)
	DBS West	0.012 (0.00003% of the SE England MU and 0.00002%of the wider reference population)	
Harbour seal	DBS East	0.00009 (0.000002% of the SE England MU reference population)	Negligible
	DBS West	0.00005 (0.0000009% of the SE England MU reference population)	

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.6.2 TTS from cumulative exposure from a single piling location

196. As outlined for PTS from cumulative exposure, the ranges indicate the distance that an individual would need to be from the noise source at the start of the piling sequence to prevent a cumulative noise exposure which could lead to TTS. This is highly conservative because the assessment assumes the worst case exposure levels for an animal in the water column, and does not take account of periods where exposure will be reduced, for example in seals when their heads are out of the water; or that the cumulative noise dose received by the marine mammal will be largely dependent on the swimming speed, and whether the animal moves away from the noise source rapidly as a flee response. The cumulative SEL dose does not take account of this and therefore is likely to overestimate the received noise levels.

197. **Table 11-29** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS due to the cumulative exposure of monopiles and jacket pin piles at the worst case location. The potential effect range for TTS is highest for minke whale at DBS West for both monopiles and jacket pin piles, with a potential cumulative TTS range of 82km and 72km respectively, for multiple piles in a 24 hour period.

198. The assessment for TTS from cumulative exposure is highly precautionary, and there is a lot of variation in the potential effect ranges for SEL_{cum} at each location and between locations (see **Appendix 11-2**). For example, for harbour porpoise, the TTS effect range for two sequential monopile installations is 24km at the East location, and 16km at the North location. In addition, the maximum hammer energy is only likely to be required at a few of the piling installation locations and for shorter periods of time.

Table 11-29 Predicted Effect Ranges for TTS in All Marine Mammal Species, at the Worst Case Modelling Location, for the Cumulative Exposure of both Monopiles and Pin Piles

Marine mammal species	**Location**	**Potential effect ranges (and areas) for TTS due to cumulative exposure**	
		Monopile (7,000kJ)	**Jacket pin pile (3,000kJ)**
Single pile installation in 24 hours		**One monopile**	**One jacket pin pile**
Harbour porpoise	DBS East	48km (3,800km^2)	39km (2,700km^2)
	DBS West	51km (4,800km^2)	43km (3,200km^2)

Marine mammal species	Location	Potential effect ranges (and areas) for TTS due to cumulative exposure	
		Monopile (7,000kJ)	Jacket pin pile (3,000kJ)
Dolphin species	DBS East	1.3km (4.3km^2)	0.28km (0.2km^2)
	DBS West	1.4km (4.8km^2)	0.33km (0.2km^2)
Minke whale	DBS East	68km (6,700km^2)	58km (5,000km^2)
	DBS West	81km (9,800km^2)	68km (7,000km^2)
Seal species	DBS East	28km (1,400km^2)	24km (1,000km^2)
	DBS West	30km (1,700km^2)	24km (1,100km^2)
Multiple sequential pile installations in 24 hours		**Two sequential monopiles**	**Four sequential jacket pin piles**
Harbour porpoise	DBS East	50km (4,000km^2)	44km (3,100km^2)
	DBS West	57km (5,200km^2)	50km (4,000km^2)
Dolphin species	DBS East	1.3km (4.4km^2)	0.33km (0.2km^2)
	DBS West	1.4km (4.9km^2)	0.35km (0.3km^2)
Minke whale	DBS East	69km (6,800km^2)	60km (5,200km^2)
	DBS West	82km (10,000km^2)	72km (7,500km^2)
Seal species	DBS East	30km (1,500km^2)	28km (1,300km^2)
	DBS West	33km (1,900km^2)	31km (1,600km^2)

199. Assessments for the modelling of a single pile in 24 hours are provided in **Appendix 11-3**, and the assessments for two sequential monopiles and four sequential pin piles in a 24 hour period are provided below, as the worst case.

200. An assessment of the maximum number of individuals that could be at risk of cumulative TTS, for both sequential monopiles and jacket pin piles, is presented in **Table 11-30**, based on the effect areas as presented in **Table 11-29**. An assessment against all marine mammal densities is provided in **Appendix 11-3**.

201. The magnitude of the potential impact (without any mitigation) is assessed as negligible for bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, and harbour seal for both monopiles and jacket pin piles for both Projects. For harbour porpoise the magnitude of impact due to sequential monopile installations is low at both DBS East and West, and negligible to low for harbour porpoise due to sequential jacket pin pile installations at DBS East and West respectively (**Table 11-30**).

202. The magnitude of the potential impact (without any mitigation) for grey seal is assessed as low (low) for both sequential monopiles at DBS East and low (negligible) at DBS West. For four sequential jacket pin piles at DBS East the magnitude for grey seals is negligible (negligible) and low (negligible) at DBS West (**Table 11-30**).

Table 11-30 Assessment of the Potential for TTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
TTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum})			
Harbour porpoise	DBS East	3552.0 (1.02% of the NS MU reference population)	Low
	DBS West	4618 (1.33% of the NS MU reference population)	
Bottlenose dolphin	DBS East	0.0006 (0.00003% of the GNS MU reference population)	Negligible
	DBS West	0.001 (0.0006 of the GNS MU reference population)	
Common dolphin	DBS East	0.16 (0.00016% of the CGNS MU reference population)	Negligible
	DBS West	0.2 (0.0002% of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.024 (0.000055% of the CGNS MU reference population)	Negligible
	DBS West	0.059 (0.00013% of the CGNS MU reference population)	
Minke whale	DBS East	68.0 (0.34% of the CGNS MU reference population)	Negligible
	DBS West	100 (0.5% of the CGNS MU reference population)	
Grey seal	DBS East	271.5 (0.79% of the SE England MU or 0.45% of the wider reference population)	Low (low)
	DBS West	494 (1.43% of the SE England or 0.82% of the wider reference population reference population)	Low (negligible)
Harbour seal	DBS East	2.6 (0.053% of the SE England MU reference population)	Negligible
	DBS West	1.9 (0.039% of the SE England MU reference population)	

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
TTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})			
Harbour porpoise	DBS East	2752.8 (0.79% of the NS MU reference population)	Negligible
	DBS West	3552.0 (1.02% of the NS MU reference population)	Low
Bottlenose dolphin	DBS East	0.00003 (0.000001% of the GNS MU reference population)	Negligible
	DBS West	0.00008 (0.000004% of the GNS MU reference population)	
Common dolphin	DBS East	0.007 (0.000007%of the CGNS MU reference population)	Negligible
	DBS West	0.01 (0.00001% of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.001 (0.000003% of the CGNS MU reference population)	Negligible
	DBS West	0.004 (0.000008% of the CGNS MU reference population)	
Minke whale	DBS East	52.0 (0.26% of the CGNS MU reference population)	Negligible
	DBS West	75.0 (0.37% of the CGNS MU reference population)	
Grey seal	DBS East	235.3 (0.68% of the SE England MU or 0.39% of the wider reference population).	Negligible (negligible)
	DBS West	416.0 (1.21% of the SE England MU or 0.69% of the wider reference population)	Low (negligible)
Harbour seal	DBS East	2.2 (0.046% of the SE England MU reference population)	Negligible
	DBS West	1.6 (0.033% of the SE England MU reference population)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.7 Magnitude of Impact – DBS East and DBS West Together

11.6.1.1.7.1 TTS From a Single Strike

203. The maximum predicted impact range for TTS from a single strike of monopile or pin pile with maximum hammer energy without any mitigation is up to 1.9km for harbour porpoise for the monopile worst-case with a maximum hammer energy of 7,000kJ (**Table 11-27**). Therefore, there would be overlap between the two Projects for the harbour porpoise impact range due to the minimum turbine spacing of 830m but the assessments for the DBS Projects in isolation are appropriate for all other species as the impact ranges are less than 830m. As a worst-case, the maximum number of marine mammals from each Project have been assessed to indicate the maximum number of marine mammals that could be impacted from DBS East and DBS West together, if they are developed concurrently (**Table 11-31**).

204. The magnitude of the potential impact for instantaneous TTS from a single strike of monopile or pin pile with maximum hammer energy without any mitigation at DBS East and West together is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 1% or less of the relevant reference populations anticipated to be exposed to any temporary effect (**Table 11-31**).

Table 11-31 Assessment of the Potential for Instantaneous TTS due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile at DBS East and DBS West Together

Marine mammal species	Assessment of effect	Magnitude of impact*
TTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})		
Harbour porpoise	20.73 (0.006% of the NS MU reference population)	Negligible
Bottlenose dolphin	0.000003 (0.0000001% of the GNS MU reference population)	Negligible
Common dolphin	0.0007 (0.0000006% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.00013 (0.00000031% of the CGNS MU reference population)	Negligible
Minke whale	0.0011 (0.0000056% of the CGNS MU reference population)	Negligible
Grey seal	0.03 (0.000097% of the SE England MU or 0.000051% of the wider reference population).	Negligible (negligible)
Harbour seal	0.00018 (0.000004% of the SE England MU reference population)	Negligible
TTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})		
Harbour porpoise	13.0 (0.004% of the NS MU reference population)	Negligible
Bottlenose dolphin	0.0000031 (0.00000015% of the GNS MU reference population)	Negligible
Common dolphin	0.0006 (0.0000043% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.00015 (0.00000033% of the CGNS MU reference population)	Negligible
Minke whale	0.0006 (0.000003% of the CGNS MU reference population)	Negligible
Grey seal	0.022 (0.000056% of the SE England MU or 0.000035% of the wider reference population).	Negligible (negligible)
Harbour seal	0.00014 (0.0000029% of the SE England MU reference population)	Negligible

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.7.2 TTS from Cumulative Exposure from Multiple Piling Locations

205. As described above for PTS, the simultaneous piling scenario assumes that animals are within potential effect ranges for a much longer period (i.e. they would be travelling from one pile location to another when piling is ongoing), and therefore cumulative effect ranges are much larger than for the cumulative exposure ranges of one pile at a time. See **Appendix 11-2** and **Appendix 11-3** for further information.

206. The full underwater noise modelling results and assessments are provided in **Appendix 11-3** for the potential for TTS due to the cumulative exposure of multiple monopile and jacket pin pile installations at the same time. The modelling includes two monopiles being installed sequentially at each location at the same time, and four jacket pin piles being installed sequentially at each location at the same time.

207. **Table 11-32** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS due to the cumulative exposure of simultaneous monopiles and jacket pin piles at DBS East, DBS West and centre modelling locations. These locations were chosen as they have the potential for the largest 'spread' in terms of underwater noise propagation (as they are the two furthest apart locations). The modelling includes two monopiles being installed sequentially at DBS East and DBS West at each location and a single monopile at the centre location at the same time, and four jacket pin piles being installed sequentially at each of the three locations at the same time.

208. The potential effect range for TTS is highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative TTS effect area of 17,000km^2 and 14,000km^2 respectively, for multiple simultaneous piles. For dolphin species, the potential TTS ranges are significantly smaller, and do not interact with each other where there are simultaneous piling events at the same time (**Table 11-32**).

209. The results from the underwater noise modelling for simultaneous piling for both monopiles and jacket pin piles have been used for the assessments; for more information see **Appendix 11.2**). The assessments for sequential piling are based on the results of the modelling at the three locations, added together. **Table 11-32** shows the potential effect areas for TTS due to combined piling for all marine mammals.

Table 11-32 Predicted Effect Ranges for TTS in all Marine Mammal Species at the Combined Modelling Locations, for the Cumulative Exposure of Multiple Monopiles and Pin Pile Installations at the Same Time (Effect Areas in Bold Used Within the Assessments for Sequential Piling)

Marine mammal species	**Potential effect areas for TTS due to cumulative exposure of simultaneous pile installations**	
	Monopile (7,000kJ)	**Jacket pin pile (3,000kJ)**
	Two sequential monopiles at the DBS East location and two sequential monopile at the DBS West location and one monopile at the centre location	Four sequential jacket pin piles at the DBS East location and four sequential jacket pin piles at the DBS West location and one monopile at the centre location
Harbour porpoise	DSB East = 4,000km^2 DBS West = 5,200km^2 DBS Central = 920km^2 **Total together = 10,120km^2**	DSB East = 3,100km^2 DBS West = 4,000km^2 DBS Central = 650km^2 Total together = 7,750km^2
Dolphin species	DSB East = 4.4km^2 DBS West = 4.9km^2 DBS Central = <0.1km^2 **Total together = 9.4km^2**	DSB East = 0.2km^2 DBS West = 0.3km^2 DBS Central = <0.1km^2 **Total together = 0.6km^2**
Minke whale	DSB East = 6,800km^2 DBS West = 10,000km^2 DBS Central = 1,600km^2 **Total together = 18,400km^2**	DSB East = 5,200km^2 DBS West = 7,500km^2 DBS Central = 960km^2 Total together = 13,600km^2
Seal species	DSB East = 1,500km^2 DBS West = 1,900km^2 DBS Central = 140km^2 Total together = 3,540km^2	DSB East = 1,300km^2 DBS West = 1,600km^2 DBS Central = 94km^2 Total together = 2,994km^2
	Multiple simultaneous monopiles (two sequential monopiles at each Project location, and one in the centre at the same time)	Multiple simultaneous jacket pin piles (four sequential jacket pin piles at each location, at the same time)
Harbour porpoise	10,000km^2	**8,800km^2**
Minke whale	17,000km^2	**14,000km^2**
Dolphin species	No interaction	No interaction
Seal species	**5,100km^2**	**4,700 km^2**

210. An assessment of the maximum number of individuals that could be at risk of cumulative TTS, for simultaneous monopiles and jacket pin piles is presented in **Table 11-33**, based on the effect areas as presented in **Table 11-32**. An assessment against all marine mammal densities is provided in **Appendix 11-3**, the assessment for the worst case density for each species from DBS East, West or the Offshore Development Area has been provided here.

211. The magnitude of the potential impact (without any mitigation) is assessed as medium (low) for grey seal and low for harbour porpoise. The magnitude is negligible for bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seals for both monopiles and jacket pin piles, due to simultaneous monopiles and jacket pin pile installations (**Table 11-33**).

Table 11-33 Assessment of the Potential for TTS due to the Cumulative Exposure of Simultaneous Monopiles or Jacket Pin Piles at the Same Time

Marine mammal species	Assessment of effect	Magnitude of impact*
TTS due to the cumulative exposure of simultaneous monopile installations (SEL_{cum})		
Harbour porpoise	8986.6 (2.59% of the NS MU reference population)	Low
Bottlenose dolphin	0.015 (0.0007% of the GNS MU reference population)	Negligible
Common dolphin	0.39 (0.0004% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.16 (0.0004% of the CGNS MU reference population)	Negligible
Minke whale	148 (0.91% of the CGNS MU reference population)	Negligible
Grey seal	1968.6 (5.71% of the SE England MU or 3.26% of the wider reference population).	Medium (low)
Harbour seal	8.7 (0.18% of the SE England MU reference population)	Negligible
TTS due to the cumulative exposure of simultaneous jacket pin pile installations (SEL_{cum})		
Harbour porpoise	7814.4 (2.25% of the NS MU reference population)	Low
Bottlenose dolphin	0.001 (0.00005% of the GNS MU reference population)	Negligible
Common dolphin	0.02 (0.00002% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.01 (0.00002% of the CGNS MU reference population)	Negligible
Minke whale	105.0 (0.52% of the CGNS MU reference population)	Negligible
Grey seal	1814.2 (5.26% of the SE England MU or 3.01% of the wider reference population)	Medium (low)
Harbour seal	7.99 (0.16% of the SE England MU reference population)	Negligible

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.1.8 Sensitivity of Receptor

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

213. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al.* 2007), but not for finding prey. Therefore, Thompson *et al.* (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. Pinnipeds also have the ability to hold their heads out of the water during exposure to loud noise, and potentially avoid PTS during piling. As such, sensitivity to PTS in harbour and grey seal is expected to be lower than cetacean species such as harbour porpoise, with the individual showing some tolerance to avoid, adapt to or accommodate or recover from the impact (for example, Russell 2016b), but as a precautionary approach they are also considered as having high sensitivity in this assessment.

214. 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 therefore unable to recover from the effects.

215. PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SPL_{peak}) of the maximum hammer energy applied during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}). All marine mammal species are assessed as having high sensitivity to PTS.

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

217. All marine mammal species are assessed as having medium sensitivity to TTS. A fleeing response is assumed to occur at the same noise levels as TTS. The response of individuals to a noise stimulus will vary and not all individuals will respond, however, for the purpose of this assessment, it is assumed that 100% of the individuals exposed to the noise stimulus will respond and flee the area.

218. 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 impact.

11.6.1.1.9 Significance of effect – DBS East or DBS West in Isolation

219. The assessment for the effect of PTS from monopile installation and jacket pin piles in marine mammals is provided in **Table 11-34**, taking into account the high marine mammal sensitivity and the potential magnitude of the impact (i.e. number of individuals as a percentage of the reference population; **Table 11-21** and **Table 11-23**).

220. The significance of effect for permanent changes in hearing sensitivity (PTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without mitigation) has been assessed as **minor adverse (not significant in EIA terms)** for all marine mammal species.

221. For the potential PTS from cumulative exposure for sequential monopile and jacket pin piles installations in 24 hours (without mitigation), the significance of effect has been assessed as **major adverse** for harbour porpoise and minke whale, **moderate adverse** for grey seal, and **minor adverse (not significant in EIA terms)** for bottlenose dolphin, common dolphin, white-beaked dolphin, and harbour seal (**Table 11-34**).

Table 11-34 Assessment of Significance of Effect for the Potential for PTS for DBS East and DBS West in Isolation due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
PTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All Marine mammals	High	Negligible	Minor adverse
PTS due to the cumulative exposure of sequential monopiles in a 24 hour period			
Harbour porpoise	High	Medium	Major adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			
White-beaked dolphin			
Minke whale		Medium	Major adverse
Grey seal		Low	Moderate adverse
Harbour seal		Negligible	Minor adverse
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period			
Harbour porpoise	High	Medium	Major adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			
White-beaked dolphin			
Minke whale		Medium	Major adverse
Grey seal		Low	Moderate adverse
Harbour seal		Negligible	Minor adverse

222. The assessment for the effect of TTS from monopile installation in marine mammals is provided in **Table 11-35**, taking into account high marine mammal sensitivity and the potential magnitude of the impact (i.e. number of individuals as a percentage of the reference population; **Table 11-28** and **Table 11-30**).

223. The significance of effect for temporary changes in hearing sensitivity (TTS) from a single strike of the maximum hammer energy for monopiles (without any mitigation) has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal.

224. For the potential TTS from cumulative exposure for sequential monopile and jacket pin pile installations (without mitigation), the significance of effect has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal, and harbour seal. (**Table 11-35**).

Table 11-35 Assessment of Significance of Effect for the Potential for TTS for DBS East or DBS West in Isolation due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All marine mammals	Medium	Negligible	Minor adverse
TTS due to the cumulative exposure of sequential monopiles in a 24 hour period			
Harbour porpoise	Medium	Low	Minor adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			
White-beaked dolphin			
Minke whale			
Grey seal		Low	Minor adverse
Harbour seal		Negligible	Minor adverse

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period			
DBS East			
All Marine mammals	Medium	Negligible	Minor adverse
DBS West			
Harbour porpoise	Medium	Low	Minor adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			
White-beaked dolphin			
Minke whale			
Grey seal		Low	Minor adverse
Harbour seal		Negligible	Minor adverse

11.6.1.1.10 Significance of effect – DBS East and DBS West Together

225. The significance of effect for PTS and TTS, based on maximum number of marine mammals that could be impacted as a result of underwater noise during concurrent piling for DBS East and DBS West is summarised in **Table 11-36** and **Table 11-37.**

226. The significance of effect for permanent changes in hearing sensitivity (PTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without mitigation) at DBS East and DBS West together has been assessed as **minor adverse (not significant in EIA terms)** for all marine mammal species.

227. For the potential PTS from cumulative exposure for simultaneous monopile installations (without mitigation), the significance of effect has been assessed as **major adverse** for harbour porpoise, minke whale, grey seal and harbour seal, and **minor adverse (not significant in EIA terms)** for bottlenose dolphin, common dolphin and white-beaked dolphin (**Table 11-36**).

228. For the potential PTS from cumulative exposure for simultaneous jacket pin pile installations (without mitigation), the significance of effect has been assessed as **major adverse** for harbour porpoise, minke whale and grey seal and **minor adverse (not significant in EIA terms)** for bottlenose dolphin, common dolphin, white-beaked dolphin, and harbour seal (**Table 11-36**).

Table 11-36 Assessment of Significance of Effect for the Potential for PTS for DBS East and DBS West Together due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
PTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All Marine mammals	High	Negligible	Minor adverse
PTS due to the cumulative exposure of simultaneous monopile installations			
Harbour porpoise	High	High	Major adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			
White-beaked dolphin			
Minke whale		High	Major adverse
Grey seal		Medium	Major adverse
Harbour seal		Negligible	Minor adverse
PTS due to the cumulative exposure of simultaneous jacket pin pile installations			
Harbour porpoise	High	Medium	Major Adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
White-beaked dolphin			
Minke whale		Medium	Major Adverse
Grey seal		Low	Moderate Adverse
Harbour seal		Negligible	Minor adverse

229. The significance of effect for temporary changes in hearing sensitivity (TTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without any mitigation) at DBS East and DBS West together has been assessed as **minor adverse (not significant in EIA terms)** for all species (**Table 11-37**).

230. For the potential TTS from cumulative exposure for simultaneous monopile and jacket pin pile installations (without mitigation), the significance of effect has been assessed as **moderate adverse** for grey seals and **minor adverse (not significant in EIA terms)** for harbour porpoise, minke whale, bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal (**Table 11-37**).

Table 11-37 Assessment of Significance of Effect for the Potential for TTS for DBS East or DBS West in Isolation due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All Marine mammals	Medium	Negligible	Minor adverse
TTS due to the cumulative exposure of simultaneous monopile installations			
Harbour porpoise	Medium	Low	Minor adverse
Bottlenose dolphin		Negligible	
Common dolphin			
White-beaked dolphin			

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
Minke whale			
Grey seal		Medium	Moderate adverse
Harbour seal		Negligible	Minor adverse
TTS due to the cumulative exposure of simultaneous jacket pin pile installations			
Harbour porpoise	Medium	Low	Minor adverse
Bottlenose dolphin		Negligible	Minor adverse
Common dolphin			
White-beaked dolphin			
Minke whale		Negligible	Minor adverse
Grey seal		Medium	Moderate adverse
Harbour seal		Negligible	Minor adverse

11.6.1.1.11 Mitigation and Residual Significance of Effect – DBS East or DBS West in Isolation

231. A MMMP for piling (section 11.3.3) would reduce the risk of PTS from a single strike of both monopiles and jacket pin piles, at the maximum hammer energy, and from the cumulative exposure of one monopile and one jacket pin pile. Mitigation will be undertaken for each pile, and therefore should be designed to ensure it addresses the potential effect of the installation of either one monopile or one jacket pin pile, as required.

232. The MMMP for piling would be developed post-consent in consultation with the MMO and other relevant stakeholders (including Natural England), and would be based on the latest information, scientific understanding and guidance and detailed project design at the time. The final MMMP is expected to be based on the standard JNCC guidance (JNCC 2010), and include:

- A monitoring zone of at least 500m (or higher if required to cover the PTS range for a single strike of the hammer), where soft-start cannot commence until the monitoring zone is clear of marine mammals;
- Soft-start piling (comprised of a period of low-energy blows at the starting hammer energy, followed by a gradual ramp-up to full hammer energy); and
- ADDs to deter marine mammals from the piling location, to a distance that is greater than the PTS range for the installation of one pile.

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

234. In addition, the presence of construction vessels themselves could act as an effective deterrent to harbour porpoise. Brandt *et al.* (2018) found that at seven German OWFs in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice OWF, indicate higher vessel activity within 1km was associated with an increased probability of response in harbour porpoise (Graham *et al.* 2019). This disturbance of marine mammals from the area around the construction site prior to piling would also reduce the risk of PTS.

235. While no mitigation is required for the potential for TTS in marine mammals, the mitigation in the MMMP to reduce the risk of PTS would also reduce the number of marine mammals at risk of TTS.

236. These measures will reduce the worst case magnitude of impact for harbour porpoise and minke whale from medium to negligible therefore the residual effect is **minor adverse** for all marine mammal species, which is deemed to be not significant.

11.6.1.1.12 Mitigation and Residual Significance of Effect – DBS East and DBS West Together

237. Further consideration will be given to the number of installation vessels and foundations to be installed in 24 hours at DBS East and DBS West together when the project requirements have been more refined.

238. Mitigation would be undertaken for each pile, and the measures should be designed to ensure they cover for the potential effect of the installation at DBS East and DBS West together. The MMMP would be based on the latest information, scientific understanding and guidance and detailed project design at the time. The Site Integrity Plan for the Southern North Sea SAC would manage and reduce the potential for significant disturbance of harbour porpoise from cumulative underwater noise during OWF piling. This would also reduce the potential for disturbance for all other marine mammal species.

239. The use of noise abatement technology will also be considered if required when taking into account wider cumulative effects in the wider North Sea area.

240. These measures will reduce the magnitude of impact from high to negligible for all marine mammal species, therefore the residual effect is **minor adverse**, which is deemed to be not significant.

11.6.1.2 Impact 2 Disturbance or Behavioural Effects from Underwater Noise During Piling

241. 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).

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

243. For marine mammals a fleeing response is assumed to occur at the same noise levels as TTS. Therefore, the potential effect range and areas for TTS, as shown in **Table 11-27** with the estimated number of marine mammals and percentage of reference populations presented in **Table 11-28** providing an indication of the effect level of a possible fleeing response.

244. Disturbance from construction activities (including piling) may have behavioural consequences on marine mammals in the study area, including reduced time spent foraging at sea as animals move away from sources of noise, displacement from vessels, etc. Repeated disruptions can have cumulative negative effects on the bioenergetic budget of marine species, with the potential for long-term effects on survival and reproductive rates (Christiansen *et al.* 2013).

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

- Behavioural response;
- Effective Deterrence Radius (EDR) approach for harbour porpoise;
- Dose response curve assessment;
- Disturbance during ADD activation; and
- Duration of piling.

11.6.1.2.1.1 Behavioural response

11.6.1.2.1.1.1 Behavioural response of harbour porpoise to piling

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

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

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

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

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

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

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

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

254. The results from Beatrice Offshore Wind Farm (Graham *et al.* 019) showed that at the start of the piling campaign, there was a 50% chance of a harbour porpoise responding to piling activity, within a distance of 7.4km, during the 24 hours following piling. In the middle of the piling campaign, this 50% response distance had reduced to 4.0km, and by the end of the piling had reduced further to 1.3km.

255. The response to audiogram-weighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 54.1dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 60.0dB re 1 1μPa^2s during the middle of the campaign, and to 70.9dB re 1 μPa^2s by the end of the piling activities. Similarly, the response to unweighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 144.3dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 150.0dB re 1 1μPa^2s during the middle of the campaign, and to 160.4dB re 1 μPa^2s by the end of the piling activities (Graham *et al.* 2019).

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

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

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

259. An increase in broadband noise levels due to piling led to a significant reduction in porpoise presence. When piling was not occurring, porpoise detections decreased by 17% as the noise levels increased (from 102dB re 1 µPa (SPL) to 159dB re 1 µPa (SPL)) (**Plate 11-1**; Benhemma-Le Gall *et al.*.2021). During piling, porpoise detections decreased by 9% as noise levels increased (from 102dB to 159dB). A similar reduction in buzz vocalisations was also evident; the presence of buzz vocalisations can be attributed to foraging behaviours. When piling was not taking place, buzz vocalisations decreased by 41.5% as the noise levels increased (from 104dB re 1 µPa (SPL) to 155dB re 1 µPa (SPL)). During piling, porpoise detections decreased by 61.8% as noise levels increased (from 104dB to 155dB re 1 µPa (SPL)) (Benhemma-Le Gall *et al.* 2021).

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

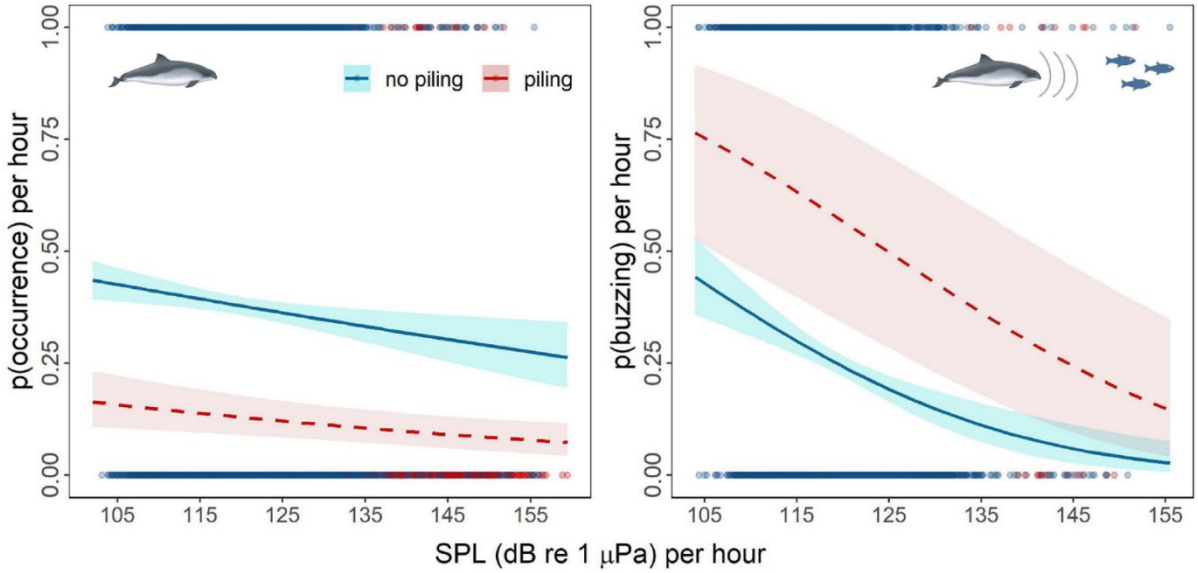

Plate 11-1 [Left] The probability of harbour porpoise presence in relation to the SPL (Red = during piling, Blue = outside of piling time, and [Right] the probability of buzzing activity per hour in relation to the SPL (Red = during piling, Blue = outside of piling time (Benhemma-Le Gall et al., 2021)

11.6.1.2.1.1.2 Behavioural response of delphinids to piling

261. There is limited information on the behavioural response of any dolphin species to piling. Within the Southall *et al.* (2007) paper, a review of the data available for mid-frequency cetaceans (which include species other than dolphins, such as sperm whale *Physeter macrocephalus* and beluga *Delphinapterus leucas*) indicate that some significant response was observed at a SPL of 120 dB to 130 dB re 1µPa (rms), although the majority of individuals did not display significant behavioural response until exposed to a level of 170 dB to 180 dB re 1µPa (rms). Other mid-frequency species were observed to have no behavioural response even when exposed to a level of 170 dB to 180 dB re 1µPa (rms). It should be noted that few of the reviewed studies were based on dolphin species.

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

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

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

265. The southern coast of the Moray Firth is the closest area to the offshore activities within this bottlenose dolphin population's range, with piling at Beatrice 50–70km from the studied population, and Moray East 40–70km from the population. The analyses showed that dolphins continued using the southern coast of the Moray Firth during the seismic survey and impact pile-driving (and therefore the species was not significantly affected at this distance of 40-70km) (Fernandez-Betelu *et al.* 2021). While displacement distances are available for other marine mammal species (such as harbour porpoise), there are no such studies conducted for bottlenose dolphins. However, as dolphins are generally less sensitive than harbour porpoises to underwater noise, shorter ranges of displacement would be expected (Fernandez-Betelu *et al.* 2021).

11.6.1.2.1.1.3 Behavioural Response of Minke Whale to Piling

266. There is limited information on the behavioural response of minke whale to piling, however behavioural studies have been conducted to look at the responses of other baleen whales, which can be assumed to represent minke whale.

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

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

269. Whale species were typically observed to respond significantly at a received level of 150dB to 160dB re 1 µPa (rms) (Malme *et al.* 1983, 1984; Richardson *et al.* 1986; Ljungblad *et al.* 1988; Todd *et al.* 1996; McCauley *et al.* 1998), with behavioural changes including visible startle responses, extended cessation or modification of vocal behaviour, brief cessation of reproductive behaviour or brief and minor separation of females and dependent offspring.

270. During migration periods, avoidance behaviours of bowhead whales *Balaena mysticetus* were observed at distances of more than 20km from seismic sources (Koski and Johnson 1987; Richardson *et al.* 1999), however, during foraging periods, bowhead whales did not respond at greater than 6km from the source (Richardson *et al.* 1986; Miller *et al.* 2005). Richardson *et al.* (1986) concluded that due to a single airgun, avoidance and behavioural response was observed once noise levels reached more than 160dB re 1 µPa.

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

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

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

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

11.6.1.2.1.1.4 Behavioural Response of Seals to Piling

275. There is limited data on the behavioural response of seals to disturbance from underwater noise such as piling. A study undertaken on ringed seals *Pusa hispida*, bearded seals *Erignathus barbatus*, and spotted seals *Phoca largha* (Harris *et al.* 2001) found the onset of a significant behavioural response at a received noise level of 160 to 170dB re 1 µPa (rms), although a larger proportion of individuals showed no response at noise levels of up to 180dB re 1 µPa (rms). Only at much higher sound pressure levels (190 to 200dB re 1 µPa (rms)) did significant numbers of seals exhibit a significant disturbance response.

276. Data from tagged harbour seals in the Wash indicated that seals were not excluded from the vicinity of the Lincs wind farm during the construction phase but there was clear evidence of avoidance during pile driving events (Russell *et al.* 2016). Seal activity was significantly reduced at ranges of up to 25km from piling sites, although within two hours of cessation of piling, seal distribution returned to pre-piling levels (Russell *et al.* 2016, Whyte *et al.* 2020).

11.6.1.2.2 Magnitude of Impact – DBS East or DBS West in Isolation

11.6.1.2.2.1 Disturbance / Displacement of Marine Mammals Based on Known Disturbance Ranges for Piling

277. The current advice from the SNCBs is that for harbour porpoise a potential disturbance range or EDR of 26km (2,123.7km^2) around piling locations for monopiles (without noise abatement), and 15km (706.9km^2) for jacket pin piles (with and without noise abatement) is used for disturbance in the relevant SAC (JNCC *et al.* 2020). DBS East and West are located wholly within the Southern North Sea SAC, and therefore this approach has been followed for this PEIR. Not all harbour porpoise within these potential disturbance areas will be disturbed, however as a worst case scenario 100% disturbance of harbour porpoise in the areas has been assumed.

278. The estimated number of harbour porpoise and percentage of the North Sea MU reference population that could be disturbed as a result of underwater noise during piling at DBS East or West based on the SCANs density is presented in **Table 11-38**.

279. For one piling event at a time, the magnitude of the potential impact is assessed as negligible for the 26km EDR for monopiles, with 0.54% (or less) of the reference population anticipated to be affected, and negligible for the 15km EDR for jacket pin piles with 0.18% or less of the reference population anticipated to be temporarily disturbed (**Table 11-38**).

280. For two simultaneous piling events, the magnitude of the potential impact is assessed as low for the 26km EDR for monopiles, with 1.08% (or less) of the reference population anticipated to be affected, or negligible for the 15km EDR for jacket pin piles, with 0.36% or less of the reference population anticipated to be temporarily disturbed (**Table 11-38**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 11-38 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for both a Single and Two Simultaneous Piling Events at DBS East or DBS West

EDR	Assessment of effect	Magnitude of Impact
For a single piling event		
Monopiles (EDR – 26km, Impact area 2,123.7km^2)	1,885.9 harbour porpoise (0.54% of the NS MU reference population)	Negligible
Jacket pin piles (EDR – 15km, Impact area 706.9km^2)	627.7 harbour porpoise (0.18% of the NS MU reference population)	Negligible
For two simultaneous piling events*		
Monopiles, at two simultaneous locations (EDR – 26km, Impact area 2,123.7km^2)	3,771.8 harbour porpoise (1.08% of the NS MU reference population)	Low
Jacket pin piles, at two simultaneous locations (EDR – 15km, Impact area 706.9km^2)	1,255.4 harbour porpoise (0.36% of the NS MU reference population)	Negligible

** not taking into account any overlap between disturbance areas between the two locations*

281. There is very little information on the potential disturbance ranges of minke whale due to impact piling. As noted above, baleen whale species (bowhead whale) have been recorded to have a deterrence distance of up to 30km from a seismic source (Richardson *et al.* 1999). While this was for a seismic survey rather than impact piling, it is an impulsive noise source with a high source level. This 30km potential avoidance range is smaller than the modelled TTS / fleeing response range for minke whale of the worst case modelling for DBS West of 82km for cumulative monopiles and 72km for jacket pin pile installation (**Table 11-29**). Therefore, in the absence of any further information, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect, and represents the worst-case on the potential disturbance range of minke whales (**Table 11-30**). There is therefore the potential for a **negligible** magnitude of impact for minke whale from the disturbance of piling.

282. For dolphin species, there is very little information on the potential disturbance ranges due to impact piling (or any impulsive noise source). Therefore, in the absence of any further information, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect for all dolphin species and represents the worst-case (**Table 11-29**). There is therefore the potential for a **negligible** magnitude of impact for all dolphin species, due to the potential disturbance effect of piling.

283. Regarding both grey and harbour seal, as noted above, a study has shown that harbour seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) (Russell *et al.* 2016). This range has been used to determine the number of grey seal and harbour seal that may be disturbed during piling at DBS East or DBS West (**Table 11-39**).

284. The magnitude of the potential impact is assessed as low (negligible) for grey seal and negligible for harbour seal for both DBS Projects with <1% of the reference population anticipated to be temporarily disturbed, for a single piling location. For two simultaneous piling locations, grey seal have a magnitude of low (low), and harbour seal have a magnitude of negligible (**Table 11-39**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 11-39 Assessment of the Potential for Disturbance to Grey Seal and Harbour Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East or DBS West

Marine mammal species	Location	Assessment of effect	Magnitude of impact#
For a single piling event			
Grey seal (25km, Impact area 1,963.5km^2)	DBS East	355.4 (1.03% of the SE England MU or 0.59% of the wider reference population)	Low (negligible)
	DBS West	510.5 (1.48% of the SE England MU or 0.85% of the wider reference population)	Low (negligible)
Harbour seal (25km, Impact area 1,963.5km^2)	DBS East	3.3 (0.07% of the SE England MU reference population)	Negligible
	DBS West	2.0 (0.04% of the SE England MU reference population)	Negligible
For two simultaneous piling events*			
Grey seal (25km, Impact area 1,963.5km^2)	DBS East	710.8 (2.06% of the SE E MU, or 1.18% of the wider reference population)	Low (low)
	DBS West	1,021.0 (2.96% of the SE E MU, or 1.07% of the wider reference population)	Low (low)
Harbour seal (25km, Impact area 1,963.5km^2)	DBS East	6.6 (0.14% of the SE England MU reference population)	Negligible
	DBS West	4.0 (0.08% of the SE England MU reference population)	Negligible

** not taking into account any overlap between disturbance areas between the two locations # Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.2.2.2 Reduction in Foraging Due to Noise Disturbance

285. Whilst underwater noise has been shown to disturb cetaceans foraging at sea it is expected that the main sources of disturbance will be short-term in nature. Construction activities such as piling will include measures to reduce the direct effects of noise on marine mammals, which will also help to mitigate disturbance to foraging behaviour and reduce the effect. In addition, the period of construction (approximately five years for each Project) is unlikely to increase this significantly. The magnitude of impact for harbour porpoise, dolphin species and minke whale is therefore low.

286. Hastie *et al.* (2021) studied the change in foraging behaviour of grey seal when exposed to underwater noise. A high density and low density area of prey was present within an experimental pool, and speakers were located at each prey patch. During the control periods, seals would forage mainly at the high-density patch, but also at the low-density patch for a smaller proportion of time. When the seals were exposed to noise at the low density patch, there was a reduction in foraging of 16-28%, however, when seals were exposed to noise at the high density prey patch, there was no change in foraging in comparison to control periods (Hastie *et al.* 2021). This indicates that seals would choose to remain at a noisy environment, if there were good prey resources at the same location (Hastie *et al.* 2021).

287. The largest disturbance range for seal species for activities within the export cable corridor would be 4km and for activities within the array areas would be 25km. Therefore, there is no potential for disturbance of seals from the identified key foraging areas of harbour seal. The magnitude for grey seal and harbour seal is therefore low.

11.6.1.2.2.3 Dose Response Curve Assessment

288. As per current best practice guidance (Southall *et al.* 2021), a behavioural disturbance dose-response analysis has been carried out for those species for which appropriate dose-response evidence exists within the scientific literature. Where, a species-specific dose-response assessment has been undertaken rather than the fixed behavioural threshold approach that is described above. The dose-response methodology has therefore been undertaken for harbour porpoise, harbour seal, and grey seal.

289. The application of a dose-response curve allows for an evidence-based estimate 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). For the purposes of this assessment, the dose is the received single-strike SEL (SEL_{SS}). The use of SEL_{SS} in a dose-response analysis, where possible, is considered to be best practice in the latest guidance provided by Southall *et al.* (2021).

290. To estimate the number of animals disturbed by piling, SEL_{SS} contours at 5dB increments (generated by the noise modelling – see **Appendix 11-2**) were overlain on the relevant species density surfaces to quantify the number of animals receiving each SEL_{SS}, and subsequently the number of animals likely to be disturbed based on the corresponding dose-response curve (**Plate 11-2**). For harbour porpoise, the Waggitt *et al.* (2019) density estimates were used for the analysis as a worst case. For both seal species, the Carter *et al.* (2022) density estimates were used.

291. The dose-response relationship used for harbour porpoise was developed by Graham *et al.* (2017) using data collected during Phase 1 of piling at the Beatrice Offshore Wind Farm. This dose response relationship is displayed in **Plate 11-3**. Following the development of this dose-response relationship, further study revealed that the responses of harbour porpoises to piling noise diminishes over the construction period (Graham *et al.* 2019). Therefore, the use of the dose-response relationship related to an initial piling event for all piling events in this assessment can be considered conservative.

292. In the absence of species-specific dose-response data for dolphins or whales, harbour porpoise is the only species of cetacean that this analysis is applied to. Due to differences in hearing of baleen whales, dolphins, and porpoise, as well as their behaviour, it would not be appropriate to extrapolate the findings of Graham *et al.* (2017) to dolphin species or minke whale.

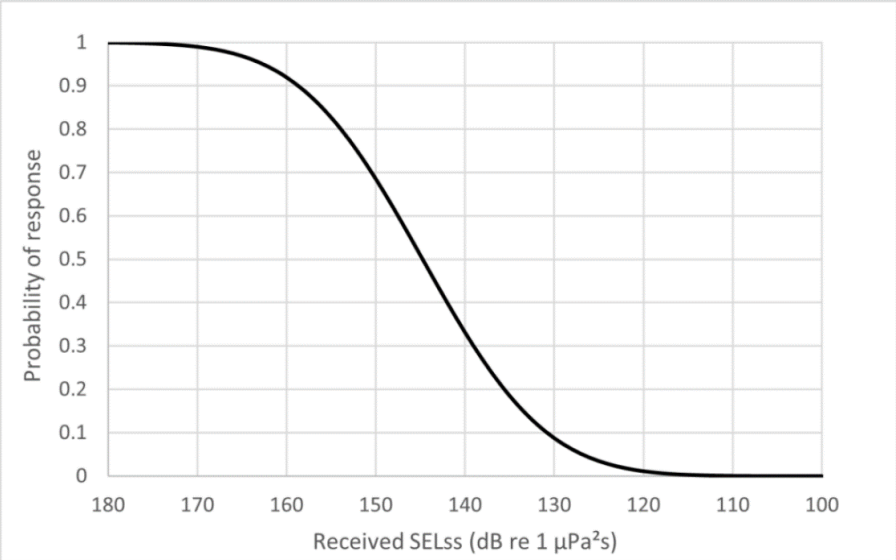

Plate 11-2 Dose-Response Relationship Developed by Graham et al. (2017) Used for Harbour Porpoise in this Assessment

293. For seals, a dose-response relationship derived from harbour seal telemetry data collected during several months of piling at the Lincs Offshore Wind Farm has been used (Whyte *et al.* 2020). As seen in **Plate 11-3**, the greatest SEL_{SS} considered in the Whyte *et al.* (2020) study was 180dB re 1 μPa^2s. This assessment has therefore conservatively assumed that at SEL_{SS} > 180dB re 1 μPa^2s all seals will be disturbed. The dose-response curve for harbour seal is appropriate for grey seal, as both species have similar hearing audiograms.

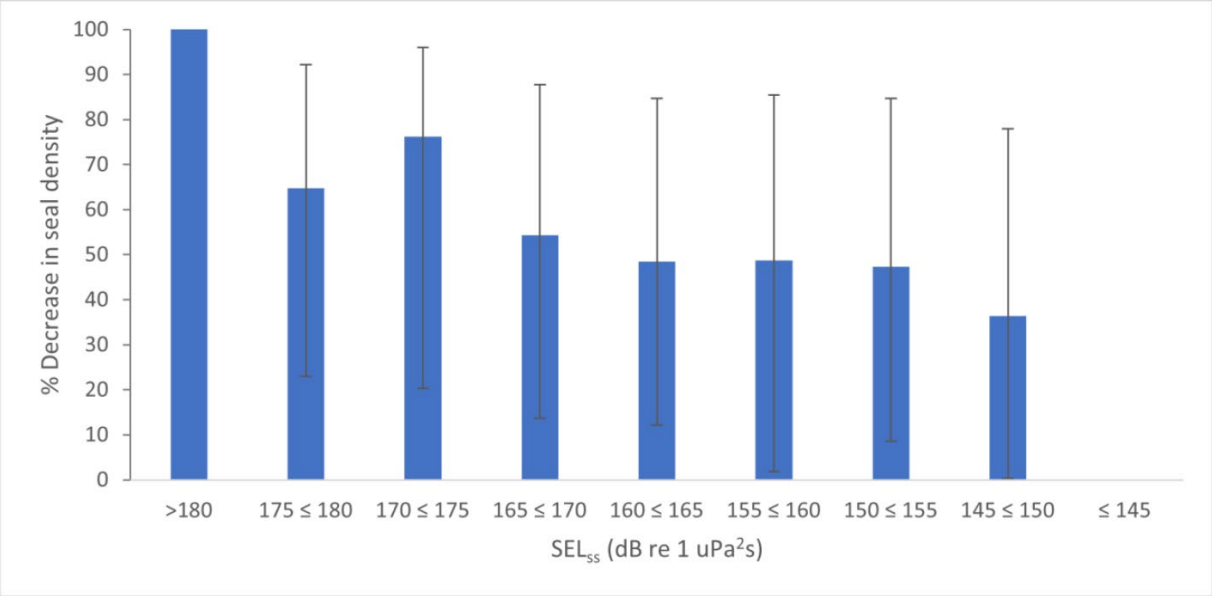

Plate 11-3 Dose-Response Behavioural Disturbance Data for Harbour Seal Derived from the Data Collected and Analysed by Whyte et al. (2020).

294. The estimated numbers (and percentage of the relevant reference populations) of harbour porpoise, grey seal, and harbour seal disturbed as a result of underwater noise during piling are presented in **Table 11-40**.

295. For all species assessed, the magnitude of the potential impact is assessed as negligible to low, see **Table 11-40**.

296. It should be noted that this dose-response analysis is 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.

Table 11-40 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East or DBS West in Isolation Based on the Dose-Response Approach

Marine Mammal Species	Location	Assessment of effect	Magnitude of Impact
Instantaneous behavioural disturbance due to a single, maximum energy monopile strike (SEL_{ss})			
Harbour porpoise	DBS East	4,630.4 (1.34% of the NS MU reference population)	Low
	DBS West	5,953.0 (1.72% of the NS MU reference population)	Low
Grey seal	DBS East	950.4 (2.76% of the SE England MU reference population)	Low
	DBS West	854.6 (2.48% of the SE England MU reference population)	Low
Harbour seal	DBS East	1.72 (0.035% of the SE England MU reference population)	Negligible
	DBS West	0.87 (0.018% of the SE England MU reference population)	Negligible
Instantaneous behavioural disturbance due to a single, maximum energy pin pile strike (SEL_{ss})			
Harbour porpoise	DBS East	3889.9 (1.12% of the NS MU reference population)	Low
	DBS West	5048.6 (1.46% of the NS MU reference population)	Low
Grey seal	DBS East	765.5 (2.22% of the SE England MU reference population)	Low
	DBS West	684.4 (1.99% of the SE England MU reference population)	Low
Harbour seal	DBS East	1.38 (0.028% of the SE England MU reference population)	Negligible
	DBS West	0.70 (0.014% of the SE England MU reference population)	Negligible

11.6.1.2.2.4 Disturbance during ADD activation

297. The assessments of the potential disturbance during any ADD activation is indicative only, as the final requirements for mitigation in the MMMP will be determined prior to construction.

298. As outlined in section 11.3.3, additional mitigation to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing. The maximum predicted PTS impact ranges are 11km for harbour porpoise and 19km for minke whale, based on worst-case for cumulative exposure (SEL_{cum}) during installation of monopile with a maximum of up to 7,000kJ (**Table 11-22**). The maximum predicted PTS SEL_{cum} impact ranges for sequential installation of four jacket pin piles is 11km for harbour porpoise and 20km for minke whale.

299. Based on a precautionary swim speed of 1.5m/s (Otani *et al.* 2000), the ADD would need to be activated for a minimum of 123 minutes to ensure harbour porpoise were beyond the maximum 11km PTS impact range or 105 minutes to ensure harbour porpoise are beyond the 280km^2 modelled impact area for monopiles or 71 minutes period to piling to clear the modelled impact area of 130km^2 for four sequential jacket pin piles.

300. ADD devices such as the Lofitech seal scarer have been recorded to be effective out to 12 - 18km for harbour porpoise (Dähne *et al.* 2017) However, Tougaard *et al.* (2014) critically evaluated ADDs and the harbour porpoise noise criteria and found that avoidance of mostly 'mid-frequency' devices were at ranges between 1 and 7.5km. This indicates that even if the ADD is used for the 123 minutes a disturbance range of 11km might not be reached.

301. The use of ADDs for 123 minutes has the potential to cause disturbance and may be deemed as excessive. Therefore, the assessments for disturbance during ADD activation is based on 80 minutes for monopiles. Through consultation with regulators the maximum an ADD can be operated will be confirmed in the MMMP prior to construction.

302. During an 80 minute ADD activation, harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal would move at least 7.2km from the ADD location resulting in a potential disturbance area of 162.9km^2. Minke whale would move at least 15.6km from the ADD location during the 80 minute activation (based on a precautionary marine mammal swimming speed of 3.25m/s; Blix and Folkow 1995), resulting in a potential disturbance area of 764.5km^2.

303. The magnitude of the potential impact is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 1% or less of the relevant reference populations anticipated to be temporarily disturbed (**Table 11-41**).

Table 11-41 Assessment of the Potential for Disturbance due to ADD Activation Based on the Worst Case 80 minute Duration for Monopile at DBS East or DBS West in Isolation

Marine mammal species	Location	Assessment of effect	Magnitude of impact*
Harbour porpoise	DBS East	144.62 (0.04% of the NS MU reference population)	Negligible
	DBS West		
Bottlenose dolphin	DBS East	0.02 (0.0011% of the GNS MU reference population)	Negligible
	DBS West	0.04 (0.002% of the GNS MU reference population)	
Common dolphin	DBS East	6.03 (0.006% of the CGNS MU reference population)	Negligible
	DBS West	6.68 (0.007% of the CGNS MU reference population)	
White-beaked dolphin	DBS East	0.9 (0.002% of the CGNS MU reference population)	Negligible
	DBS West	1.95 (0.004% of the CGNS MU reference population)	
Minke whale	DBS East	7.65 (0.04% of the CGNS MU reference population)	Negligible
	DBS West		
Grey seal	DBS East	29.48 (0.09% of the SE E MU reference population, or 0.05% of the wider reference population).	Negligible (negligible)
	DBS West	42.34 (0.12% of the SE E MU reference population, or 0.07% of the wider reference population).	
Harbour seal	DBS East	0.28 (0.006% of the SE England MU reference population)	Negligible
	DBS West	0.16 (0.003% of the SE England MU reference population)	

* Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.2.2.5 Duration of piling and ADD activation

304. The foundation installation period (for both monopiles and jacket pin piles) is currently expected to take place over five years per Project. This will include transit of the foundation components in batches to the array areas and foundation installation, including any piling.

305. Piling would not be constant during the piling phases and construction periods. There will be gaps between the installations of individual piles, and if installed in groups there could be time periods when piling is not taking place as piles are brought out to the site. There will also be potential delays for weather or other technical issues.

306. **Table 11-42** summarises the worst case scenarios for the duration of piling based on the maximum number of wind turbines, number of piles and piling duration to install each pile, including soft-start and ADD activation. For monopiles, including ADD activation, there will be up to 30 days of active piling within the five year foundation installation period (or for 1.6% of each Project period), and for jacket pin piles, including ADD activation, there will be up to 65 days of active piling within the foundation installation period (or for 3.6% of each Project period). Note that the actual active piling period will be less than this, as piling will not be required for the full 5.20 hours per pile for monopiles, or 3.10 hours per pile for jacket pin piles at all locations.

Table 11-42 Maximum Duration of Piling and ADD activation at each Array Area, Based on Worst Case Scenarios, Including Soft-Start, and ADD Activation

Parameter	Number of Piles	Maximum Active Piling Time per Pile	Total Piling Time	ADD Activation*	Total Duration
Up to 100 wind turbines	Up to 100 monopiles	320 minutes including soft-start and ramp-up	533 hours and 20 minutes for 100 monopiles	133 hours and 20 minutes for 80 min ADD activation per monopile	666 hours and 40 minutes with 80 min ADD activation for 100 monopiles
	Up to 400 jacket pin piles	190 minutes including soft-start and ramp-up	1,266 hours and 40 minutes for 400 jacket pin piles	118 hours and 20 minutes for 71 min ADD activation per jacket pin piles	1,385 hours with 71 min ADD activation for 400 jacket pin piles
Six platforms	Up to 6 monopiles	320 minutes including soft-start and ramp-up	32 hours for 6 monopiles	8 hours for 80 min ADD activation per monopile	40 hours and with 80 min ADD activation for 4 monopiles
	Up to 48 OSP jacket pin piles	190 minutes including soft-start and ramp-up	152 hours for 48 jacket pin piles	7 hours and 06 minutes for 71 min ADD activation per jacket pin piles	159 hours and 06 minutes with 71 min ADD activation for 48 jacket pin piles
Piling of up to 106 monopiles and (including soft-start, ramp-up and ADD activation) = up to 706 hours and 40 minute (less than 30 days) or for 1.6% of the total piling programme days; or Piling of up to 448 jacket pin piles (including soft-start, ramp-up and ADD activation) = up to 1,544 hours and 06 minute (less than 65 days) or for 3.4% of the total piling programme days.					

**Where the ADD is used only once per foundation*

307. The duration of piling is based on a worst case scenario and a very precautionary approach. As has been shown at other OWFs, the duration used in the impact assessment can be overestimated. For example, for the installation of monopile foundations at Dudgeon Offshore Wind Farm, 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 3 days) with the average time for installation per monopile of 71 minutes (Dudgeon Offshore Wind Farm Limited (DOWL) 2016). Therefore, the actual piling duration was approximately 21% of the predicted maximum piling duration.

308. The piling duration to install the individual monopiles at Dudgeon Offshore Wind Farm 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 Offshore Wind Farm, 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).

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

310. Once the piling is completed, the duration of the exclusion could last up to three days following a single piling event if the animal is close to the source. Data presented by Brandt *et al.* (2009, 2011) indicated that harbour porpoise would completely leave the area (indicated by the duration of waiting time between porpoise detections after first piling) for a median time of 16.6 hours and a maximum of 74.2 hours within 0.5 to 6.0km of the noise source. Waiting times did not return to 'normal' until 22.7 hours after piling. At distances of greater than approximately 9.0km from the noise source there was a much shorter duration of effect; with waiting times returning to 'normal' between one and 2.6 hours after piling ceased. However, at 18 to 25km there was still a marked effect. Porpoise activity was significantly lower within approximately 3km of the noise source for 40 hours after piling.

311. 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 vessel activity during preparation works. The study concluded that although there were adverse short-term effects (1-2 days in duration) of construction on acoustic porpoise detections, there 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.

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

313. Nabe-Nielsen *et al.* (2018) developed the DEPONS (Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea) 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 impact of OWF construction noise on the North Sea harbour porpoise population, based on the acoustic monitoring of harbour porpoise during construction of the Gemini OWF. Local population densities around the Gemini OWF recovered 2–6 hours after piling, similar recovery rates were obtained in the model. The model indicated that, assuming noise influenced porpoise movements as observed at the Gemini offshore wind farm, the North Sea harbour porpoise population was not affected by construction of 65 OWFs, as required to meet the EU renewable energy target (Nabe-Nielsen *et al.* 2018).

314. 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 OWF. 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 OWFs. 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 will differ depending on the distance of the individual from the piling activity and the noise level to which the animal is exposed.

11.6.1.2.3 Magnitude of impact – DBS East and DBS West Together

11.6.1.2.3.1 Disturbance / Displacement of Marine Mammals Based on Known Disturbance Ranges for Piling

315. The estimated number of harbour porpoise and percentage of the North Sea MU reference population that could be disturbed as a result of underwater noise during piling for a single piling event is the same as DBS East or DBS West in isolation. Therefore in this section, the focus is on concurrent and simultaneous piling.

316. The estimated number of harbour porpoise and percentage of the North Sea MU reference population that could be disturbed as a result of underwater noise during piling at DBS East and DBS West together is presented in **Table 11-43**. Based on the worst case scenario of three piling installation vessels at the DBS Projects together the EDR for three monopiles and three concurrent jacket pin pile installation has been calculated in **Table 11-43**. Magnitude levels are set out in **Table 11-12**.

317. For three simultaneous piling events, the magnitude of the potential impact is assessed as low for the 26km EDR for monopiles, with 1.63% (or less) of the reference population anticipated to be affected, or negligible for the 15km EDR for jacket pin piles, with 0.54% or less of the reference population anticipated to be temporarily disturbed (**Table 11-43**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 11-43 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for Both a Single and Two Simultaneous Piling Events

EDR*	Assessment of effect	Magnitude of Impact
EDR of 26km for mono-piles, at three simultaneous locations	5,657.6 harbour porpoise (1.63% of the NS MU reference population)	Low
EDR of 15km for jacket pin piles, at three simultaneous locations	1,883.1 harbour porpoise (0.54% of the NS MU reference population)	Negligible

** Not taking into account any overlap between disturbance areas between the three locations*

318. **Table 11-32** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS due to the cumulative exposure of simultaneous monopiles and jacket pin piles at the DBS East and DBS West and centre modelling locations. Therefore, in the absence of any further information on the potential for disturbance of minke whale from piling, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect, and represents the worst-case for the potential disturbance range of minke whales (**Table 11-33**). There is therefore the potential for a **negligible** magnitude of impact for minke whale from the disturbance of piling of either monopiles or jacket pin piles at DBS East and DBS West together.

319. For dolphin species, there is very little information on the potential disturbance ranges due to impact piling (or any impulsive noise source). Therefore, in the absence of any further information, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect for all dolphin species, and represents the worst-case for the cumulative exposure from the concurrent scenario (**Table 11-32**). There is therefore the potential for a **negligible** magnitude of impact for all dolphin species, due to the potential disturbance effect of piling of either monopiles or jacket pin piles at DBS East and DBS West together (**Table 11-33**).

320. Regarding both grey and harbour seal, as noted above, a study has shown that harbour seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) (Russell *et al.* 2016). This range has been used to determine the number of grey seal and harbour seal that may be disturbed during piling at DBS East and DBS West together based on three piles being installed at any one time (or a disturbance area of 5,890.5km^2) and applying the worst case density for each species (**Table 11-44**).

321. The magnitude of the potential impact is assessed as **medium (low)** for grey seal at both DBS Projects together and **negligible** for harbour seal at both DBS Projects together with <1% of the reference population anticipated to be temporarily disturbed, for three piling location in combination (**Table 11-44**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 11-44 Assessment of the Potential for Disturbance to Grey Seal and Harbour Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East and DBS West Together

Marine mammal species	Assessment of effect	Magnitude of impact#
For three simultaneous piling events*		
Grey seal (based on a density of 0.386)	2,273.7 (6.6% of the SE England MU or 3.77% of the wider reference population)	Medium (low)
Harbour seal (based on a density of 0.0017)	10.0 (0.21% of the SE England MU reference population)	Negligible

** Not taking into account any overlap between disturbance areas between the three locations*
 # Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.2.3.2 Reduction in Foraging Due to Noise Disturbance

322. As the construction period for the DBS Projects together is the same duration as one Project being built in isolation (approximately five years for the DBS Projects together) it is unlikely to increase the predicted disturbance from DBS East or DBS West in isolation significantly. The magnitude of impact for harbour porpoise, dolphin species and minke whale is therefore low.

323. The largest disturbance range for seal species for activities within the export cable corridor would be 4km (section 11.6.1.3.4), and for activities within the array areas has been assessed on the worst case of three installations at any one time (**Table 11-44**). The number of seals with the potential to be disturbed by three simultaneous installations does not take into account the overlap between disturbance areas between the three locations making the impact highly precautionary. Due to the distance of the DBS Projects from the coast, there is no potential for disturbance of seals from the identified key foraging areas of harbour seal. The magnitude for grey seal and harbour seal to a reduction in foraging due to noise disturbance is expected to remain low.

11.6.1.2.3.3 Dose Response Curve Assessment

324. The estimated numbers (and percentage of the relevant reference populations) of harbour porpoise, grey seal, and harbour seal disturbed as a result of underwater noise during piling at DBS East and DBS West together are presented in **Table 11-45** based on one installation at DBS East, DBS West and the worst case central location**.**

325. The magnitude of the potential impact is assessed as low for harbour porpoise and negligible for harbour seal with less than 5% and less than 1% of the respective MU reference population predicted to be disturbed. For grey seal the magnitude of the potential impact is medium for monopiles installed at DBS East, West and a central location together and low for jacket pin piles installed concurrently **Table 11-45.**

326. It should be noted that this dose-response analysis is 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.

Table 11-45 Number of Individuals (and % of Reference Population) That Could be Disturbed During Piling at DBS East and DBS West Together Based on the Dose-Response Approach

Marine Mammal Species	Assessment of effect	Magnitude of Impact
Instantaneous behavioural disturbance at maximum energy monopile strike (SEL_{ss}) at three locations		
Harbour porpoise	12,207.4 harbour porpoise (3.52% of the NS MU reference population)	Low
Grey seal	1,967.2 grey seal (5.71% of the SE E MU reference population)	Medium
Harbour seal	3.5 harbour seal (0.07% of the SE E MU reference population).	Negligible
Instantaneous behavioural disturbance at maximum energy pin pile strike (SEL_{ss}) at three locations		
Harbour porpoise	10,192.8 harbour porpoise (2.94% of the NS MU reference population)	Low
Grey seal	1,564.5 grey seal (4.54% of the SE E MU reference population).	Low
Harbour seal	2.8 harbour seal (0.06% of the SE E MU reference population).	Negligible

11.6.1.2.3.4 Disturbance During ADD Activation

327. As outlined in section 11.6.1.1.11**,** additional mitigation to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing and the final requirements for mitigation in the MMMP will be determined prior to construction.

328. The maximum predicted PTS impact ranges for construction of DBS East and West together are given in **Table 11-25**. The assessment has been undertaken based on the precautionary approach of 80 minutes of ADD use at three locations in combination using the worst case density for each species.

329. The magnitude of the potential impact is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 1% or less of the relevant reference populations anticipated to be temporarily disturbed (**Table 11-46**).

Table 11-46 Assessment of the Potential for Disturbance Due to ADD Activation Based on the Worst Case 80 Minute Duration for Monopile at DBS East and DBS West Together

Marine mammal species	Assessment of effect	Magnitude of impact*
Harbour porpoise	433.8 (0.12% of the NS MU reference population)	Negligible
Bottlenose dolphin	0.78 (0.04% of the GNS MU reference population)	Negligible
Common dolphin	20.1 (0.021% of the CGNS MU reference population)	Negligible
White-beaked dolphin	8.4 (0.018% of the CGNS MU reference population)	Negligible
Minke whale	22.95 (0.12% of the CGNS MU reference population)	Negligible
Grey seal	188.7 (0.54% of the SE England MU reference population, or 0.3% of the wider reference population).	Negligible (negligible)
Harbour seal	0.84 (0.18% of the SE England MU reference population)	Negligible

* *Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.2.3.5 Duration of piling and ADD activation

330. The foundation installation period (for both monopiles and jacket pin piles) is currently expected to take place over five years for both Projects installed concurrently. This will include transit of the foundation components in batches to the array areas and foundation installation, including any piling.

331. **Table 11-47** summarises the worst case scenarios for the duration of piling based on the maximum number of wind turbines, number of piles and piling duration to install each pile, including soft-start and ADD activation. For monopiles, including ADD activation, there will be up to 59 days of active piling within the five year foundation installation period (or for 3.2% of the total period), and for jacket pin piles, including ADD activation, there will be less than 128 days of active piling within the foundation installation period (or for 7.0%). Note that the actual active piling period will be less than this, as piling will not be required for the full 5.20 hours per pile for monopiles, or 3.10 hours per pile for jacket pin piles at all locations.

Table 11-47 Maximum Duration of Piling and ADD activation at DBS Project Areas Together, based on Worst Case Scenarios, Including Soft-Start, and ADD Activation

Parameter	Number of Piles	Maximum Active Piling Time per Pile	Total Piling Time	ADD Activation*	Total Duration
Up to 200 wind turbines	Up to 200 monopiles	320 minutes including soft-start and ramp-up	1,066 hours and 40 minutes for 200 monopiles	266 hours and 40 minutes for 80 min ADD activation per monopile	1,333 hours and 20 minutes with 80 min ADD activation for 200 monopiles
	Up to 800 jacket pin piles	190 minutes including soft-start and ramp-up	2,533 hours and 20 minutes for 400 jacket pin piles	236 hours and 40 minutes for 71 min ADD activation per jacket pin piles	2,770 hours with 71 min ADD activation for 400 jacket pin piles
11platforms	Up to 11 monopiles	320 minutes including soft-start and ramp-up	58 hours and 40 minutes for 11 monopiles	14 hours and 40 minutes for 80 min ADD activation per monopile	73 hours and 20 minutes with 80 min ADD activation for 11 monopiles
	Up to 88 OSP jacket pin piles	190 minutes including soft-start and ramp-up	278 hours and 40 minutes for 88 jacket pin piles	13 hours and 06 minutes for 71 min ADD activation per jacket pin piles	291 hours and 46 minutes with 71 min ADD activation for 88 jacket pin piles
Piling of up to 111 monopiles and (including soft-start, ramp-up and ADD activation) = up to 1,406 hours and 40 minute (less than 59 days) or for 3.2% of the total piling programme days; or Piling of up to 888 jacket pin piles (including soft-start, ramp-up and ADD activation) = up to 3,061 hours and 46 minute (less than 128 days) or for 7.0% of the total piling programme days.					

**Where the ADD is used only once per foundation*

11.6.1.2.4 Sensitivity of Receptor

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

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

334. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased.

335. Harbour porpoise have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein *et al.* 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for an estimated three to five days, depending on body condition (Kastelein *et al.* 1997). Should harbour porpoise be excluded from an area of key prey resource it will likely seek an alternative food resource and this could have an effect on the individual's fitness. For example, they may have to travel further or take less than optimum prey species. The effects on an individual's fitness are partly caused by the exclusion of animals from high-quality foraging areas and partly by the net energy losses associated with fleeing from disturbances (Nabe-Nielsen *et al.* 2014). Therefore, impacts in lower quality habitat are likely to have a lower potential impact on an animal's fitness.

336. Harbour porpoise are assessed as having medium sensitivity to disturbance from foraging at sea during construction.

337. Minke whales spend approximately 15% of their time foraging and have been shown to exhibit reduced foraging behaviour in the presence of increased vessel traffic. For example, in a study looking at the effects of wildlife tour boats on minke whale behaviour, a decrease in energy intake of 42% was estimated during disturbance events lasting one hour, as a result of reduced time spent foraging and surface feeding (Christiansen *et al.* 2013). It is therefore possible that construction vessels will have a similar effect, with the additional disturbance sources of noise from construction activities such as piling (see Impacts 1 and 2).

338. Minke whale are expected to move away from sources of noise and have been shown to demonstrate increased horizontal movement and swimming speeds from anthropogenic disturbance, likely leading to a short-term change in foraging behaviour (Christiansen *et al.* 2014). In addition, navy training operations have been shown to produce similar effects, with increased horizontal avoidance movements during disturbances that included vessel traffic and the use of sonar, likely resulting in a decrease in time spent foraging. It was noted these behaviours were largely short-term and isolated to during disturbance events (Durbach *et al.* 2021).

339. Minke whale are therefore assessed as having a medium sensitivity to disturbance to foraging at sea during construction.

340. For dolphin species human-caused disturbance could result in the movement of prey away from dolphin foraging areas, the displacement of dolphins from their foraging grounds, or could reduce the ability of dolphins to forage even if both dolphins and prey remain in the area of the disturbance. As a result, dolphins may spend more energy trying to catch food, catch less food, or even be forced into a fasting state because they cannot obtain food. As the dolphins in the North Sea are part of a large, open populations with no food limitation they appeared to be able to withstand a higher probability of disturbance (New *et al.* 2020).

341. As a conservative approach all dolphin species will assessed as having a medium sensitivity to disturbance to foraging at sea during construction.

342. Grey seal and harbour seal exhibit alternate periods of foraging and resting at haul out sites (during which limited, or no feeding occurs). Prolonged fasting also occurs in these species during annual breeding and moult, when there are marked seasonal changes in body condition (Rosen and Renouf 1997; Bäcklin *et al.* 2011). Although adult seals may be relatively robust to short term (weeks rather than days compared to harbour porpoise) changes in prey resources, young and small individuals have a more sensitive energy balance. This is exhibited through effects of mass dependent survival (Harding *et al.* 2005). Although disturbance to harbour or grey seal may lead to a severe or sustained avoidance of an area, these species can be considered less sensitive to such an impact than harbour porpoise (low sensitivity).

343. The sensitivity of both seal species to disturbance is considered to be medium in this assessment as a precautionary approach.

11.6.1.2.5 Significance of Effect – DBS East or DBS West in Isolation

344. The assessment for the potential for disturbance to marine mammals due to both monopile and jacket pin pile installation is provided in **Table 11-48,** taking into account the medium sensitivity and the potential magnitude of the impact.

345. The significance of effect for disturbance based on the known effect ranges for marine mammals has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, for either monopiles or jacket pin piles (**Table 11-48**).

346. The significance of effect for disturbance from construction on disturbance to foraging at sea has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise and minke whale, and negligible for bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal (**Table 11-48**).

Table 11-48 Assessment of Significance of Effect for the Potential for Disturbance from Monopiles and Jacket Pin Piles for DBS East or DBS West in Isolation

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
Potential for disturbance based on known effect ranges for up to two monopiles or jacket pin piles installations			
Harbour porpoise	Medium	Negligible to low	Minor adverse
Bottlenose dolphin, common dolphin, and white-beaked dolphin, (Based on TTS / fleeing response)	Medium	Negligible	Minor adverse
Minke whale (Based on TTS / fleeing response)	Medium	Negligible	Minor adverse
Grey seal	Medium	Low	Minor adverse
Harbour seal	Medium	Negligible	Minor adverse
Reduction in foraging due to underwater noise disturbance			
Harbour porpoise	Medium	Low	Minor adverse

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
Bottlenose dolphin, common dolphin and white-beaked dolphin	Medium	Low	Minor adverse
Minke whale	Medium	Low	Minor adverse
Grey seal and Harbour seal	Low	Low	Minor adverse
Potential for disturbance based on a dose-response curve for monopiles or jacket pin piles			
Harbour porpoise	Medium	Low	Minor adverse
Grey seal	Medium	Low	Minor adverse
Harbour seal	Medium	Negligible	Minor adverse
Potential for disturbance from ADD activation prior to piling			
All marine mammals	Medium	Negligible	Minor adverse

11.6.1.2.6 Significance of effect – DBS East and DBS West Together

347. The assessment for the potential for disturbance to marine mammals due to both monopile and jacket pin pile installation is provided in **Table 11-49,** taking into account the medium sensitivity for marine mammals and the potential magnitude of the impact.

348. The significance of effect for disturbance based on the known effect ranges for marine mammals has been assessed as moderate adverse for grey seal and **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal, for either monopiles or jacket pin piles (**Table 11-49**).

349. The significance of effect for disturbance from construction on disturbance to foraging at sea has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise and minke whale, and negligible for bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal (**Table 11-50**).

Table 11-49 Assessment of Significance of Effect for the Potential for Disturbance from Monopiles and Jacket Pin Piles for DBS East and DBS West Together

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
Potential for disturbance based on known effect ranges for up to three monopiles or jacket pin piles installations			
Harbour porpoise	Medium	Negligible to low	Minor adverse
Bottlenose dolphin, common dolphin and white-beaked dolphin (Based on TTS / fleeing response)	Medium	Negligible	Minor adverse
Minke whale (Based on TTS / fleeing response)	Medium	Negligible	Minor adverse
Grey seal	Medium	Medium	Moderate adverse
Harbour seal	Medium	Negligible	Minor adverse
Reduction in foraging due to underwater noise disturbance			
Harbour porpoise	Medium	Low	Minor adverse
Bottlenose dolphin, common dolphin and white-beaked dolphin	Medium	Low	Minor adverse

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
Minke whale	Medium	Low	Minor adverse
Grey seal Harbour seal	Low	Low	Minor adverse
Potential for disturbance based on a dose-response curve for monopiles or jacket pin piles			
Harbour porpoise	Medium	Low	Minor adverse
Grey seal		Low to medium	Moderate to minor adverse
Harbour seal		Negligible	Minor adverse
Potential for disturbance from ADD activation prior to piling			
All marine mammals	Medium	Negligible	Minor adverse

11.6.1.2.7 Mitigation and Residual Significance of Effect – DBS East or DBS West in Isolation

350. Taking into account the mitigation to reduce the risk of PTS, the residual effect of the potential risk of disturbance to marine mammals as a result of underwater noise during piling would be **minor adverse (not significant in EIA terms)** for all species (**Table 11-48**), with the proposed mitigation (section 11.6.1.1.11).

11.6.1.2.8 Mitigation and residual significance of effect – DBS East and DBS West Together

351. Taking into account the mitigation to reduce the risk of PTS, the residual effect of the potential risk of disturbance to marine mammals as a result of underwater noise during piling would be **minor adverse (not significant in EIA terms)** for all species (**Table 11-49**), with the proposed mitigation (section 11.6.1.1.12).

11.6.1.3 Impact 3: TTS and Disturbance from Underwater Noise During Other Construction Activities

352. Potential sources of underwater noise during construction activities, other than piling, include seabed preparation, dredging, trenching, cable installation and rock placement.

353. The cable installation methods that are currently being considered are ploughing, jetting, trenching or cutting, also surface laid with cable protection where burial is not possible.

354. Dredging and cable installation activities have the potential to generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals.

355. There are no clear indications that underwater noise caused by the installation of sub-sea cables poses a high risk of harming marine mammals (Oslo and Paris Convention for the Protection of the Marine Environment (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).

356. 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 will influence the distance at which sounds can be detected.

357. 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), indicate 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 as a result of dredging activity is highly unlikely.

358. 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, which is highly unlikely (Todd *et al.* 2014).

359. 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). However, the results of tagging harbour seal in the Wash in 2012 (Russell 2016b), indicated foraging activity during wind farm construction activities at Sheringham Shoal.

360. If the response to underwater noise form other construction activities is displacement from the area, it is predicted that marine mammals will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance effects on marine mammals.

361. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources). Southall *et al.* (2007) presents a review of behavioural response studies in marine mammals, according to the behavioural severity scores. For continuous noise sources, the lowest SPL at which a score of five or more was recorded for whale species was 90dB to 100dB re 1 µPa (rms). However, this relates to a study involving migrating grey whales.

362. One study recorded a significant behavioural response on a single harbour seal at a received level of 100 to 110dB re 1 µPa (rms), although other studies found no response much higher received levels of up to 140dB re 1 µPa (rms).

363. The noise levels generated by the majority of the other construction activities are not significantly higher than the noise levels associated with vessels (e.g. cable laying, cable trenching and rock placement have source levels of up to 172dB re 1 µPa @ 1m (rms), compared to a source level of 168dB re 1 µPa@ 1m (rms) for a large vessel (**Appendix 11-2**).

11.6.1.3.1.1 Underwater Noise Modelling

364. To determine the potential risk for PTS and TTS from underwater noise during dredging, trenching, cable laying and rock placement, site specific underwater noise modelling was undertaken to estimate the noise levels likely to arise during noisy activities (**Appendix 11-2**) and determine the potential effects on marine mammals. Key information on the methodology of underwater noise modelling, and the full results of the assessments for marine mammals, is provided in **Appendix 11-3**.

11.6.1.3.2 Impact 3a: TTS from Underwater Noise During Other Construction Activities

365. The results of the underwater noise modelling (**Table 11-50**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours, to be exposed to noise levels that could induce PTS or TTS, with the exception of harbour porpoise. Predicted impact ranges for harbour porpoise for TTS were 0.99km for rock placement and 0.23km for dredging, based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum} (**Appendix 11-2**).

366. As a precautionary approach the potential impact area for all activities occurring at the same time has also been determined (**Table 11-50**).

Table 11-50: Predicted Impact Ranges (and Areas) For TTS From 24 Hour Cumulative Exposure During Other Construction Activities

Species	Criteria and threshold (Southall *et al.*.2019)	Cable laying	Dredging	Trenching	Rock placement	All activities
Harbour porpoise (VHF)	SEL_{cum} Weighted (153 dB re 1 μPa^2s) Non-impulsive	0.11km (0.04km^2)	0.23km (0.17km^2)	<0.1km (<0.03km^2)	0.99km (3.08km^2)	3.32km^2
Dolphin species (HF)	SEL_{cum} Weighted (178 dB re 1 μPa^2s) Non-impulsive	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	0.12km^2
Minke whale (LF)	SEL_{cum} Weighted (179 dB re 1 μPa^2s) Non-impulsive	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	0.12km^2
Grey and Harbour seal (PCW)	SEL_{cum} Weighted (181 dB re 1 μPa^2s) Non-impulsive	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	0.12km^2

11.6.1.3.2.1 Magnitude of Impact – DBS East or DBS West in Isolation

367. The number of marine mammals that could be impacted as a result of underwater noise during construction activities other than piling has been assessed based on the number of animals that could be present in each of the modelled impact ranges (**Table 11-50**).

368. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours for any potential risk of PTS (**Appendix 11-2**). Therefore, PTS as a result of construction activity, other than piling, is highly unlikely and has not been assessed further.

369. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours in a day. With the exception of harbour porpoise which would have to remain within 1km during rock placement for 24 hours or 230m or less during dredging for 24 hours to be at risk of TTS (**Table 11-50**).

370. The magnitude of the potential impact for any TTS as a result of non-piling construction activities, for each activity individually or all together, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact from DBS East or DBS West in Isolation (**Table 11-51**).

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

Table 11-51: Maximum Number of Individuals (and % Of Reference Population) That Could Be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for Each Individual Activity And For All Activities At The Same Time At DBS East or DBS West

Species	Potential Impact	Location	Maximum number of individuals (% of reference population) for TTS for each individual activity	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary impact)
Harbour porpoise	TTS from cumulative SEL for: Cable laying	DBS East or DBS West or the offshore ECC	0.036 (0.00001% of NS MU reference population)	Negligible	2.95 (0.0009% of NS MU reference population)	Negligible
	TTS from cumulative SEL for: Trenching	DBS East or DBS West or the offshore ECC	0.028 (0.000008% of NS MU reference population)	Negligible		
	TTS from cumulative SEL for: Rock placement	DBS East or DBS West or the offshore ECC	2.74 (0.00079% of NS MU reference population)	Negligible		
	TTS from cumulative SEL for: Dredging	DBS East or DBS West or the offshore ECC	0.15 (0.000043% of NS MU reference population)	Negligible		

Species	Potential Impact	Location	Maximum number of individuals (% of reference population) for TTS for each individual activity	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary impact)
Bottlenose dolphin	TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Drilling - Dredging	DBS East	0.000004 (0.0000002 % of GNS MU reference population)	Negligible	0.0002 (0.00001% of GNS MU reference population)	Negligible
		DBS West	0.000008 (0.0000003 % of GNS MU reference population)	Negligible		
		Offshore ECC	0.00004 (0.000002% of GNS MU reference population)	Negligible		
Common dolphin		DBS East	0.0012 (0.0000011% of CGNS MU reference population)	Negligible	0.0092 (0.000009% of CGNS MU reference population)	Negligible
		DBS West	0.0013 (0.0000013% of CGNS MU reference population)	Negligible		
		Offshore ECC	0.002 (0.000002% of CGNS MU reference population)	Negligible		

Species	Potential Impact	Location	Maximum number of individuals (% of reference population) for TTS for each individual activity	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary impact)
White-beaked dolphin		DBS East	0.00017 (0.0000004% of CGNS MU reference population)	Negligible	0.006 (0.000013% of CGNS MU reference population)	Negligible
		DBS West	0.00038 (0.0000009% of CGNS MU reference population)	Negligible		
		Offshore ECC	0.001 (0.000003% of CGNS MU reference population)	Negligible		
Minke whale	TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement	DBS East or DBS West or the offshore ECC	0.00031 (0.0000016% of CGNS MU reference population)	Negligible	0.0013 (0.0000062% of CGNS MU reference population)	Negligible
Grey seal		DBS East	0.0057 (0.000017% of SE England MU or 0.0000038% of wider ref pop)	Negligible (negligible)	0.067 (0.00019 % of SE England MU or 0.00011% of wider ref pop)	Negligible (negligible)

Species	Potential Impact	Location	Maximum number of individuals (% of reference population) for TTS for each individual activity	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary impact)
	- Drilling - Dredging	DBS West	0.0082 (0.000024% of SE England MU or 0.0000014% of wider reference population)	Negligible (negligible)		
		Offshore ECC	0.017 (0.00005% of SE England MU or 0.00003% of wider reference population)	Negligible (negligible)		
Harbour seal		DBS East	0.00005 (0.0000011% of SE England MU reference population)	Negligible	0.0002 (0.0000044% of SE England MU reference population)	Negligible
		DBS West	0.000031 (0.0000006% of SE England MU reference population)	Negligible		
		Offshore ECC	0.00005 (0.0000011% of SE England MU reference population)	Negligible		

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.3.3 Magnitude of Impact – DBS East and DBS West Together

372. As a worst-case, the maximum number of marine mammals from each Project has been assessed to indicate the maximum number of marine mammals that could be impacted from the Projects together, if they are developed concurrently (**Table 11-52**). The magnitude of the potential impact for TTS during construction activities other than piling at DBS East and DBS West together is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-52**).

373. The noise level generated by the construction activities are barely audible above the predicted vessel noise (section 11.6.1.4). The underwater noise impacts from non-piling noise will be significantly less than that of impact piling and will be localised and short term. Any potential disturbance would be temporary and therefore unlikely to significantly affect marine mammal populations.

Table 11-52: Maximum Number of Individuals (And % Of Reference Population) That Could Be Impacted as A Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for All Activities at The Same Time at The Projects

Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary impact)
Harbour porpoise	DBS East & West including Offshore ECC	5.90 (0.0018 % of NS MU)	Negligible
Bottlenose dolphin	DBS East & West including Offshore ECC	0.0004 (0.000018% of GNS MU)	Negligible
Common dolphin	DBS East & West including Offshore ECC	0.018 (0.00002% of CGNS MU)	Negligible
White-beaked dolphin	DBS East & West including Offshore ECC	0.012 (0.000026% of CGNS MU)	Negligible
Minke whale	DBS East & West including Offshore ECC	0.0026 (0.000012% of CGNS MU)	Negligible
Grey seal	DBS East & West including Offshore ECC	0.13 (0.00038% of SE England MU or 0.0002% of wider ref pop)	Negligible (negligible)
Harbour seal	DBS East & West including Offshore ECC	0.0004 (0.0000088% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for seal species*

11.6.1.3.4 Impact 3b: Disturbance from Underwater Noise During Other Construction Activities

374. If the response is displacement from the area, it is predicted that marine mammals will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance impact on marine mammals.

375. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources).

376. Southall *et al.* (2007) presents a review of behavioural response studies in marine mammals, according to the behavioural severity scores. For continuous noise sources, the lowest SPL at which a score of five or more was recorded for whale species was 90dB to 100dB re 1 µPa (rms). However, this relates to a study involving migrating grey whales.

377. 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 with much higher received levels of up to 140dB re 1 µPa (rms).

378. The noise levels generated by the majority of the other construction activities are not significantly higher than the noise levels associated with vessels (e.g. cable laying, cable trenching and rock placement have source levels of <172dB re 1 µPa @ 1m (rms), compared to a source level of 168dB re 1 µPa@ 1m (rms) for a large vessel (**Appendix 11-2**)).

379. In 2012, 25 harbour seal from The Wash were tagged, as well as a further 10 from the Thames (Russell 2016b). Of those, 24 of the tags were in place for sufficient time to determine key foraging areas of harbour seal in the southern North Sea. The results of this study show foraging activity of harbour seal off the coast off Norfolk (**Plate 11-4**: Russell 2016b). The results of this tagging study show foraging activity (in red) within Sheringham Shoal OWF[4] which was undergoing construction, with turbine installation undertaken from 2011 to 2012, and cabling works from 2010 to 2012. This indicates that harbour seal will still undertake foraging activity during wind farm construction activities.

[4] Note that although seals are shown foraging further offshore, all of the OWFs beside Sheringham Shoal were only in planning or pre-construction at the time.

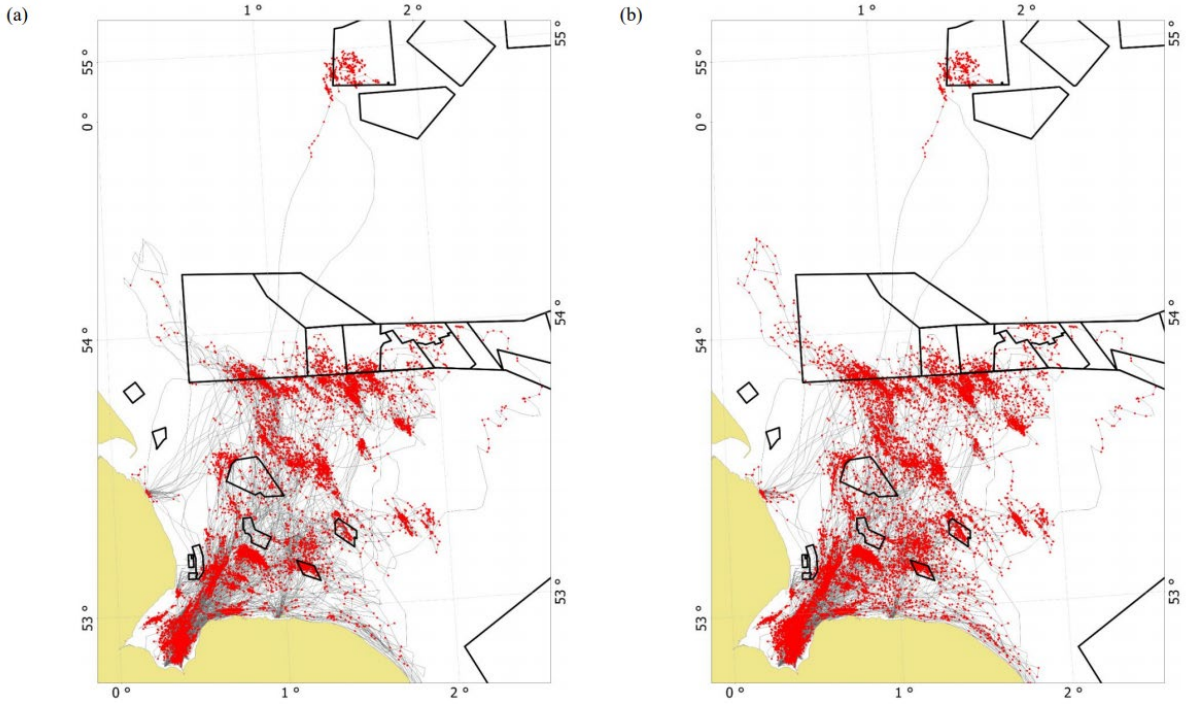

Plate 11-4 The Tracks (Grey) and Estimated Foraging Locations (Red) of Tagged Harbour Seals in Geo- (a) And Hydro- (b) Space (Russell 2016b).

380. Studies undertaken during the construction of two Scottish Wind Farms (Beatrice OWF and Moray East OWF) (Benhemma-Le Gall *et al.* 2021), found that the probability of harbour porpoise being present increased with distance from the vessels and construction activities, and decreased with increasing vessel presence and background noise. During the period of turbine installation at Beatrice OWF, a significant reduction in harbour porpoise presence was detected even while no piling was taking place. Various construction activities were undertaken during this turbine installation phase, including jacket installation, turbine and cable installations, with some activities occurring simultaneously, which led to high levels of vessel traffic within the OWF site.

381. A reduction in porpoise presence was detected at up to 4km from construction related vessels (**Plate 11-5**; Benhemma-Le Gall *et al.* 2021). With construction vessels at 2km from CPOD locations, harbour porpoise activity decreased by up to 35.2%, with construction vessels at 3km from the CPODs, there was a decrease of up to 24%, and at 4km from construction vessels, there was an increase of 7.2%. Outside of the piling period, the study found that the presence of harbour porpoise decreased by 17% with SPLs of 57dB (above ambient noise). It was not possible to determine what activities were being undertaken by the construction vessels in order to determine what activity was causing this effect (Benhemma-Le Gall *et al.* 2021).

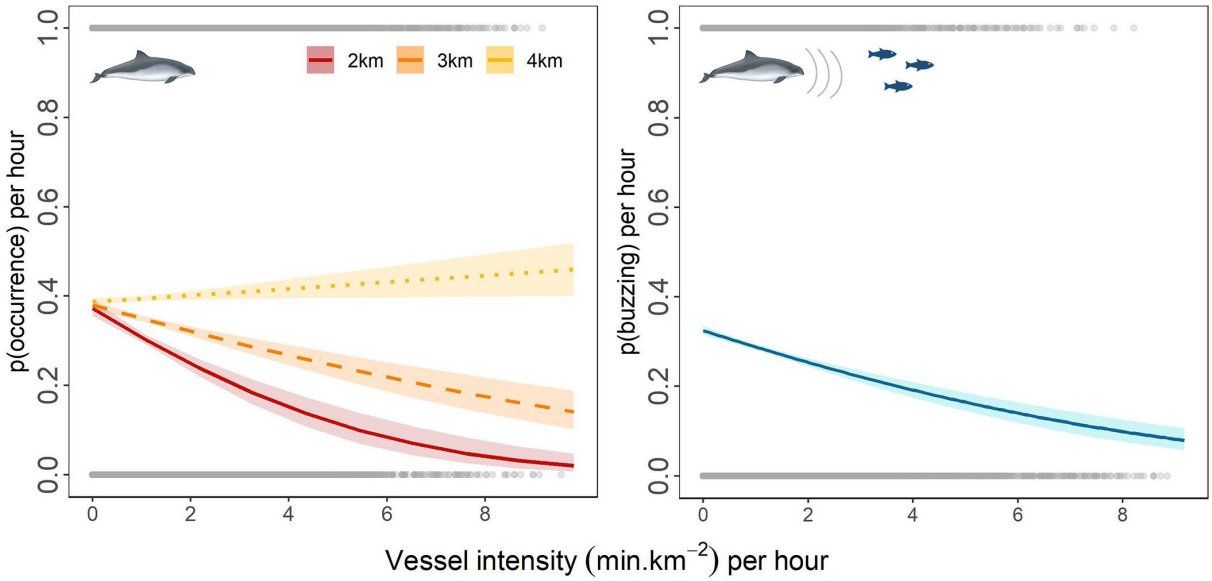

Plate 11-5 [Left] The Probability Of Harbour Porpoise Presence in Relation to Vessel Activity (Red = mean vessel distance of 2km, Orange = mean vessel distance of 3km, Yellow = mean vessel distance of 4km, and [Right] The Probability of Buzzing Activity Per Hour in Relation to Vessel Activity (Benhemma-Le Gall et al..2021)

382. While the study did not define which activities were taking place to cause the disturbance, it was while a number of construction vessels were on site (Benhemma-Le Gall *et al.* 2021). Therefore, this reported 4km reduction in harbour porpoise presence has been used as a potential disturbance range for other construction activities in this assessment.

383. As harbour porpoise are the most sensitive marine mammal species, this 4km potential disturbance range has been used for all species assessed, due to the absence of any other data to inform an assessment. All related construction activities are considered to be a moving source, and therefore once the activity / vessel moves past a certain area, the marine mammals would return to baseline numbers.

11.6.1.3.5 Magnitude of Impact – DBS East or DBS West in Isolation

384. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range (with an effect area of 50.27km^2) is presented in **Table 11-53.** This is a precautionary approach as it is unlikely that all marine mammal species would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place in the offshore project area. The magnitude of the potential impact is assessed as negligible for all species (**Table 11-53**).

Table 11-53 Assessment of The Potential for Disturbance Due to Other Construction Activities, for One and Multiple Activity Taking Place at Any One Time Either DSB East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for disturbance for each individual activity (50.27km²)	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for disturbance for multiple construction activity (201.06km²)	Magnitude* (temporary impact)
Harbour porpoise	DBS East or DBS West or the Offshore ECC	44.64 (0.013% of the NS MU reference population)	Negligible	178.56 (0.052% of NS MU reference population)	Negligible
Bottlenose dolphin	DBS East	0.007 (0.0003% of GNS MU reference population)	Negligible	0.32 (0.016% of GNS MU reference population) based on the worst case density within the DBS Offshore Development Area.	Negligible
	DBS West	0.013 (0.0006% of GNS MU reference population)	Negligible		
	Offshore ECC	0.06 (0.003% of GNS MU reference population)	Negligible		
Common dolphin	DBS East	1.86 (0.002% of CGNS MU reference population)	Negligible	14.68 (0.014% of CGNS MU reference population) based on the worst case density within the DBS Offshore Development Area.	Negligible
	DBS West	2.06 (0.002% of CGNS MU reference population)	Negligible		
	Offshore ECC	3.67 (0.004% of CGNS MU reference population)	Negligible		

Species	Location	Maximum number of individuals (% of reference population) for disturbance for each individual activity (50.27km²)	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for disturbance for multiple construction activity (201.06km²)	Magnitude* (temporary impact)
White-beaked dolphin	DBS East	0.28 (0.00063% of CGNS MU reference population)	Negligible	9.25 (0.021% of CGNS MU reference population) based on the worst case density within the DBS Offshore Development Area.	Negligible
	DBS West	0.60 (0.0014% of CGNS MU reference population)	Negligible		
	Offshore ECC	2.31 (0.0053% of CGNS MU reference population)	Negligible		
Minke whale	DBS East or DBS West or the offshore ECC	0.50 (0.0025% of CGNS MU reference population)	Negligible	2.01 (0.01% of CGNS MU reference population)	Negligible
Grey seal	DBS East	9.10 (0.03% of SE England MU or 0.015% of wider ref pop)	Negligible (negligible)	106.76 (0.31% of SE England MU or 0.18% of wider ref pop) based on the worst case density within the DBS Offshore Development Area.	Negligible (negligible)
	DBS West	13.07 (0.04% of SE England MU or 0.022% of wider ref pop)			

Species	Location	Maximum number of individuals (% of reference population) for disturbance for each individual activity (50.27km²)	Magnitude* (temporary impact)	Maximum number of individuals (% of reference population) for disturbance for multiple construction activity (201.06km²)	Magnitude* (temporary impact)
	Offshore ECC	26.7 (0.077% of SE England MU or 0.044% of wider ref pop)			
Harbour seal	DBS East	0.085 (0.0018% of SE England MU reference population)	Negligible	0.34 (0.007% of SE England MU reference population) based on the worst case density within the DBS Offshore Development Area.	Negligible
	DBS West	0.05 (0.001% of SE England MU reference population)	Negligible		
	Offshore ECC	0.075 (0.0016% of SE England MU reference population)	Negligible		

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for seal species*

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

386. The duration for the offshore construction period, including piling and export cable installation, is approximately five years for each Project. However, construction activities would not be underway constantly throughout this period. Further details on the construction schedule is provided in **Chapter 5 Project Description**.

11.6.1.3.6 Magnitude of Impact – DBS East and DBS West Together

387. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range at DBS East and DBS West Together for up to eight vessels (with an effect area of 402.12km^2) is presented in **Table 11-54**. This is a precautionary approach as it is unlikely that all marine mammal species would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place in the offshore project area. The assessment has been undertaken on the worst case density within the DBS Offshore Development Area for each species.

388. The magnitude of the potential impact is assessed as negligible for all species (**Table 11-54**).

Table 11-54 Assessment of The Potential for Disturbance Due to Other Construction Activities Taking Place at Any One Time at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for disturbance for all activities at the same time	Magnitude* (temporary impact)
Harbour porpoise	357.09 (0.103% of NS MU reference population)	Negligible
Bottlenose dolphin	0.64 (0.032% of GNS MU reference population) based on the worst case density within the DBS Offshore Development Area.	Negligible
Common dolphin	29.36 (0.029% of CGNS MU reference population)	Negligible
White-beaked dolphin	18.5 (0.042% of CGNS MU reference population)	Negligible
Minke whale	4.02 (0.02% of CGNS MU reference population)	Negligible
Grey seal	213.53 (0.62% of SE England MU or 0.35% of wider reference population)	Negligible (negligible)
Harbour seal	0.68 (0.014% of SE England MU reference population)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for seal species*

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

390. With both DBS East and DBS West being developed together there is the potential for construction in more than one area at any given time, but the disturbance effects are expected to remain limited. The duration for the offshore construction period, including piling and export cable installation, is approximately five years for the Projects being constructed concurrently and seven years when constructed sequentially. However, construction activities would not be underway constantly throughout this period.

11.6.1.3.7 Sensitivity of Receptor

391. The sensitivity of marine mammals to temporary changes in hearing sensitivity (TTS) and disturbance as a result of underwater noise during construction activities other than piling and vessels, is considered to be medium in this assessment, as a precautionary approach. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

11.6.1.3.8 Significance of Effect – DBS East or DBS West in Isolation

392. Taking into account the marine mammal sensitivity to TTS and disturbance (**Table 11-50** and **Table 11-54** respectively) and the potential magnitude of the impact, as assessed in **Table 11-55**, the significance of effect for construction activities other than piling at either DBS East or DBS West has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-55**).

393. The underwater noise impacts from non-piling noise will be significantly less than that of impact piling and will be localised and short term. Any potential disturbance would be temporary and therefore unlikely to significantly affect marine mammal populations.

Table 11-55 Assessment of Significance of Effect for the Potential for Underwater Effects Due to Other Construction Activities at DBS East or DBS West in Isolation

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to other construction activities			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to other construction activities			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse

11.6.1.3.9 Significance of Effect – DBS East and DBS West Together

394. As a worst-case, the maximum number of marine mammals from each Project has been assessed to indicate the maximum number of marine mammals that could be impacted from DBS East and DBS West together, if they are developed concurrently (**Table 11-54**). The significance of effect for construction activities other than piling at DBS East and DBS West together has been assessed as **minor adverse (not significant in EIA terms)** for all species (**Table 11-56**).

395. The noise level generated by the construction activities are barely audible above the predicted vessel noise (section 11.6.1.4 and **Appendix 11-2**). The underwater noise impacts from non-piling noise will be significantly less than that of impact piling and will be localised and short term. Any potential disturbance would be temporary and therefore unlikely to significantly affect marine mammal populations.

Table 11-56 Assessment of Significance of Effect for the Potential for Underwater Effects Due to Other Construction Activities at DBS East or DBS West in Isolation

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to other construction activities			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to other construction activities			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse

11.6.1.3.10 Mitigation and Residual Significance of Effect

396. No mitigation is proposed for underwater noise for construction activities, other than piling, Therefore, the residual significance of effect for TTS or disturbance from underwater noise during construction activities other than piling at the Project would be **minor adverse (not significant in EIA terms)** for all species.

11.6.1.4 Impact 4 TTS and Disturbance from Underwater Noise due to the Presence of Vessels

397. Vessels onsite will generally be associated with piling and other construction activities during the construction period as assessed in section 11.6.1.3. However, as a precautionary approach and to take into account vessels that could be in the windfarm site when these activities are not being conducted, the potential for TTS and disturbance from underwater noise and presence of vessels has also been assessed separately.

398. During the construction phase there will be an increase in the number of vessels in the windfarm sites. The maximum number of vessels that could be within the array sites at any one time has been estimated as up to 66 vessels for each array area (**Table 11-2**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

399. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore any increase in disturbance as a result of underwater noise from vessels during construction will be predominantly within the windfarm site. As outlined in **Chapter 14 Shipping and Navigation**, between a total of 5,745 transits to port per year for each array area in isolation.

400. The vessels in the windfarm site will be slow moving (or stationary), and most noise emitted is likely to be of a lower frequency. Noise levels reported by Malme *et al.* (1989) and Richardson *et al.* (1995) for transiting large surface vessels indicate that physiological damage to auditory sensitive marine mammals is unlikely. The potential risk of permanent auditory injury (PTS) in marine mammals as a result of vessel noise is highly unlikely, as the sound levels are well below the threshold for PTS (Southall *et al.* 2019).

401. A study of the noise source levels from several different vessels (Jones *et al.* 2017) indicates that for a cargo vessel of 126m in length (on average), travelling at a speed of 11 knots (on average) would generate a mean sound level of 160dB re 1 µPa @ 1m (with a maximum sound level recorded of 187dB re 1 µPa @ 1m). The 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.

402. Thomsen *et al.* (2006) reviewed the effects of ship noise on harbour porpoise and seal species. The review concluded that ship noise around 0.25kHz could be detected at distances of 1km and ship noise around 2kHz could be detected at around 3km.

11.6.1.4.1.1 Underwater Noise Modelling

403. To determine the potential risk for PTS and TTS from underwater noise of vessels underwater noise modelling was undertaken (see **Appendix 11-2**) and determine the potential effects on marine mammals. Information on the methodology of underwater noise modelling, and the full results of the assessments for marine mammals, is provided in **Appendix 11-3**.

404. Underwater noise modelling was undertaken for medium and large vessels. Medium vessels are less than 100m in length, while large vessels are over 100m.

11.6.1.4.2 Impact 4a TTS from Underwater Noise and Presence of Vessels

405. Impact ranges for PTS and TTS for large and medium vessels for all species are less than 100m (see **Appendix 11-2**). Results and assessments are based on risk of TTS.

406. The results of the underwater noise modelling (**Table 11-57**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours, to be exposed to noise levels that could induce TTS.

407. As a precautionary approach the potential impact area for all vessels on site at the same time has also been determined (**Table 11-57**).

Table 11-57 Predicted Impact Ranges (and Areas) For TTS From 24 Hour Cumulative Exposure for Construction Vessels

Species	Criteria and threshold (Southall *et al.*.2019)	Large vessel	Medium vessels	Up to 66 vessels
Harbour porpoise (VHF)	SEL_{cum} Weighted (153 dB re 1 µPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)	2.07km²
Dolphin species	SEL_{cum} Weighted (178 dB re 1 µPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)	2.07km²
Minke whale (LF)	SEL_{cum} Weighted (179 dB re 1 µPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)	2.07km²
Grey and Harbour seal (PCW)	SEL_{cum} Weighted (181 dB re 1 µPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)	2.07km²

11.6.1.4.3 Magnitude of Impact – DBS East or DBS West in Isolation

408. 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 11-58**).

409. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours for any potential risk of PTS (see **Appendix 11-2**). Therefore, PTS as a result of construction vessels is highly unlikely and has not been assessed further.

410. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours in a day (**Table 11-58**). Although TTS as a result of construction vessels is highly unlikely, it has been assessed as precautionary approach.

411. The magnitude of the potential impact for any TTS as a result of construction vessels, for one vessel or for up to 66 vessels in the array area, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-58**).

412. The potential effect of TTS (without any mitigation) that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Project and would be limited to only part of the overall construction period and area at any one time.

Table 11-58 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 DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude* (temporary effect)
Harbour porpoise	DBS East, DBS West, Offshore ECC and Offshore Development Area	0.028 (0.000008% of NS MU reference population)	1.84 (0.000531% of NS MU reference population)	Negligible
Bottlenose dolphin	DBS East	0.000004 (0.0000002% of GNS MU reference population)	0.0003 (0.000014% of GNS MU reference population)	Negligible
	DBS West	0.000008 (0.0000004% of GNS MU reference population)	0.0005 (0.000026% of GNS MU reference population)	
	Offshore ECC	0.00004 (0.000002% of GNS MU reference population)	0.003 (0.00013% of GNS MU reference population)	
	Offshore Development Area	0.00004 (0.000002% of GNS MU reference population)	0.003 (0.00014% of GNS MU reference population)	
Common dolphin	DBS East	0.0012 (0.000001% of CGNS MU reference population)	0.08 (0.000074% of CGNS MU reference population)	Negligible
	DBS West	0.0013 (0.000001% of CGNS MU reference population)	0.09 (0.000082% of CGNS MU reference population)	
	Offshore ECC	0.0023 (0.000002% of CGNS MU reference population)	0.15 (0.00014% of CGNS MU reference population)	
	Offshore Development Area	0.0012 (0.000001% of CGNS MU reference population)	0.08 (0.000076% of CGNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude* (temporary effect)
White-beaked dolphin	DBS East	0.0002 (0.0000003% of CGNS MU reference population)	0.01 (0.000025% of CGNS MU reference population)	Negligible
	DBS West	0.0003 (0.0000007% of CGNS MU reference population)	0.02 (0.000051% of CGNS MU reference population)	
	Offshore ECC	0.0014 (0.000003% of CGNS MU reference population)	0.09 (0.00021% of CGNS MU reference population)	
	Offshore Development Area	0.0005 (0.000001% of CGNS MU reference population)	0.03 (0.000080% of CGNS MU reference population)	
Minke whale	DBS East, DBS West, Offshore ECC and Offshore Development Area	0.0003 (0.0000016% of CGNS MU reference population)	0.02 (0.00010% of CGNS MU reference population)	Negligible
Grey seal	DBS East	0.0057 (0.000017% of SE England MU or 0.000009% of Wider MU reference population)	0.37 (0.0010% of SE England MU or 0.0006% of Wider MU reference population)	Negligible (negligible)
	DBS West	0.0082 (0.000024% of SE England MU or 0.000014% of Wider MU reference population)	0.53 (0.0015% of SE England MU or 0.0008% of Wider MU reference population)	
	Offshore ECC	0.0167 (0.000048% of SE England MU or 0.000028% of Wider MU reference population)	1.10 (0.0031% of SE England MU or 0.0018% of Wider MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude* (temporary effect)
	Offshore Development Area	0.0121 (0.000035% of SE England MU or 0.000020% of Wider MU reference population)	0.80 (0.0023% of SE England MU or 0.001% of Wider MU reference population)	
Harbour seal	DBS East	0.00005 (0.0000011% of SE England MU reference population)	0.0035 (0.000072% of SE England MU reference population)	Negligible
	DBS West	0.00003 (0.0000006% of SE England MU reference population)	0.0020 (0.000042% of SE England MU reference population)	
	Offshore ECC	0.00005 (0.0000011% of SE England MU reference population)	0.0035(0.000072% of SE England MU reference population)	
	Offshore Development Area	0.00005 (0.0000010% of SE England MU reference population)	0.0031(0.000064% of SE England MU reference population)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for seal species*

11.6.1.4.4 Magnitude of Impact – DBS East and DBS West Together

413. 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 applied to the number of vessels that could be on site at any one time (**Table 11-59**).

414. The magnitude of the potential impact for any TTS as a result of construction vessels, for up to 132 vessels in the Offshore Development Area, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-59**).

415. The potential for TTS effects that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Projects of five to seven years and would be limited to only part of the overall construction period.

Table 11-59 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 DBS East or DBS West Together

Species	Location	Maximum number of individuals (% of reference population) for up to 132 vessels	Magnitude* (temporary effect)
Harbour porpoise	DBS East, DBS West, Offshore ECC and Offshore Development Area	3.7 (0.00106% of NS MU reference population)	Negligible
Bottlenose dolphin	DBS East	0.0006 (0.000029% of GNS MU reference population)	Negligible
	DBS West	0.001 (0.00005% of GNS MU reference population)	
	Offshore ECC	0.005 (0.00026% of GNS MU reference population)	
	Offshore Development Area	0.005 (0.00028% of GNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for up to 132 vessels	Magnitude* (temporary effect)
Common dolphin	DBS East	0.15 (0.00014% of CGNS MU reference population)	Negligible
	DBS West	0.17 (0.00016% of CGNS MU reference population)	
	Offshore ECC	0.30 (0.00029% of CGNS MU reference population)	
	Offshore Development Area	0.15 (0.00015% of CGNS MU reference population)	
White-beaked dolphin	DBS East	0.02 (0.000051% of CGNS MU reference population)	Negligible
	DBS West	0.04 (0.00010% of CGNS MU reference population)	
	Offshore ECC	0.19 (0.00043% of CGNS MU reference population)	
	Offshore Development Area	0.07 (0.00016% of CGNS MU reference population)	
Minke whale	DBS East, DBS West, Offshore ECC and Offshore Development Area	0.04 (0.0002% of CGNS MU reference population)	Negligible
Grey seal	DBS East	0.75 (0.002% of SE England MU or 0.001% of Wider MU reference population)	Negligible (negligible)
	DBS West	1.08 (0.003% of SE England MU or 0.001% of Wider MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for up to 132 vessels	Magnitude* (temporary effect)
	Offshore ECC	2.20 (0.006% of SE England MU or 0.003% of Wider MU reference population)	
	Offshore Development Area	1.60 (0.0046% of SE England MU or 0.002% of Wider MU reference population)	
Harbour seal	DBS East	0.007 (0.00014% of SE England MU reference population)	Negligible
	DBS West	0.004 (0.000085% of SE England MU reference population)	
	Offshore ECC	0.007 (0.00014% of SE England MU reference population)	
	Offshore Development Area	0.006 (0.00012% of SE England MU reference population)	

**The Wider MU for grey seal is combined MUs from the SE and NE MU*

11.6.1.4.5 Impact 4b Disturbance from Underwater Noise and Presence of Vessels

416. There is limited data on the potential for a behavioural response or disturbance from vessel noise. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

417. Construction vessel activity may generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals. Whilst the main focus of concern remains on the loudest noise sources such as impact piling, dredging etc., intense vessel activity during construction may also alter the acoustic habitat and disturb marine mammal species (Merchant *et al.* 2014).

11.6.1.4.6 Magnitude of Impact – DBS East or DBS West in Isolation

418. As outlined previously, Brandt *et al.* (2018) found that at seven German OWFs in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice OWF, indicate higher vessel activity within 1km was associated with an increased probability of response in harbour porpoise (Graham *et al.* 2019).

419. Studies in the Moray Firth indicate that at a mean distance of 2km from construction vessels harbour porpoise occurrence decreased by up to 35.2% as vessel intensity increased. Harbour porpoise responses decreased with increasing distance to vessels, out to 4km where no response was observed (Benhemma-Le Gall *et al.* 2021).

420. During the periods when piling and other construction activities are underway, vessel noise is unlikely to add an additional impact, as the vessels and vessel noise would be within the maximum impact areas assessed.

421. The distance at which animals may react to vessels is difficult to predict and behavioural responses can vary a great deal depending on species, location, type and size of vessel, vessel speed, noise levels and frequency, ambient noise levels and environmental conditions.

422. Vessel type and speed rather than presence seemed to be the relevant factors for the reactions of harbour porpoise to vessel traffic in the coastal waters of South-West Wales (Oakley *et al.* 2017). There was a significant correlation between numbers of vessels and number of harbour porpoise sightings. During 729 hours of survey effort (268 total surveys), there were 39 occasions when porpoise exhibited neutral or negative behaviour to vessels. With 75% of all negative reactions in response to high-speed planing-hulled vessels (Oakley *et al.*.2017).

423. Modelling by Heinänen and Skov (2015) indicates that the number of ships represents a relatively important factor determining the density of harbour porpoise North Sea MU during both seasons, with markedly lower densities with increasing levels of traffic. A threshold level in terms of impact seems to be approximately 20,000 ships per year (approximately 80 vessels per day within a 5km^2 area). This equates to 50 vessels per day in 25km^2 (approximately two vessels per km^2).

424. Taking into account the maximum number of up to 66 vessels that could be in the windfarm site during construction, the number of vessels would not exceed the Heinänen and Skov (2015) threshold. For example, 66 vessels within the windfarm site area of 496km^2 (using DBS West array area for worse case) would equate to less than 0.13 vessels per km^2.

425. As a precautionary approach, based on the studies by Brandt *et al.* (2018) and Benhemma-Le Gall *et al.* (2021) that harbour porpoise could be disturbed up to 2km from construction vessels, assessments for all species has been based on a disturbance impact range of 2km

426. The magnitude of the potential impact is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal for up to 66 vessels in the windfarm array area. The potential effect is assessed as negligible to low for grey seal (**Table 11-60**).

Table 11-60 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude (temporary effect)
Harbour porpoise	DBS East, DBS West, Offshore ECC and Offshore Development Area	11.2 (0.003% of NS MU reference population)	Negligible	736.7 (0.212% of NS MU reference population)	Negligible
Bottlenose dolphin	DBS East	0.002 (0.0001% of GNS MU reference population)	Negligible	0.12 (0.0057% of GNS MU reference population)	Negligible
	DBS West	0.003 (0.0002% of GNS MU reference population)		0.21 (0.01% of GNS MU reference population)	
	Offshore ECC	0.16 (0.0008% of GNS MU reference population)		1.08 (0.053% of GNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude (temporary effect)
	Offshore Development Area	0.18 (0.0009% of GNS MU reference population)		1.3 (0.065% of GNS MU reference population)	
Common dolphin	DBS East	0.5 (0.0005% of CGNS MU reference population)	Negligible	30.7 (0.03% of CGNS MU reference population)	Negligible
	DBS West	0.5 (0.0005% of CGNS MU reference population)		34.0 (0.033% of CGNS MU reference population)	
	Offshore ECC	1.0 (0.009% of CGNS MU reference population)		60.6 (0.059% of CGNS MU reference population)	
	Offshore Development Area	0.5 (0.0005% of CGNS MU reference population)		31.5 (0.031% of CGNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude (temporary effect)
White-beaked dolphin	DBS East	0.07 (0.0002% of CGNS MU reference population)	Negligible	4.6 (0.01% of CGNS MU reference population)	Negligible
	DBS West	0.1 (0.0003% of CGNS MU reference population)		9.1 (0.021% of CGNS MU reference population)	
	Offshore ECC	0.6 (0.0013% of CGNS MU reference population)		38.2 (0.087% of CGNS MU reference population)	
	Offshore Development Area	0.2 (0.0005% of CGNS MU reference population)		14.1 (0.032% of CGNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude (temporary effect)
Minke whale	DBS East, DBS West, Offshore ECC and Offshore Development Area	0.13 (0.0006% of CGNS MU reference population)	Negligible	8.3 (0.041% of CGNS MU reference population)	Negligible
Grey seal	DBS East	2.3 (0.006% of SE England MU or 0.003% of the wider MU reference population)	Negligible (negligible)	150.2 (0.44% of SE MU or 0.25% of the wider MU reference population)	Negligible - Low (negligible)
	DBS West	3.3 (0.009% of SE England MU or 0.005% of the wider MU reference population)		215.7 (0.63% of SE England MU or 0.036% of the wider MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude (temporary effect)
	Offshore ECC	6.7 (0.019% of SE England MU or 0.011% of the wider MU reference population)		440.5 (1.28% of SE England MU or 0.73% of the wider MU reference population)	
	Offshore Development Area	4.9 (0.014% of SE England MU or 0.008% of the wider MU reference population)		320.2 (0.93% of SE England MU or 0.53% of the wider MU reference population)	
Harbour seal	DBS East	0.02(0.0004% of SE England MU reference population)	Negligible	1.4 (0.029% of SE England MU reference population)	Negligible

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude (temporary effect)	Maximum number of individuals (% of reference population) for up to 66 vessels	Magnitude (temporary effect)
	DBS West	0.01(0.0003% of SE England MU reference population)		0.8 (0.017% of SE England MU reference population)	
	Offshore ECC	0.02 (0.0004% of SE England MU reference population)		1.4 (0.029% of SE England MU reference population)	
	Offshore Development Area	0.02 (0.0004% of SE England MU reference population)		1.2 (0.026% of SE England MU reference population)	

**The Wider MU for grey seal is combined MUs from the SE and NE MU*

11.6.1.4.7 Magnitude of Impact – DBS East and DBS West Together

427. The maximum number of construction vessels on site at any one time will be up to 132 vessels. This would not exceed the Heinänen and Skov (2015) threshold. For example, 132 vessels within the windfarm site area of 989km^2 would equate to less than 0.13 vessels per km^2. As a precautionary approach, based on the studies by Brandt *et al.* (2018) and Benhemma-Le Gall *et al.* (2021) that harbour porpoise could be disturbed up to 2km from construction vessels, assessments for all species has been based on a disturbance impact range of 2km (**Table 11-61**).

428. The magnitude of the potential impact is assessed as negligible for all species for up to 132 vessels in both array areas, with the exception of grey seal from the SE England MU which could have a negligible to low magnitude for up to 132 vessels in the array areas (**Table 11-61**).

429. The disturbance area of up to 1,659.24km^2 for 132 vessels, is an unrealistic worst-case as it does not take into account the overlap in the 2km disturbance range between the vessels (**Table 11-61).**

Table 11-61 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East and DBS West Together

Species	Location	Maximum number of individuals (% of reference population) for up to 132 vessels	Magnitude (temporary effect)
Harbour porpoise	DBS East, DBS West, Offshore ECC and Offshore Development Area	1473.4 (0.425% of NS MU reference population)	Negligible
Bottlenose dolphin	DBS East	0.23 (0.011% of GNS MU reference population)	Negligible
	DBS West	0.42 (0.020% of GNS MU reference population)	
	Offshore ECC	2.2 (0.106% of GNS MU reference population)	
	Offshore Development Area	2.3 (0.11% of GNS MU reference population)	
Common dolphin	DBS East	61.4 (0.059% of CGNS MU reference population)	Negligible
	DBS West	68.0 (0.066% of CGNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for up to 132 vessels	Magnitude (temporary effect)
	Offshore ECC	121.1 (0.118% of CGNS MU reference population)	
	Offshore Development Area	63.1 (0.061% of CGNS MU reference population)	
White-beaked dolphin	DBS East	9.1 (0.020% of CGNS MU reference population)	Negligible
	DBS West	18.3 (0.041% of CGNS MU reference population)	
	Offshore ECC	76.3 (0.173% of CGNS MU reference population)	
	Offshore Development Area	28.2 (0.064% of CGNS MU reference population)	
Minke whale	DBS East, DBS West, Offshore ECC and Offshore Development Area	16.6 (0.082% of CGNS MU reference population)	Negligible
Grey seal	DBS East	300.3 (0.87% of SE England MU or 0.5% of the wider MU reference population)	Negligible - Low
	DBS West	431.4 (1.25% of SE England MU or 0.72% of the wider MU reference population)	
	Offshore ECC	881.1 (2.56% of SE England MU or 1.46% of the wider MU reference population)	
	Offshore Development Area	640.5 (1.86% of SE England MU or 1.06% of the wider MU reference population)	
Harbour seal	DBS East	2.8 (0.058% of SE England MU reference population)	Negligible
	DBS West	1.7 (0.034% of SE England MU reference population)	
	Offshore ECC	2.8 (0.058% of SE England MU reference population)	
	Offshore Development Area	2.5 (0.051% of SE England MU reference population)	

**The Wider MU for grey seal is combined MUs from the SE and NE MU*

11.6.1.4.8 Sensitivity of Receptor

430. The sensitivity of marine mammals to temporary changes in hearing sensitivity (TTS) and disturbance as a result of underwater noise from construction vessels, is considered to be medium in this assessment, as a precautionary approach. Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the noise had ceased or they had become habituated to the sound.

431. There is the potential for sensitive species with high metabolic requirements, such as the harbour porpoise, to be more vulnerable to anthropogenic stressors such as vessel noise, forcing individuals to make trade-off decisions between using energy to leave the area or remaining in exposed areas (Benhemma-Le Gall *et al.* 2021). This additional energy use may have biological consequences in the short and long-term (Pirotta *et al.* 2014), and harbour porpoise have been shown to be displaced by vessel activity up to 7km away depending on vessel type (Wisniewska *et al.* 2018). In a 2012 study, high-speed planning vessels (small boats, jet skis etc.) caused the most negative reactions in this species (Oakley *et al.* 2017). Whilst short to medium term behavioural responses have been recorded from vessel disturbance, there are no long-term or population level effects recorded to date; therefore, harbour porpoise are deemed to have a medium sensitivity to disturbance from construction vessels.

432. Other cetacean species in the study area may also be disturbed by construction vessels, however, this is expected to a lesser degree than harbour porpoise. Minke whale have been shown to decrease foraging behaviour around wildlife tour boats, displaying horizontal avoidance behaviour and increased swimming speeds which may incur an energy cost (Machernis *et al.* 2018). The sensitivity of minke whale and dolphin species to disturbance as a result of underwater noise due to construction vessels is considered to be medium in this assessment as a precautionary approach.

433. Pinnipeds vary in their reaction to vessels depending on vessel type and proximity to haul out sites; however, disturbance (flushing behaviour) has been demonstrated at haul-out sites in the UK up to 200m away if there are pups present (Cates and Acevedo-Gutierrez 2017). The relationship between where grey seals forage and breed is not known. Such information enables the determination of where the effects of any given at-sea impact (during the foraging phase) may be reflected on hauled out or breeding population ashore. This is of particular relevance in monitoring the putative effects of at-sea disturbance on haul out sites (Russel and McConnell 2014). Land-based disturbance has been shown to cause higher levels of disturbance compared to marine sources, and smaller, quiet vessels like kayaks can cause the highest levels of flushing behaviour (Bonner 2021). In areas of high vessel traffic, there are habituation effects and disturbance behaviour is generally reduced (Strong *et al.* 2010). A 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% four hours after disturbance (Paterson *et al.* 2019). Seals are therefore considered to have a low sensitivity to disturbance from construction vessel traffic.

11.6.1.4.9 Significance of Effect – DBS East or DBS West in Isolation

434. Taking into account the marine mammal sensitivity to TTS and disturbance and the potential magnitude of the impact significance of effect for TTS and disturbance from underwater noise of construction vessels at the Projects has been assessed as **minor adverse (not significant in EIA terms)** for all species (**Table 11-62**).

435. If the response is displacement from the area, it is predicted that marine mammals will return once the activity has been completed and therefore any effects from underwater noise as a result of construction activities, other than piling, will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance for marine mammals.

Table 11-62 Assessment of Significance of Effect for the Potential for Disturbance Due to Construction Vessels at DBS East or DBS West in Isolation

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Significance of effect
TTS due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale	Medium	Negligible	Minor adverse
Grey seal	Low	Negligible - Low	Minor adverse
Harbour seal	Low	Negligible	Negligible

11.6.1.4.10 Significance of Effect – DBS East and DBS West Together

436. Taking into account the medium to low sensitivity to TTS and disturbance and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise of construction vessels at DBS East and DBS West together has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-63**).

Table 11-63 Assessment of Significance of Effect for the Potential for Disturbance Due To Construction Vessels at DBS East and DBS West Together

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Significance of effect
TTS due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale	Medium	Negligible	Minor adverse
Grey seal	Low	Negligible - Low	Minor adverse
Harbour seal	Low	Negligible	Negligible

11.6.1.4.11 Mitigation and Residual Significance of Effect

437. No mitigation is proposed for underwater noise from construction vessels, as the significance of effect is minor adverse which is not significant in EIA terms.

11.6.1.5 Impact 5 Barrier Effects as A Result of Underwater Noise During Construction

11.6.1.5.1 Magnitude of Impact – DBS East or DBS West in Isolation

438. 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.

439. DBS East is located approximately 122km from the nearest point on the coast, DBS West 100km. The windfarm sites are not located on any known migration routes for marine mammals.

440. The marine mammal species that could potentially be most affected by barrier effects from underwater noise are harbour porpoise accessing foraging areas, bottlenose dolphin, common dolphin and white-beaked dolphin, and minke whale if they are moving between areas, and grey and harbour seal as they move to and from haul-out sites.

441. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the 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 effects that could restrict harbour porpoise accessing foraging areas could have implications for individuals.

442. Based on assessment in **Table 11-2**, if DBS East or DBS West were constructed in isolation the maximum duration of piling, based on worst-case scenarios, including soft-start and ADD activation would be:

- Piling of up to 100 monopiles and six platforms (including soft-start, and ADD activation) = up to 706 hours and 40 minute (less than 30 days) with 80 minute ADD activation; and
- Piling of 400 jacket piles and six platforms (including soft-start, ramp-up and ADD activation) = up to 1,544 hours (65 days) with 71 minute ADD activation.

11.6.1.5.2 Magnitude of impact – DBS East and DBS West Together

443. If DBS East and DBS West were constructed concurrently, and assuming piling at the same time on each site the maximum duration of piling, based on worst-case scenarios, including soft-start, ramp-up and ADD activation would be:

- Piling of up to 200 monopiles and 11 platforms (including soft-start, ramp-up and ADD activation) = up to 1,406 hours (up to 59 days) with 80 minute activation; or
- Piling of 800 jacket pin piles and 11 platforms (including soft-start, ramp-up and ADD activation) = 3,061 hours (128 days) with 71 minute ADD activation.

11.6.1.5.3 Sensitivity of Receptor

444. The greatest potential barrier effect for marine mammals could be from underwater noise during piling. As outlined in section 11.6.1.2, piling would not be constant during the piling phases and construction periods. There will be gaps between the installations of individual piles, and if installed in groups there could be time periods when piling is not taking place as piles are brought out to the site. There will also be potential delays for weather or other technical issues.

445. The maximum duration of any barrier effects would be for the maximum piling duration at DBS East and DBS West, based on worst-case scenarios, including soft-start, ramp-up and ADD activation, as assessed in section 11.6.1.2.3. There is unlikely to be the potential for any barrier effects from underwater noise for other construction activities (section 11.6.1.3) and vessels (section 11.6.1.4), as it is predicted that marine mammals will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of marine mammals.

446. Marine mammals are wide ranging. For example, grey seals have been recorded to travel over 448km between haul-out sites (Carter *et al.* 2022) and with foraging trips lasting up to 30 days (SCOS 2020). Data from The Wash (from 2003- 2005) suggest that harbour seal in this area travel and forage between 75km and 120km offshore (Sharples *et al.et al.* 2008) and are predicted to have maximum foraging ranges of up to 273km (Carter *et al.* 2022). Therefore, if there are any potential barrier effects from underwater noise, marine mammals would be able to compensate by travelling to other foraging areas within their range.

447. The maximum area for any potential barrier effects due to underwater noise for the construction phase would be during impact piling. The maximum predicted impact range for TTS from cumulative exposure (SEL_{cum}) during installation of monopile with maximum hammer energy of 7,000kJ is up to 57km for harbour porpoise and 82km for minke whale, based on worst-case without any mitigation.

448. Therefore, is unlikely to be any significant long-term impacts from any barrier effects, as any areas affected would be relatively small in comparison to the range of marine mammals and would not be continuous throughout the offshore construction period. The magnitude of impact for any potential temporary barrier effects, based on worst case, is assessed as negligible for all species.

11.6.1.5.4 Significant of Effect DBS or DBS West Isolation

449. There is unlikely to be any significant long-term impacts from any barrier effects, as any areas affected would be relatively small in comparison to the range of marine mammals and would not be continuous throughout the offshore construction period. The magnitude of impact for any potential temporary barrier effects, based on worst-case, is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-64**).

450. Taking into account the marine mammal sensitivity and the potential magnitude of the impact, as assessed for DBS East and DBS West in isolation the significance of effect for any potential barrier effects as a result of underwater noise during concurrent construction at DBS East and DBS West has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-64**).

Table 11-64 Assessment of Significance of Effect for Any Potential Barrier Effects from Underwater Noise during Construction at DBS East or DBS West

Species	Sensitivity	Magnitude	Significance	Residual Impact
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse	Minor adverse

11.6.1.5.5 Significance of Effect – DBS East and DBS West Together

451. Taking into account the marine mammal sensitivity and the potential magnitude of the impact, as assessed for DBS East and DBS West in isolation the significance of effect for any potential barrier effects as a result of underwater noise during concurrent construction at DBS East and DBS West has been assessed as **minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-65**)

Table 11-65 Assessment of Significance of Effect for Any Potential Barrier Effects from Underwater Noise during Construction at DBS East and DBS West Together

Species	Sensitivity	Magnitude	Significance	Residual Impact
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse	Minor adverse

11.6.1.5.6 Mitigation and Residual Significance of Effects

452. No mitigation is proposed for barrier effects as a result of underwater noise. Therefore, the residual significance of effect for barrier effects as a result of underwater noise during construction activities at the Project would be **minor adverse (not significant in EIA terms)** for all species.

11.6.1.6 Impact 6 Increased Collision Risk with Vessels During Construction

11.6.1.6.1 Magnitude of Impact – DBS East or DBS West in Isolation

453. During the construction phase there will be an increase in the number of vessels in the array areas. The maximum number of vessels that could be at either of the array sites at any one time has been estimated as up to 66 vessels (**Table 11-2**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

454. Vessel movements to and from any port will be incorporated within existing vessel routes, where possible. The construction vessels in the windfarm site are likely to be stationary or slow moving, depending on the activity with which they are involved.

455. As outlined in **Chapter 14 Shipping and Navigation**, there could be up to 5,745 round trips to port per year for five years during the construction of both DBS East and DBS West array areas in isolation.

456. Marine mammals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al.* 2007). Therefore, increased vessel movements, especially those out with recognised vessel routes, can pose an increased risk of vessel collision to marine mammals.

457. Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80m in length causing the most damage to marine mammals (Laist *et al.* 2001). Vessels travelling at high speeds are considered to be more likely to collide with marine mammals, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al.* 2001).

458. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek .*et al.* 2001, Lusseau 2003, 2006).

459. In 2016, SMRU conducted a study to determine the likelihood of harbour seal injury occurring due to co-presence with large vessels within the Moray Firth (Onoufriou *et al.* 2016). This study used telemetry data of harbour seal within the Moray Firth, alongside vessel AIS data. The data indicated vessel and seal co-occurrence was high (defined as over 2,500 co-occurrence minutes per year) in very localised areas. However, there appeared to be no relationship between areas in high co-occurrence and incidences of injury (Onoufriou *et al.* 2016).

460. Harbour porpoise are small and highly mobile, and, given their responses to vessel noise (e.g. Thomsen *et al.* 2006; Polacheck and Thorpe 1990), are expected to largely avoid vessel collisions. As previously outlined, the Heinänen and Skov (2015) modelling indicates a negative relationship between the number of ships and the distribution of harbour porpoise in the Irish and Celtic Seas during summer, suggesting that the species could exhibit avoidance behaviour which reduces the risk of collision risk with vessels.

461. Approximately 4% of all harbour porpoise post-mortem examinations from the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS area) are thought to have evidence of interaction with vessels (Evans *et al.* 2011).

462. There is currently limited information on the collision risk of marine mammals in the North Sea.

463. Between 2005 and 2015, the UK Cetacean Strandings Investigation Programme (CSIP) conducted 849 post-mortem examinations of the 3,598 reported harbour porpoise strandings. A cause of death was established in 815 examined individuals, of these, 45 had died from physical trauma of unknown cause and 17 (2%) died as a result of physical trauma following probable impact from a ship or boat (CSIP 2011-2016; **Table 11-66**).

Table 11-66 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collision With a Vessel

Species	Number of strandings	Number of post-mortems where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from vessels	Collision risk rate (%) (number attributed to vessels strike / other physical trauma as proportion of total known cause of death)
Harbour porpoise	6599	1535	71	16	0.0567
Bottlenose dolphin	183	43	1	0	0.0233
Common dolphin	2043	533	27	13	0.0750
White-beaked dolphin	297	104	3	0	0.0288
Minke whale	373	93	2	3	0.0538
Grey seal	2987	577	22	4	0.0451
Harbour seal	624	185	5	0	0.0270

464. To estimate the potential collision risk of vessels associated with the Projects during construction, the potential risk rate per vessel has been calculated for all relevant species (**Table 11-66**), which is then used to calculate the risk to marine mammal species due to the increased number of vessel movements during construction.

465. The increased number of vessel movements has been based on the estimated 5,745 return vessel trips during the five year construction period for each array area, and 1,149 per year for either DBS East or DBS West in isolation.

466. The number of marine mammals at risk of collision, per vessel, in UK waters, has been estimated based on the total number of each marine mammal species in UK waters and the total number vessels present in UK waters, and the potential collision risk rate of each species based on the CSIP and Scottish Marine Animal Stranding Scheme data.

467. The total UK populations are taken from IAMMWG (2022) for all cetacean species, and the total UK populations for seal species are taken from SCOS (2021). The total presence of vessels in UK waters is taken from the total vessel transits within the 2015 AIS data[5], which is the latest publicly available.

468. The number of marine mammals (percentage of the relevant reference population) at risk of collision from the increased number of vessel movements during the construction period of the Projects has been used to determine the possible magnitude of the permanent effect (**Table 11-67**).

469. For and white-beaked dolphin and minke whale the magnitude of impact is negligible, for harbour porpoise, bottlenose dolphin, common dolphin and harbour seal the magnitude is low. For grey seal from the SE England MU (and the wider reference population) the magnitude is low (low).

470. This is a highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, that vessels within DBS East and DBS West would be stationary for much of the time or very slow moving. Taking into account the disturbance from vessels, the actual risk is likely to be very low to negligible for all species.

[5] https://www.data.gov.uk/dataset/963c1a7b-5b72-4cce-93f5-3f1e223fd575/anonymised-ais-derived-track-lines-2015

Table 11-67 Predicted Number of Marine Mammals at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (Magnitude of Impact Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West in Isolation

Marine mammal species	Collision risk rate[6]	Estimated total number of individuals in UK waters[7]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[8]	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	% reference population and Magnitude
Harbour porpoise	0.0567	200,714	11,376	38,52030	0.00295	1,149	3.4	0.001% Low
Bottlenose dolphin	0.0233	7,545	175	38,52030	0.00005	1,149	0.1	0.003% Low

[6] Where species specific data is not available, the species group data is used

[7] Based on the IAMMWG (2022) UK population estimates for cetacean species, SCOS (2021) UK population estimates for seal species

[8] Latest publicly available data

Marine mammal species	Collision risk rate[6]	Estimated total number of individuals in UK waters[7]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[8]	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	% reference population and Magnitude
Common dolphin	0.0750	57,417	4,309	38,52030	0.00112	1,149	1.3	0.0013% Low
White-beaked dolphin	0.0288	34,025	981.5	38,52030	0.00025	1,149	0.3	0.0007% Negligible
Minke Whale	0.0538	10,288	553	38,52030	0.00014	1,149	0.2	0.0008% Negligible
Grey Seal	0.0451	170,040	7,662	38,52030	0.002	1,149	2.3	0.007% (0.004%) Low

Marine mammal species	Collision risk rate[6]	Estimated total number of individuals in UK waters[7]	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015[8]	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	% reference population and Magnitude
Harbour Seal	0.0270	43,731	1,182	38,52030	0.00031	1,149	0.4	0.007% Low

11.6.1.6.2 Magnitude of Impact – DBS East and DBS West Together

471. As a precautionary worst-case the number of marine mammals that could be at increased risk of collision with construction vessels, if DBS East and DBS West are constructed concurrently has been based on the estimated maximum number of construction vessels for both array arrays (**Table 11-2**).

472. To estimate the potential collision risk of vessels associated with DBS East and DBS West array areas during construction together, the potential risk rate per vessel has been calculated for all relevant species (**Table 11-68**), which is then used to calculate the risk to marine mammal species due to the increased number of vessel movements during construction.

473. The increased number of vessel movements has been based on the estimated 2,298 return vessel trips per year during the five year construction period for DBS East and DBS West together (**Table 11-68**) and a total of 11,489 over the 5 years of construction.

474. The number of marine mammals (percentage of the relevant reference population) at risk of collision from the increased number of vessel movements during the construction period of the Projects together has been used to determine the potential magnitude of the permanent effect (**Table 11-68**).

475. The magnitude for potential increased collision risk with construction vessels based on a precautionary worst-case scenario has been assessed as low for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale. For harbour seal the magnitude is medium, and medium (low) for grey seal (**Table 11-68**).

476. This is a highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, considering the existing number of vessel movements in the area, and that vessels within the windfarm would be stationary for much of the time or very slow moving. Taking into account the disturbance from vessels, the actual risk is likely to be very low or negligible for all species.

Table 11-68 Predicted Number of Marine Mammals at risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (Magnitude of Impact Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West Together

Species	Collision risk rate	Estimated total number of individuals in UK waters	Number of marine mammals at risk in UK waters	Annual number of vessel transits in UK and RoI for 2015	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Number of marine mammals at increased risk	% of reference population and Magnitude
Harbour porpoise	0.0567	200,714	11,376	38,52030	0.00295	2,298	6.8	0.002% Low
Bottlenose dolphin	0.0233	7,545	175	38,52030	0.00005	2,298	0.1	0.005% Low
Common dolphin	0.0750	57,417	4,309	38,52030	0.00112	2,298	2.6	0.003% Low
White-beaked dolphin	0.0288	34,025	981.5	38,52030	0.00025	2,298	0.6	0.0013% Low

Species	Collision risk rate	Estimated total number of individuals in UK waters	Number of marine mammals at risk in UK waters	Annual number of vessel transits in UK and RoI for 2015	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Number of marine mammals at increased risk	% of reference population and Magnitude
Minke Whale	0.0538	10,288	553	38,52030	0.00014	2,298	0.3	0.0016% Low
Grey Seal	0.0451	170,040	7,662	38,52030	0.002	2,298	4.6	0.013% (0.008%) Medium
Harbour Seal	0.0270	43,731	1,182	38,52030	0.00031	2,298	0.7	0.015% Medium

11.6.1.6.3 Sensitivity of Receptor

477. The sensitivity of marine mammals as a precautionary approach to collision risk with vessels during construction is considered to be high. While marine mammals are expected to be able to avoid collision with vessels, in the case that a collision were to take place, there is the potential for fatal injury to occur.

11.6.1.6.4 Significance of Effect – DBS East or DBS West in Isolation

478. Taking into account the high marine mammal sensitivity and the potential magnitude of impact, the significance of effect for any potential increased collision risk as a result of construction vessels without mitigation has been assessed as a precautionary **moderate** to **minor adverse** .

479. However, as outlined above, this is precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, considering that vessels within the windfarms would be stationary for much of the time or very slow moving.

11.6.1.6.5 Significance of Effect – DBS East and DBS West Together

480. Taking into account the high marine mammal sensitivity and the fact there is no change in the potential magnitude of impact for construction of DBS East and DBS West together, the significance of effect for any potential increased collision risk as a result of construction vessels has been assessed as a precautionary **moderate** to **minor adverse**.

481. There have been no known reported incidents of marine mammal collisions with offshore wind farm vessels. The expected magnitude for collision risk would be very low to negligible for all species and the significance of effect for the Projects in isolation is seen as more representative. As such, the magnitude would be considered as low as the worst case and the significance effect for DBS East and DBS West together would be moderate adverse for all species.

Table 11-69 Assessment of Significance of Effect for Increased Collision Risk with Vessels during Construction for DBS East and West in Isolation and Together

Species	Sensitivity	Magnitude	Significance
DBS East or DBS West			
White-beaked dolphin and minke whale	High	Negligible	Minor adverse
Harbour porpoise, bottlenose dolphin, common dolphin, grey seal and harbour seal		Low	Moderate adverse
DBS East and DBS West together			
All marine mammals	High	Low	Moderate adverse

11.6.1.6.6 Mitigation and Residual Significance of Effect

482. As outlined in section 11.6.1.4, vessel movements, where possible, would follow set vessel routes where available and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements would be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators would use good practice to reduce any risk of collisions with marine mammals. These measures would be detailed within the PEMP as secured through a dML Condition.

483. The residual impact, taking into account good practice to reduce any risk of collisions with marine mammals, would be **minor adverse (not significant in EIA terms)** at either DBS East or DBS West array areas including the offshore export cable corridor for all marine mammals.

11.6.1.7 Impact 7 Changes to Prey Resources

484. Potential effects to prey species that may cause changes to prey resources for marine mammals include:

- Physical seabed disturbance;
- Increased suspended sediment concentrations (SSC) and sediment re-deposition;
- Remobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Changes in fishing activity.

485. Relevant marine mammal prey species in the study area include Atlantic herring, Atlantic cod, mackerel, Atlantic horse mackerel, whiting, sandeels, European sprat, which are key prey species for:

- Harbour porpoise – 'schooling fish' e.g. herring, whiting, sprat, sandeels;
- Bottlenose dolphin – 'opportunistic feeders' e.g., mackerel, cod, whiting, sprat, sandeels and cephalopods;
- Common dolphin – 'cooperative feeders' e.g. mackerel, whiting, and cephalopods;
- White-beaked dolphin – whiting, cod, herring and cephalopods;
- Minke whale - sandeel, mackerel, herring;
- Grey seal – 'generalist feeders' e.g. sandeel, whiting, cod, , flatfish and cephalopods; and
- Harbour seal – 'flexible' e.g. sandeels, sprat, herring, flatfish and cephalopods.

486. **Chapter 10 Fish and Shellfish Ecology** provides an assessment of these impact pathways on the relevant fish and shellfish species. Any reductions in prey availability would be small scale, localised and temporary. It is considered highly unlikely that potential reductions in prey availability as a result of construction activities at the Projects would result in detectable changes to marine mammal populations.

11.6.1.7.1 Physical Disturbance and Temporary Habitat Loss

487. During construction activities, such as foundation installation, seabed preparation (including sandwave levelling, and boulder removal), cable installation, cable protection, vessel moorings and jack-up vessel legs, there is the potential to cause physical disturbance or temporary loss of seabed habitat (see **Chapter 9 Benthic Habitats** and **Chapter 10 Fish and Shellfish Ecology**).

488. This can cause indirect impacts to marine mammals, as any habitat loss in the sediments, would not have a direct effect on marine mammals but can cause changes in prey availability.

11.6.1.7.2 Magnitude of Impact – DBS East or DBS West in Isolation

489. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS East is 22.9km² and at DBS West is 31km². Of the two Projects, the DBS West Project represents the worst case scenario in isolation. The assessment of temporary habitat disturbance and direct damage in isolation will therefore assume this worst case scenario for both Projects.

490. The disturbance would be temporary during the approximately five years of construction for either site with the majority of disturbance occurring during installation of foundations and cables.

491. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group and the medium sensitivity of effect for the demersal fish, pelagic fish and shellfish receptor groups, results in the assessment that the magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** is assessed as low for all species at DBS East and DBS West in isolation. With a low adverse magnitude of impact the significance of effect for fish species is assessed as minor adverse (not significant in EIA terms). Therefore, any potential changes to prey availability as a result of physical disturbance and temporary habitat loss is assessed as having a low magnitude of impact for marine mammals.

11.6.1.7.3 Magnitude of Impact – DBS East and DBS West Together

492. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of both DBS East and DBS West is 59.4km². The magnitude of temporary habitat disturbance and direct damage will be reduced if construction of DBS East and DBS West is staggered compared to being undertaken concurrently.

493. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor and the medium sensitivity of effect for the demersal fish, pelagic fish, and shellfish receptor groups, results in the assessment that the magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** is assessed as low for all species at DBS East and DBS West in isolation. With a low adverse magnitude of impact the significance of effect for fish species is assessed as minor adverse (not significant in EIA terms).

494. Therefore, any potential changes to prey availability as a result of physical disturbance and temporary habitat loss is assessed as having a low magnitude of impact for marine mammals.

11.6.1.7.4 Increased Suspended Sediments Concentrations and Sediment Deposition

495. Construction activities such as seabed preparation, foundation installation, drilling operations and cable installation may lead to the potential for increased suspended sediment concentrations (SSC) in the water column and subsequent sediment re-deposition. Activities such as seabed disturbances from jack-up vessels and placement of cable protection are not expected to increase the SSCs to the extent to which it would cause an impact to benthic or fish receptors.

11.6.1.7.5 Magnitude of Impact – DBS East or DBS West in Isolation

496. Increases in suspended sediment are expected to cause localised and short-term increases in SSC at the point of discharge. Released sediment may then be transported by tidal currents in suspension in the water column. Due to the small quantities of fine-sediment released, the fine-sediment is likely to be widely and rapidly dispersed. This would result in only low SSCs and low changes in sea bed level when the sediments are deposited. In **Chapter 9 Benthic Habitats**, the impact magnitude is considered to be negligible at DBS East and DBS West in isolation. The magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** is assessed as low for all species at DBS East and DBS West in isolation. With a low adverse magnitude of impact the significance of effect for fish species is assessed as minor adverse (not significant in EIA terms). Therefore, any potential changes to prey availability as a result of increased SSCs and sediment deposition is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.6 Magnitude of Impact – DBS East and DBS West Together

497. As the low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a negligible effect.

498. The medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, migratory fish and shellfish receptor groups, results in the assessment that the magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** is assessed as low for all species at DBS East and DBS West together. With a low adverse magnitude of impact the significance of effect for fish species is assessed as **minor adverse** (not significant in EIA terms.

499. Therefore, any potential changes to prey availability as a result of increased SSCs and sediment deposition is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.7 Re-Mobilisation of Contaminated Sediment

500. Re-mobilisation of sediments has the potential to release toxic substances (e.g. mercury and arsenic) into the water column, that may adversely impact fish and shellfish species.

501. **Chapter 8 Marine Physical Environment** indicates that likely nature of the seabed sediments within the Offshore Development Areas significantly reduces the potential for contaminants to accumulate and this is reflected in the historical data collected for Dogger Bank A & B which has similar sediment types. It is therefore predicted that contaminant levels would be similar in the Offshore Development Area but this will be confirmed with project-specific data that will be incorporated into the assessment for the ES.

502. Fish are not considered sensitive to most natural contaminants present within seabed sediments, provided the concentration of contaminants remain within environmental protection standards. There is evidence to suggest that contaminant uptake through gills is poor, and that lower trophic levels are more susceptible to increased contaminant concentrations (De Gieter *et al.* 2002).

11.6.1.7.8 Magnitude of Impact – DBS East or DBS West in Isolation

503. The magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the localised, short-term disturbance of sediments, and the low likelihood of significant contamination within the Offshore Development Area. Therefore the magnitude of impact is considered negligible sensitivity for all fish and shellfish receptor groups, resulting in the assessment that the release of sequestered contaminants following sediment disturbance has a negligible effect for marine mammals.

504. Therefore, any potential changes to prey availability as a result of re-mobilisation of sediments is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.9 Magnitude of impact – DBS East and DBS West Together

505. The magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** for DBS East and West together predicts that both the level of suspended sediment release (expected to be localised, short-term, and episodic) and the levels of potential contaminants will be low.

506. Therefore, any potential changes to prey availability as a result of re-mobilisation of sediments is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.9.1.1 Underwater noise

507. Potential sources of underwater noise and vibration during construction include piling, increased vessel traffic, seabed preparation, rock placement and cable installation. Of these piling is considered to produce the highest levels of underwater noise and therefore has the greatest potential to result in adverse impacts on fish.

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

509. Underwater noise modelling (**Appendix 11-2**) assessed the following fish groups (based on Popper *et al.* 2014):

- No swim bladder (e.g. sole, plaice, lemon sole, mackerel and sandeels);
- Swim bladder not involved in hearing (e.g. sea bass, salmon and sea trout); and
- Swim bladder which is involved in hearing (e.g. cod, whiting, sprat and herring).

510. The underwater noise modelling results (**Appendix 11-2**) indicates that fish species in which the swim bladder is involved in hearing are the most sensitive to the impact of underwater noise, therefore the worst-case scenario assessment uses these species as an indicator of overall effects.

11.6.1.7.10 Magnitude of Impact - DBS East or DBS West in Isolation

511. Effects associated with underwater noise and vibration via all sources are likely occur. Noise and vibration associated with both piling and UXO is likely to result in a change that is outside the natural variation in background conditions. However, both noise sources pertain to discrete events, with noise and vibrations emissions occurring only in the short term (0 – 1 year). Noise and vibration associated with construction and vessel activities is likely to result in emissions that is within the natural variation of background conditions, but that may occur over the full construction period of five years for a Project in isolation. Therefore, the magnitude of impact for underwater noise and vibration is considered low.

512. For fish with a swim bladder involved in hearing, TTS onset is likely to occur at an exposure to 186dB SEL_{cum}, across an area of 4,100km² for each pile installed. Injury is not determined as likely to occur until exposure to 203dBSELcum, and mortality until 207dB SEL_{cum}. Recoverable injury is, therefore, possible to occur across an area of up to 560km² (2.09% of the fish and shellfish ecology Study Area). Mortality is likely to be limited to an area of 97km² (see the **Chapter 10 Fish and Shellfish Ecology**).

513. When considering noise associated with construction and vessel activities, the magnitude on fish and shellfish is considered negligible within the context of the fish and shellfish ecology Study Area. Each of the activities presenting recoverable injury thresholds of <50m from the noise source following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, and that vessel movement and construction activity will move around the site over the period, it is not considered likely that this will result in notable impacts to any receptor groups.

514. The magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** underwater noise at DBS East or DBS West along with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a minor adverse effect. All other fish and shellfish receptor groups present low magnitude of impact, results in the assessment that impacts associated with noise and vibration are negligible.

515. Therefore, any potential changes to prey availability as a result of underwater noise is assessed as having a negligible magnitude of impact for marine mammals.

516. It is important to note that there is unlikely to be any additional displacement of marine mammals as a result of any changes in prey availability during piling as marine mammals would already be disturbed from the area (see section 11.6.1.2).

517. The magnitude of impact for any changes in prey resource from underwater noise and vibration during construction for marine mammals would be low to negligible.

11.6.1.7.11 Magnitude of Impact - DBS East and DBS West Together

518. The cumulative area of exposure to 186dB SEL_{cum} increases to a total of 9,400km² for the Project together. However, injury is not determined as likely to occur until exposure to 203dB SEL_{cum}, and mortality until 207dB SEL_{cum}. Impacts that will result in recoverable injury are predicted to occur across an area of up to 560km² (2.09% of the fish and shellfish ecology Study Area). Mortality is likely to be limited to an area of 220km² (see the **Chapter 10 Fish and Shellfish Ecology**).

519. The magnitude of impact in **Chapter 10 Fish and Shellfish Ecology** underwater noise at DBS East and DBS West together with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a minor adverse effect. All other fish and shellfish receptor groups present low magnitude of impact, results in the assessment that impacts associated with noise and vibration are negligible.

520. Therefore, the magnitude of impact for any changes to prey availability as a result of underwater noise is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.11.1 Changes in fishing activity

521. Fishing activity within the array areas may be reduced due to the presence of safety zones during construction. This may also alter the level of fishing in other areas through displacement of fishing activities. However, it is not expected that this change in fishing levels would affect the overall population level of fish species in the wider area. It would also be a short-term and temporary affect during construction. The magnitude is therefore assessed as low within **Chapter 10 Fish and Shellfish Ecology**.

522. The low magnitude of impact for DBS East and DBS West in isolation and together, combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the array areas and increased fishing pressure outside of the array area has a minor adverse effect (not significant in EIA terms).

11.6.1.7.12 Summary of magnitudes of impact

523. The following sections summarise the potential effects to fish species, based on the assessments provided in **Chapter 10 Fish and Shellfish Ecology**. The magnitude of impact to marine mammal species is based on the magnitude of impact to prey species, although it should be noted that this is a precautionary approach as marine mammals are generally opportunistic foragers, and would be able to prey upon a range of other species.

Table 11-70 Magnitude of Potential Changes to Prey Resources During Construction, Based on Assessments in Chapter 10 Fish and Shellfish Ecology

Potential effect to prey resources		Magnitude as assessed in Chapter 10
Physical disturbance and temporary habitat loss		Low (overall significance of effect of minor to negligible)
Increased SSC and sediment deposition		Low (overall significance of effect of minor to negligible).
Re-mobilisation of contaminated sediment		Negligible (overall significance of effect of negligible).
Underwater noise	Piling noise	Negligible to low (overall significance of negligible), or for fish and shellfish with a swim bladder used in hearing, an overall significance of effect of minor (with an increased sensitivity).
	Other construction activities	Low (overall significance of effect of negligible).
	UXO clearance	Low (overall significance of effect of minor).
Changes in fishing activity		Low (overall significance of effect of negligible).

11.6.1.7.13 Sensitivity of Receptor

524. As outlined in **Appendix 11-1**, the diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the environmental conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.* 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes on prey resources.

525. Dolphin species, including bottlenose dolphin, common dolphin and white-beaked dolphin have a broad diet, feeding on a wide range of prey species. All dolphin species are considered to have large foraging ranges, and a broad range of prey species, and are therefore considered to have low sensitivity to changes in prey resources.

526. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species. Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

527. Grey seal are opportunistic feeders, preying on a variety of species, dominated by sandeel. Within the southern North Sea, diet is more varied in composition where grey seals also prey on flat fish, sandy benthic, large gadid prey and scorpion fish (the latter mainly during autumn/winter) (Wilson and Hammond 2019).

528. Harbour seals are considered generalist feeders, and feed on a variety of species, e.g. large gadid prey (Wilson and Hammond 2019).

529. Both grey and harbour seals are able to forage in other areas and have relatively large foraging ranges. Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

530. Further information on the diet of marine mammal species is provided in **Appendix 11-1**.

11.6.1.7.14 Significant of effect – DBS East or DBS West in Isolation

531. Taking into account the low to medium marine mammal sensitivity, and the potential magnitude of impact of negligible to low (**Table 11-71**) for all fish species, the significance for any effect of the changes of prey for marine mammals has been assessed as **negligible** to **minor adverse** for harbour porpoise, minke whale, grey seal and harbour seal and **negligible (not significant in EIA terms)** for bottlenose dolphin, common dolphin and white-beaked dolphin (**Table 11-71**).

11.6.1.7.15 Significant of effect – DBS East and DBS West Together

532. Taking into account the low to medium marine mammal sensitivity, and the potential magnitude of impact of negligible to low (**Table 11-71**) for all fish species, the significance for any effect of the changes of prey for marine mammals has been assessed as **negligible** to **minor adverse** for harbour porpoise, minke whale, grey seal and harbour seal and **negligible (not significant in EIA terms)** for all dolphin species (**Table 11-71**).

11.6.1.7.16 Mitigation and residual significance of effect

533. Mitigation in the MMMP and SIP to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species. No further mitigation is required or proposed in relation to any changes in prey availability.

Table 11-71 Assessment of Significance of Effect for the Potential of an Indirect Effect to Marine Mammals Through Changes to Prey Resources During Construction

Potential effect	Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Significance of effect
Physical disturbance and temporary habitat loss	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Increased suspended sediments and sediment deposition	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Re-mobilisation of contaminated sediment	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Negligible	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Underwater noise	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Negligible to low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible to Minor adverse
Change in fishing activity	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse

11.6.1.8 Impact 8 Changes to Water Quality

534. As described in **Chapter 8 Marine Physical Environment** potential changes in water quality during construction could occur through:

- Deterioration in water quality due to an increase in suspended sediment associated with seabed preparation for the installation of foundations, and cables;
- Deterioration in water quality due to an increase in sediment concentrations due to drill arisings for installation of piled foundations for wind turbines and platforms;
- Deterioration in water quality due to increases in suspended sediment associated with the installation of the export cable; and
- Deterioration in water quality associated with release of sediment bound contaminants.

535. All vessels involved with the Project will be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. An outline Pollution Environmental Management Plan (will set out all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed to minimise the risk of, and effects in the event of an accidental spill or leak. The final PEMP would be agreed with the MMO prior to construction and would include, for example, measures to control accidental release of drilling fluids whilst ensuring that any chemicals used are listed on the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR) (OSPAR 2021).

11.6.1.8.1 Magnitude of Impact – DBS East or DBS West in Isolation

536. The magnitude for the potential changes in water quality has been based on the assessments in **Chapter 8 Marine Physical Environment**.

11.6.1.8.2 Magnitude of Impact – DBS East or DBS West in Isolation

537. There would be no change in the magnitude of the impact if DBS East and DBS West were constructed separately or simultaneously. The magnitude for the potential changes in water quality has been based on the assessments in **Chapter 8 Marine Physical Environment.** Sensitivity of Receptor

538. Marine mammals often inhabit turbid environments and cetaceans use sonar to sense the environment around them and there is little evidence that turbidity affects cetaceans directly (Todd *et al.* 2014).

539. 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, such as sensing the environment with the vibrissae in their whiskers. Studies have shown that vision is not essential to seal survival, or ability to forage (Todd *et al.* 2014).

540. Increased turbidity is therefore unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. Therefore, harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal have negligible sensitivity to increases in suspended sediments during construction.

541. Any direct impacts to marine mammals as a result of any contaminated sediment during construction activities are unlikely because any exposure is more likely to be through potential indirect impacts via prey species, as assessed in section 11.6. Therefore, marine mammals are considered to have negligible sensitivity to any direct impacts from contaminated sediment during construction activities.

11.6.1.8.3 Significance of effect – DBS East or DBS West in Isolation

542. Looking at the potential magnitude of the impact, the significance of effect for any potential changes in water quality during construction at DBS West or DBS East has been assessed as **negligible adverse** (and not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-72**).

Table 11-72 Assessment of Significance of Effect for any Changes in Water Quality during Construction at DBS East or DBS West

Species	Location	Sensitivity	Magnitude	Significance of Effect
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	DBS East	Negligible	Low	Negligible
	DBS West	Negligible	Low	Negligible

11.6.1.8.4 Significance of effect – DBS East and DBS West Together

543. The impacts for DBS East and DBS West simultaneously would be the same as those assessed for DBS East and DBS West in isolation due to the limited range of potential changes in water quality with a low magnitude of impact and a negligible adverse (and not significant in EIA terms) significance of effect (**Table 11-72**).

11.6.1.8.5 Mitigation and Residual Significance of Effect

544. No mitigation is proposed for changes to water quality, as the significance of effect is minor adverse which is not significant in EIA terms.

11.6.1.9 Impact 9 Disturbance of Seals at Haul-Out Sites

545. Seals vary in their reaction to construction disturbance depending on disturbance type (vessel noise/presence, piling etc,) and proximity to haul-out sites.

546. Grey seal and harbour seal have been shown to be sensitive at haul-out sites to disturbance 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 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).

547. During construction, piling represents the loudest and most likely source of disturbance to seal haul-outs, as well as increased vessel activity, and the number of seals spending time on land has been shown to decrease during the construction phase of wind farms (e.g. up to 60% reduction in number of seals hauling out at sites 4km away from construction activities during piling periods) (Edren *et al.* 2010).

548. A 2016 study at Sheringham Shoal OWF demonstrated that there was no significant displacement of seals overall during construction. However, during pile driving activities there was a significant reduction in seals at haul-out sites up to 25km away, returning to typical levels two hours after piling had ceased (Russel *et al.* 2016).

549. Disturbance to seals from vessel noise and presence has been demonstrated at haul-out sites in the UK up to 500m away (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.

550. A study was carried out by SMRU (Paterson *et al.* 2015) using a series of controlled disturbance tests at harbour seal haul-out sites, consisting of regular (every three days) disturbance through direct approaches by vessel and effectively 'chasing' the seals into the water. The seal behaviour was recorded via GPS tags and found that even intense levels of disturbance did not cause seals to abandon their haul-out sites more than would be considered normal (for example seals travelling between sites) and the seals were found to haul-out at nearby sites or to undertake a foraging trip in response to the disturbance (but would later return).

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

552. In areas of high vessel traffic, there can be habituation effects and disturbance behaviours are generally reduced over time (Strong *et al.* 2010).

11.6.1.9.1 Magnitude of Impact DBS East or DBS West in Isolation

553. The closest seal haul out is at Filey Brigg which is the located approximately 28km from landfall, 25km from the offshore export cable corridor, 106km from DBS East and 132km from DBS West. The haul-out site is referred to as a 'transient resting spot for seals' with a maximum of 15 individuals recorded at any one time (Yorkshire Seals org 2023), and harbour seal counts in single numbers (Filey bird Observatory Group 2023). Other haul-out sites further from the Projects are Ravenscar (52km from landfall, 62km from export cable corridor, 140km from DBS East and 150km from DBS West). Donna Nook (62km from landfall, 65km from export cable corridor, 153km form DBS East and 151km from DBS West) mean grey seal count recorded in 2012 was 3,897 and harbour seal 122 (SCOS 2021).

554. The closest seal haul out site is 106km from the DBS East array area site and 25km from the offshore export cable corridor, there is therefore no potential for any direct disturbance as a result of construction activities from either DBS East or DBS West (including landfall and the export cable corridor).

555. As outlined above, the studies by Edren *et al.* (2010) and Russel *et al.* (2016), demonstrate there could be disturbance at seal haul-out sites 4km for construction activities and 25km for piling, respectively, during construction of offshore wind farms. Taking into account the distance from shore of the windfarm site (100km closest point) and the distances to the seal haul-out sites, there is unlikely to be any significant disturbance of seals at haul-out sites.

556. The construction ports to be used for DBS East and DBS West are not yet confirmed. Vessel movements to and from any port will be incorporated within existing vessel routes, where available. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels.

557. It is expected that if there is any disturbance to seals at haul-out sites from construction activities it is a short-term effect. For example, a 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% pre-disturbance levels four hours after a disturbance event (Paterson *et al.et al.* 2019).

558. There is no pathway for impact due to distances from the seal haul out sites, therefore the only impact would be construction vessels to ports that we consider any further.

559. In total, for the construction of either DBS East or DBS West, up to 5,745 round trips to ports from the array area each year for five years. This represents a slight significant increase in the current number of vessels in the area.

560. However, taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels. Therefore, the magnitude of impact of grey and harbour seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be low.

11.6.1.9.2 Magnitude of Impact – DBS East and DBS West Together

561. The magnitude of impact for disturbance at seal haul-out sites during piling and other construction activities in the windfarm site has been assessed as negligible.

562. In total, for the construction of DBS East and DBS West together, up to 11,489 round trips to port from the array areas each year for five years. This represents a relatively significant increase in the current number of vessels in the area.

563. However, taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels. Therefore, the magnitude of impact of grey and harbour seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be negligible.

11.6.1.9.3 Sensitivity of Receptor

564. Both grey seal and harbour seal may become disturbed from haul-out sites due to the presence of vessels, which, if occurring in the breeding season, can result in the abandonment of pups. Due to this, both grey seal and harbour seals are considered to be sensitive to vessel disturbance at haul-out sites, particularly if that occurs within the breeding season.

565. A study of the reactions of harbour seal from cruise ships found that, if a cruise ship was less than 100m from a harbour seal haul-out site, individuals were 25 times more likely to flee into the water than if the cruise ship was at a distance of 500m from the haul-out site (Jansen *et al.et al.* 2010). At distances of less than 100m, 89% of individuals would flee into the water, at 300m this would fall to 44% of individuals, and at 500m, only 6% of individuals would flee into the water (Jansen *et al.* 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

566. Therefore, it is considered that, for grey seal, vessels travelling within 300m of a haul-out site, a grey seal may flee into water, but significant disturbance would be expected at a distance of less than 150m. For harbour seal, if a vessel travels within 600m of a haul-out site, there is the potential for a flee response, and if a vessel is within 300m, a significant number of harbour seal would flee.

567. The sensitivity of both seal species to disturbance from seal haul-out sites is therefore low, and as a very precautionary approach, it is proposed that sensitivity during the breeding season and annual moult could be slightly higher and has therefore been considered as medium in this assessment.

11.6.1.9.4 Significance of effect – DBS East or DBS West Together

568. Taking into account the low to medium sensitivity, and the potential magnitude of negligible for the temporary impact, the significance of effect for disturbance at seal haul-out sites during construction of DBS East and DBS West in isolation has been assessed as **negligible to minor adverse** (not significant in EIA terms) for both grey seal and harbour seal (**Table 11-73**).

11.6.1.9.5 Significance of effect – DBS East and DBS West Together

569. Taking into account the low to medium sensitivity, and the potential magnitude of negligible for the temporary impact, the significance of effect for disturbance at seal haul-out sites during construction of DBS East and DBS West together has been assessed as **negligible to minor adverse** (not significant in EIA terms) for both grey seal and harbour seal (**Table 11-73**).

Table 11-73 Assessment of significance of effect for Disturbance at Seal Haul-Out Sites During Construction

Species	Impact	Sensitivity	Magnitude	Significance
Grey seal	Disturbance from construction activities	Low to Medium	Negligible	**Negligible to minor adverse**
	Disturbance from vessels		Low	**Minor adverse**
Harbour seal	Disturbance from construction activities	Low to Medium	Negligible	**Negligible to minor adverse**
	Disturbance from vessels		Low	**Minor adverse**

11.6.1.9.6 Mitigation and residual significance of effect

570. No mitigation is required for the disturbance of seals at haul-out sites. However, as outlined in the section 11.3.3 where possible and safe to do so, transiting vessels would maintain distances reasonable distance from the coast, particularly in areas near known seal haul-out sites during sensitive periods.

11.6.2 Potential Effects During Operation

571. The potential effects during operation and maintenance (O&M) that have been assessed for marine mammals are:

- Impact 1: Impacts from underwater noise associated with operational wind turbines;
  - Impact 1a: Temporary auditory injury (TTS).
  - Impact 1b: Disturbance or behavioural impacts.
- Impact 2: Impacts from underwater noise associated with O&M activities;
  - Impact 2a: Temporary auditory injury (TTS).
  - Impact 2b: Disturbance.
- Impact 3: Underwater noise and presence from O&M vessels;
  - Impact 3a: Temporary auditory injury (TTS).
  - Impact 3b: Disturbance.
- Impact 4: Barrier effects as a result of underwater noise;
- Impact 5: Increased collision risk with vessels during operation and maintenance;
- Impact 6: Changes to water quality;
- Impact 7: Changes to prey resource; and
- Impact 8: Disturbance at seal haul-out sites.

572. The realistic worst case scenario on which the assessments are based is outlined in **Table 11-2**.

11.6.2.1 Impact 1 Impacts from Underwater Noise Associated with Operational Wind Turbines

573. The operational wind turbines will operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The Projects operation and maintenance period is 32 years. The underwater noise levels emitted during the operation of the turbines are low and not expected to cause physiological injury to marine mammals, but could cause behavioural reactions if the animals are in the immediate vicinity of the wind turbines (Tougaard *et al.* 2009a; Sigray and Andersson 2011).

574. The main source of underwater noise from operational wind turbines will be mechanically generated vibration from the rotating machinery in 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 low enough that no significant airborne sound will pass from the air to the water (e.g. Godin, 2008).

575. Measurements made at three different offshore wind farms in Denmark and Sweden at ranges between 14m and 40m from the foundations 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).

576. 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).

577. The underwater noise from operational wind turbines is described as continuous and non-impulsive and is characterized by one or more tonal components that are typically at frequencies below 1kHz (Madsen *et al.* 2006). There is the potential for proposed larger wind turbines to have greater noise levels compared to smaller wind turbines currently in operation (Stöber and Thomsen 2021). This increase in size of operational wind turbines at the Projects have been taken into account in the underwater noise modelling (see **Appendix 11-3**).

11.6.2.1.1.1 Underwater Noise Modelling

578. Underwater noise modelling was undertaken by Subacoustech Environmental Ltd to estimate the noise levels likely to arise during the operational phase (**Appendix 11-2**), and determine the potential effects on marine mammals. Key information on the methodology of underwater noise modelling, and the full results of the assessments for marine mammals, is provided in **Appendix 11-3**.

11.6.2.1.2 Impact 1a: TTS Due to Operational Wind Turbine Noise

579. The results of the underwater noise modelling does not define effect ranges of <100m, and therefore, where the effect ranges are less than that, the results show effect ranges of <100m (it is possible that the actual effect ranges are therefore considerably lower).

11.6.2.1.3 Magnitude of Impact - DBS East or DBS West in Isolation

580. The number of marine mammals that could be impacted as a result of underwater noise from operational wind turbines has been assessed based on the number of animals that could be present in the modelled impact area (**Table 11-74**).

Table 11-74 Predicted Impact Ranges (And Areas) for PTS of TTS from 24 hour Cumulative Exposure of Underwater Noise From Operational Turbines

Species	Impact	Operational wind turbine	Area of impact for up to 100 Wind turbines
Harbour porpoise (VHF)	PTS or TTS	<0.01km **(0.031km²)**	**3.1km²**
Dolphin species (HF)	PTS or TTS	<0.1km **(0.031km²)**	**3.1km²**
Minke whale (LF)	PTS or TTS	<0.1km **(0.031km²)**	**3.1km²**
Grey seal and harbour seal (PCW)	PTS or TTS	<0.1km **(0.031km²)**	**3.1km²**

581. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would have to remain less than 100m from a turbine for 24 hours for any potential risk of PTS. Therefore, PTS is highly unlikely and has not been assessed further.

582. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that the marine mammal would have to remain less than 100m from a turbine for 24 hours in a day (**Table 11-75**). However, as a precautionary approach the number of marine mammals that could be at risk of TTS has been estimated (**Table 11-75**). As outlined previously this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been rounded up to 100m.

583. More than one wind turbine will be operating at the same time, and therefore an assessment of the potential for auditory injury, due to all operational wind turbines, is required. As the potential auditory effect ranges are the same for the range of wind turbines included in the DBS East or DBS West design envelope, the worst case would be for a total of 100 operational wind turbines.

584. The magnitude of the potential impact for any TTS as a result of underwater noise from 100 operational wind turbines at DBS East or DBS West, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 0.01% of the reference populations exposed to any long-term impact (**Table 11-75**).

Table 11-75 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TSS as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East and DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Magnitude* (Long-term impact)
Harbour porpoise	DBS East	2.8 (0.0008 % of NS MU reference population)	Negligible
	DBS West		
Bottlenose dolphin	DBS East	0.0004 (0.00002 % of GNS MU reference population)	Negligible
	DBS West	0.0008 (0.00004 % of GNS MU reference population)	
Common dolphin	DBS East	0.09 (0.00008% of CGNS MU reference population)	Negligible
	DBS West	0. 1 (0.0001% of CGNS MU reference population)	
White-beaked dolphin	DBS East	0.017 (0.00004% of CGNS MU reference population)	Negligible
	DBS West	0.035 (0.00008% of CGNS MU reference population)	
Minke whale	DBS East	0.03 (0.00016% of CGNS MU reference population)	Negligible
	DBS West		
Grey seal	DBS East	0.57 (0.0017% of SE England MU or 0.0009% of wider reference population)	Negligible (negligible)

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Magnitude* (Long-term impact)
	DBS West	0.82 (0.0024% of SE England MU or 0.0014% of wider reference population)	
Harbour seal	DBS East	0.0053 (0.00011% of SE England MU reference population)	Negligible
	DBS West	0.0051 (0.00006% of SE England MU reference population)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for seal species*

11.6.2.1.4 Magnitude of Impact - DBS East and DBS West Together

585. The number of marine mammals that could be impacted as a result of underwater noise from operational wind turbines at DBS East and DBS West together has been assessed based on the number of animals that could be present in the modelled impact area when applied across the worst case number of operational wind turbines (**Table 11-2**).

586. The predicted impact ranges for TTS from 24 hour cumulative exposure of underwater noise from operational turbines is <0.1km and the potential impact area for the 200 operational wind turbines at DBS East and DBS West together is up to 6.28km^2.

587. An assessment of the maximum number of individuals that could be at risk of TTS, due to the underwater noise associated with all operational wind turbines is presented in **Table 11-76**.

588. The magnitude of the potential impact is assessed as negligible for all species for the potential long-term effect with less than 0.01% of the reference population impacted. The potential TTS effect ranges are significantly lower than the turbine spacing, (<0.1km, and turbine spacing up to 6.28 km) and therefore there is no potential for an overlap in effect areas.

Table 11-76 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TSS as a Result of Underwater Noise Associated with Operational Turbines at DBS East and DBS West Together

Species	**Maximum number of individuals (% of reference population) for 200 wind turbines (*highest density in DBS Projects*)**	**Magnitude*** **(Long-term impact)**
Harbour porpoise	5.6 (0.0016 % of NS MU reference population)	Negligible
Bottlenose dolphin	0.01 (0.0005% of GNS MU reference population)	Negligible
Common dolphin	0.026 (0.0003% of CGNS MU reference population)	Negligible
White-beaked dolphin	0.11 (0.0002% of CGNS MU reference population)	Negligible
Minke whale	0.06 (0.0003% of CGNS MU reference population)	Negligible
Grey seal	2.4 (0.007% of SE England MU or 0.004% of wider reference population)	Negligible (negligible)
Harbour seal	0.011 (0.00022% of SE England MU reference population)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.2.1.5 Impact 1b: Disturbance Due to Operational Wind Turbine Noise

589. 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 suggests that any behavioural responses for harbour porpoise and seal may only occur up to a few hundred metres away (Touggard *et al.* 2009b; McConnell *et al.* 2012).

590. Monitoring was carried out at the Horns Rev and Nysted wind farms in Denmark during the operation between 1999 and 2006 (Diederichs *et al.* 2008). Numbers of harbour porpoise within Horns Rev were slightly reduced compared to the wider area during the first two years of operation, however, it was not possible to conclude that the wind farm was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard *et al.* 2009a). Later studies by Diederichs *et al.* (2008) recorded no noticeable effect on the abundances of harbour porpoise at varying wind velocities at both of the offshore wind farms studied, following two years of operation.

591. 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.et al.* 2012). Tagged harbour seals have been recorded within two operational wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around wind turbines fixed foundation structures (Russell *et al.* 2014).

592. 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), indicating no restriction to movements in operational offshore wind farm sites. There is currently limited information for other marine mammal species, however, bottlenose dolphin are frequently observed in and around the Aberdeen Offshore Wind Farm (European Offshore Wind Deployment Centre; pers. comm.).

593. Modelling of noise effects of operational offshore wind turbines suggest that marine mammals are not considered to be at risk of displacement by operational wind farms (Marmo *et al.* 2013). Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

594. Based on the review of marine mammals and operational wind farms, the noise levels associated with operational wind turbines and duration of the operational life of the Projects, a precautionary magnitude of impact of low has been given to all marine mammal species for DBS East and DBS West in isolation or together.

11.6.2.1.6 Sensitivity of Receptor

595. The sensitivity of marine mammals to TTS as a result of underwater noise due to operational wind turbines, is considered to be medium.

596. As a precautionary approach, harbour porpoise, dolphin species, grey seal and harbour seal are likely to have low sensitivity (rather than negligible) to disturbance from underwater noise as a result of operational wind turbines.

597. Taking into account that minke whales are more sensitive to low frequency noise, it is probable that they could be more sensitive to operational wind turbine noise (Marmo *et al.* 2013). Therefore, as a precautionary approach minke whale are classed as having medium sensitivity.

11.6.2.1.7 Significance of Effect – DBS East or DBS West in Isolation

598. Taking into account the medium sensitivity of all marine mammal species and the precautionary negligible magnitude for 100 operational turbines (**Table 11-75)** the significance of effect has been assessed as **minor adverse** for TTS from underwater noise of operational turbines during the operational life of DBS East or DBS West isolation (**Table 11-77**).

599. For the potential for disturbance due to operational turbines at DBS East and DBS West together, the significance of effect has been assessed as **minor adverse** for minke whale and **negligible** for all other species (**Table 11-77**) during the operational life of the Projects.

Table 11-77 Assessment of Significance of Effect for the Potential for Disturbance Due to Operational Wind Turbines at DBS East and DBS West in isolation

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to operational wind turbines, from either a single turbine or 100 turbines			
All species	Medium	Negligible	Minor adverse
Disturbance due to operational wind turbines, from either a single turbine or 100 turbines			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible
Minke whale	Medium	Negligible	Minor adverse

11.6.2.1.8 Significance of Effect – DBS East and DBS West Together

600. Taking into account the medium sensitivity of all marine mammal species and the precautionary negligible magnitude for 200 operational turbines (**Table 11-76**) the significance of effect has been assessed as **minor adverse** for TTS from underwater noise of operational turbines during the operational life of DBS East and DBS West together (**Table 11-78**).

601. For the potential for disturbance due to operational turbines at DBS East and DBS West together, the significance of effect has been assessed as **minor adverse** for minke whale and **negligible** for all other species (**Table 11-78**) during the operational life of the Projects.

Table 11-78 Assessment of Significance Of Effect for the Potential for Disturbance Due To Operational Wind Turbines at DBS East and DBS West Together

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Potential significance of effect
TTS due to operational wind turbines, from up to 200 turbines			
All species	Medium	Negligible	Minor adverse
Disturbance due to operational wind turbines, from up to 200 turbines			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible
Minke whale	Medium	Negligible	Minor adverse

11.6.2.1.9 Mitigation and Residual Significance of Effect

602. No mitigation is required or proposed. Therefore, the residual significance of effect for TTS or disturbance from underwater noise of operational turbines at DBS East or DBS West arrays would be **minor adverse** for all species.

11.6.2.2 Impact 2: Impacts from Underwater Noise Associated with Operation and Maintenance Activities

11.6.2.2.1 Impact 2a: TTS from Underwater Noise Associated with Operation and Maintenance Activities

603. The requirements for any potential Operation and Maintenance work, such as additional rock placement or cable re-burial, are currently unknown, however the work required, and associated effects to marine mammals would be less than those during construction. **Table 11-2** provides estimates (as outlined in **Chapter 5 Project Description**) for potential cable repairs and reburial during the operational period.

604. As outlined in section 11.6.1.3 and **Appendix 11-2**, the potential for PTS is only likely in very close proximity to cable laying or rock placement activities, and if the marine mammal remains within close proximity for 24 hours. Therefore, it is highly unlikely for there to be any PTS due to maintenance activities.

605. The effects from additional cable laying and protection are temporary in nature and will be limited to relatively short periods during the operation and maintenance phase. Disturbance responses are likely to occur at significantly shorter ranges than construction noise. Any disturbance is likely to be limited to the area in and around where the actual activity is taking place.

11.6.2.2.2 Magnitude of Impact -DBS East or DBS West in Isolation

606. The magnitude of impact for TTS from underwater noise during maintenance activities (e.g. cable laying and rock placement) has been based on the underwater noise modelling undertaken for other construction activities (see section 11.6.1.3 and **Appendix 11-2**).

607. The magnitude of the potential impact for any TTS as a result of non-piling construction activities, for each activity individually or all together, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact from DBS East or DBS West in isolation (**Table 11-51**).

608. The potential for TTS effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, not consistent throughout the O&M period for the Projects and would be limited to only part of the overall Offshore Development Area at any one time.

609. The potential for TTS effects that could result from underwater noise during maintenance activities, such as cable laying and protection would be localised and temporary to where and when the work was undertaken.

11.6.2.2.3 Magnitude of Impact -DBS East and DBS West Together

610. The magnitude of impact for TTS from underwater noise during maintenance activities (e.g. cable laying and rock placement) has been based on the underwater noise modelling undertaken for other construction activities taking into account activities at DBS East and DBS West in combination (see section 11.6.1.3 and **Appendix 11-2**).

611. As a worst-case, the maximum number of marine mammals from each Project has been assessed to indicate the maximum number of marine mammals that could be impacted from the Projects together, if they are developed concurrently (**Table 11-52**).

612. The magnitude of the potential impact for TTS during construction activities other than piling at DBS East and DBS West together is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-52**).

613. The magnitude of the potential impact for any TTS as a result of maintenance activities, for each activity individually or both together is therefore negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact during maintenance activities.

614. As previously stated, the potential for TTS effects that could result from underwater noise during maintenance activities, such as cable laying and protection would be localised and temporary to where and when the work was undertaken.

11.6.2.2.4 Impact 2b Disturbance from Underwater Noise Associated with O&M Activities

11.6.2.2.5 Magnitude of Impact - DBS East or DBS West in Isolation

615. As a precautionary approach, 4km has also been used as a potential disturbance range for maintenance activities and vessels, based on construction activities (see section 11.6.1.3.4**).**

616. The potential disturbance from maintenance activities occurring at the same time has also been assessed based on maximum impact area of 50.27km^2 for each activity, 201.08km^2 for four activities happening simultaneously. (**Table 11-53**,

617. The magnitude of the potential impact is assessed as negligible for all species for up to four maintenance activities occurring (**Table 11-55).**

618. The potential for disturbance that could result from underwater noise during maintenance activities, including cable laying and protection would be localised and temporary to where and when the work is being undertaken.

11.6.2.2.6 Magnitude of Impact -DBS East and DBS West Together

619. The potential disturbance from construction activities occurring at the same time has also been assessed based on maximum impact area of 402.12km^2 for up to eight construction activities at the same time (**Table 11-54**).

620. The magnitude of the potential impact is assessed as negligible for all species for all activities together (**Table 11-54**). This has been taken as a precautionary worst case for the O&M phase.

621. The potential for disturbance that could result from underwater noise during maintenance activities, including cable laying and protection would be localised and temporary to where and when the work is being undertaken.

11.6.2.2.7 Sensitivity of Receptor

622. The sensitivity of marine mammals to TTS and disturbance as a result of underwater noise is considered to be medium for maintenance activities (see section 11.6.1.3.7).

623. Marine mammals within the potential disturbance area would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

11.6.2.2.8 Significance of Effect - DBS East or DBS West in Isolation

624. Taking into account the marine mammal sensitivity to TTS and disturbance and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise during maintenance activities at DBS East or DBS West array site has been assessed as **minor adverse (not significant in EIA terms)** for all species (**Table 11-79**).

11.6.2.2.9 Significance of Effect - DBS East and DBS West Together

625. Taking into account the marine mammal sensitivity to TTS and disturbance and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise during maintenance activities simultaneously happening at DBS East and DBS West array sites has been assessed as **minor adverse (not significant in EIA terms)** for all species (**Table 11-79**).

11.6.2.2.10 Mitigation and Residual Significance of Effect

626. No mitigation is required or proposed. Therefore, the residual significance of effect for TTS or disturbance from underwater noise during maintenance activities at the array area would be **minor adverse (not significant in EIA terms)** for all species.

Table 11-79 Assessment of Significance of Effect for TTS or Disturbance from Underwater Noise During Maintenance Activities at the DBS East and DBS West Array Areas

Species	Potential Impact	Sensitivity	Magnitude	Significance
All marine mammal species	TTS	Medium	Negligible	Minor adverse
	Disturbance	Medium	Negligible	Minor adverse

11.6.2.3 Impact 3 Impacts from Underwater Noise due to the Presence of Vessels

627. Vessels will generally be in the windfarm sites during maintenance activities; however, as a precautionary approach and to take into account vessels that could be in the array area when these activities are not being conducted, the potential for TTS and disturbance from underwater noise and presence of vessels has also been assessed separately.

628. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore any increase in disturbance as a result of underwater noise from vessels during operation and maintenance will be within the windfarm site.

629. The vessels in the windfarm site during operation and maintenance will be slow moving or stationary.

11.6.2.3.1 Impact 3a TTS from Underwater Noise due to the Presence of Vessels

11.6.2.3.1.1 Magnitude of Impact – DBS East or DBS West in Isolation

630. During the operation and maintenance phase there will be an increase in the number of vessels in the array areas. The maximum number of vessels that could be on the array areas at any one time has been estimated at up to a total of 11 vessels per Project (**Table 11-2**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

631. The magnitude of impact for TTS from underwater noise from maintenance vessels has been based on the underwater noise modelling undertaken for construction vessels (see section 11.6.1.4.2 and **Appendix 11-2**).

632. The results of the underwater noise modelling (**Table 11-57**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours, to be exposed to noise levels that could induce TTS, based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}

633. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours for any potential risk of PTS (**Appendix 11-2**). Therefore, PTS as a result of construction vessels is highly unlikely and has not been assessed further.

634. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours in a day. Although TTS as a result of vessels is highly unlikely, it has been assessed as precautionary approach.

635. As a precautionary approach the potential impact area of 0.35km^2 for up to 11 vessels in the windfarm site at the same time has been determined.

636. The magnitude of the potential impact for any TTS as a result of vessels, for individual vessels or up to 11 vessels in the array area at the same time, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, , white-beaked dolphin, minke whale, grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-80**).

637. The potential for TTS effects that could result from underwater noise from vessels would be localised and temporary.

Table 11-80 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TTS as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for up to 11 vessels	Magnitude* (temporary effect)
Harbour porpoise	DBS East, DBS West, Offshore ECC and Offshore Development Area	0.31 (0.00009% of NS MU reference population)	Negligible
Bottlenose dolphin	DBS East	0.000048 (0.000002% of GNS MU reference population)	Negligible
	DBS West	0.00008 (0.000004% of GNS MU reference population)	
	Offshore ECC	0.00004 (0.00002% of GNS MU reference population)	
	Offshore Development Area	0.0006 (0.00003% of GNS MU reference population)	
Common dolphin	DBS East	0.0012 (0.00001% of CGNS MU reference population)	Negligible
	DBS West	0.0013 (0.00001% of CGNS MU reference population)	
	Offshore ECC	0.0023 (0.000025% of CGNS MU reference population)	
	Offshore Development Area	0.012 (0.00001% of CGNS MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for up to 11 vessels	Magnitude* (temporary effect)
White-beaked dolphin	DBS East	0.0019 (0.000004% of CGNS MU reference population)	Negligible
	DBS West	0.0038 (0.000009% of CGNS MU reference population)	
	Offshore ECC	0.0016 (0.000036% of CGNS MU reference population)	
	Offshore Development Area	0.0059 (0.000013% of CGNS MU reference population)	
Minke whale	DBS East, DBS West, Offshore ECC and Offshore Development Area	0.003 (0.00002% of CGNS MU reference population)	Negligible
Grey seal	DBS East	0.06 (0.0002% of SE England MU or 0.0001% of Wider MU reference population)	Negligible (negligible)
	DBS West	0.09 (0.0003% of SE England MU or 0.0001% of Wider MU reference population)	
	Offshore ECC	0.018 (0.0005% of SE England MU or 0.0003% of Wider MU reference population)	
	Offshore Development Area	0.013 (0.0004% of SE England MU or 0.0002% of Wider MU reference population)	
Harbour seal	DBS East	0.0006 (0.000012% of SE England MU reference population)	Negligible
	DBS West	0.0003 (0.000007% of SE England MU reference population)	
	Offshore ECC	0.0006 (0.000012% of SE England MU reference population)	

Species	Location	Maximum number of individuals (% of reference population) for up to 11 vessels	Magnitude* (temporary effect)
	Offshore Development Area	0.0005 (0.00001% of SE England MU reference population)	

**The Wider MU for grey seal is combined MUs from the SE and NE MU*

11.6.2.3.2 Magnitude of Impact – DBS East and DBS West Together

638. As a precautionary approach the potential impact area for up to 21 vessels in the windfarm site at the same time has also been considered. As the worst case the TTS impact range for 21 vessels is 0.66km^2 which would be double the effect in **Table 11-80.**

639. The magnitude of the potential impact for any TTS as a result of up to 21 vessels in the array area at the same time using the worst case density across the Offshore Development Area is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-81**).

Table 11-81 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TTS as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East and DBS West Together

Marine mammal species	Maximum number of individuals (% of reference population) for up to 21 vessels	Magnitude of impact
Harbour porpoise	0.59 (0.0002% of the NS MU reference population)	Negligible
Bottlenose dolphin	0.0009 (0.00005% of the GNS MU reference population)	Negligible
Common dolphin	0.048 (0.00005% of the CGNS MU reference population)	Negligible
White-beaked dolphin	0.03 (0.00007% of the CGNS MU reference population)	Negligible
Minke whale	0.007 (0.00003% of the CGNS MU reference population)	Negligible
Grey seal	0.35 (0.001% of the SE England MU or 0.0006% of the wider reference population).	Negligible (negligible)
Harbour seal	0.001 (0.000003% of the SE England MU reference population)	Negligible

11.6.2.3.3 Impact 3b Disturbance from Underwater Noise and Presence of Vessels

11.6.2.3.4 Magnitude of Impact – DBS East or DBS West in Isolation

640. As a precautionary approach, 2km has also been used as a potential disturbance range for operational and maintenance vessels, based on construction vessels (see section 11.6.1.4.5). The potential disturbance from up to 11 vessels in the DBS East or DBS West array area at the same time also been assessed based on maximum impact area of 138.27km^2 (for further information see **Appendix 11-3**). This is much less than the 66 vessels anticipated to be on site during the construction phase of the works.

641. Therefore, the magnitude of the potential impact is assessed as negligible for all species for any individual vessel and up to 11 vessels together (**Table 11-60**). The disturbance area of up to 138.27km^2 for 11 vessels does not take into account the overlap in the 2km disturbance range between vessels, therefore the disturbance area is the worst case scenario. The potential for disturbance that could result from underwater noise from vessels during operation and maintenance would be localised and temporary.

11.6.2.3.5 Magnitude of Impact – DBS East and DBS West Together

642. The magnitude of the potential impact of potential disturbance during construction is assessed as negligible for all species for up to 132 vessels in both array areas, with the exception of grey seal from the SE England MU which could have a low magnitude for up to 132 vessels in the array areas (**Table 11-61**).

643. There is the potential disturbance from up to 21 vessels in the array areas at the same time with a maximum impact area of 263.97km^2. Based on the magnitude of impact of vessels during the construction phase the magnitude of the potential impact is assessed as negligible for all species for individual vessel and up to 21 vessels together during operation and maintenance(for further information see **Appendix 11-3**). The disturbance area of up to 263.97km^2 for 21 vessels, is a highly conservative worst-case as it does not take into account the overlap in the 2km disturbance range between vessels.

11.6.2.3.6 Sensitivity of Receptor

644. The sensitivity of marine mammals to TTS as a result of underwater noise from vessels, is considered to be medium, as a precautionary approach. The sensitivity of disturbance is assessed as medium for harbour porpoise, minke whale and dolphin species and low for seal species (see section 11.6.1.4.8).

645. Marine mammals within the potential disturbance area would be expected to return to the area once the noise had ceased or they had become habituated to the sound.

11.6.2.3.7 Significance of effect – DBS East or DBS West in Isolation

646. Taking into account the marine mammal sensitivity to TTS and disturbance and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise of operational and maintenance vessels at either DBS East or DBS West has been assessed as **minor adverse (not significant in EIA terms)** for all species for TTS and for disturbance as **minor adverse** for harbour porpoise, minke whale and dolphin species and **negligible** (**not significant in EIA terms)** for grey and harbour seal (**Table 11-82)**

11.6.2.3.8 Significance of effect – DBS East and DBS West Together

647. The significance of effect for DBS East and DBS West together is assessed to have the same level of effect as DBS East or DBS West in isolation for TTS and disturbance as **negligible** to **minor adverse (not significant in EIA terms).**

11.6.2.3.9 Mitigation and residual significance of effect

648. No mitigation is required or proposed. Therefore, the residual significance of effect for TTS or disturbance from underwater noise of vessels at the array areas during operation and maintenance would remain the same for all species **negligible** to **minor adverse (not significant in EIA terms)**

Table 11-82 Assessment of Significance of Effect for the Potential for Disturbance from Vessels During Operation and Maintenance at DBS East and DBS West in Isolation or Together

Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Significance of effect
TTS due to construction vessels			
All marine mammal species	Medium	Negligible	Minor adverse
Disturbance due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale	Medium	Negligible	Minor adverse
Grey seal and harbour seal	Low	Negligible	Negligible

11.6.2.4 Impact 4 Barrier Effects

11.6.2.4.1 DBS East or DBS West in Isolation

649. No barrier effects as a result of underwater noise during operation and maintenance are anticipated at DBS East and DBS West in isolation.

650. As assessed in section 11.6.2.1, the magnitude for displacement (based on TTS / fleeing response) as a result of underwater noise from operational turbines has been assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with an significance of effect of **negligible (not significant)** for all species from TTS for DBS East and DBS West operating in isolation.

651. As outlined in **Chapter 5 Project Description**, the indicative separation distance between turbines would be a minimum of 0.83km therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine and there would be adequate room for marine mammals to move through the wind farm arrays at DBS East and/or DBS West.

652. As assessed in section 11.6.1.5 the magnitude for disturbance as a result of barrier effects from underwater noise from operation and maintenance activities is assessed as negligible for all marine mammal species based on maximum impact areas for all activities, with a **negligible** to **minor adverse** significance of effect for each DBS East or DBS West.

653. Therefore, any potential barrier effects as a result of underwater noise during operation and maintenance has not been assessed further for DBS East and DBS West in isolation.

11.6.2.4.2 DBS East and DBS West Together

654. No barrier effects as a result of underwater noise during operation and maintenance are anticipated for DBS East and DBS West together.

655. As assessed in section 11.6.2.1, the magnitude for displacement (based on TTS or disturbance) as a result of underwater noise from operational turbines has been assessed as **negligible to minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal for DBS East and DBS West operating together.

656. Therefore, any potential barrier effects as a result of underwater noise during operation and maintenance has not been assessed further.

11.6.2.5 Impact 5 Increased Collision Risk with Vessels During Operation and Maintenance

657. The increased risk of collision with vessels during operation and maintenance will be less than assessed for the construction period (section 11.6.1.6).

658. During the operation and maintenance phase the maximum number of vessels that could be on the windfarm site at any one time has been estimated at up to a total of 21 vessels in the Offshore Development Area at any given time (**Table 11-2**). The number, type and size of vessels will vary depending on the activities taking place at any one time. The vessels in the windfarm site during operation and maintenance will be slow moving or stationary.

659. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the array areas.

11.6.2.5.1 Magnitude of Impact – DBS East or DBS West in Isolation

660. It is estimated that the maximum number of vessels that could be required on site at any one-time during operation and maintenance could be 11 at DBS East or DBS West array area, which is less than the 66 vessels that could be on site during construction (**Table 11-83).** However, as a precautionary approach the assessment for construction has been used for the operation and maintenance assessment, as a worst-case scenario.

661. The potential for increased collision risk with construction or operation and maintenance vessels based on a precautionary worst-case scenario has been assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale the magnitude is negligible. For grey seal from the combined MUs the magnitude is low and negligible for the wider reference population and for the harbour the magnitude is low (**Table 11-83**).

662. This is a highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during operation and maintenance, considering the existing number of vessel movements in the area, and that vessels within the windfarm would be stationary for much of the time or very slow moving. Taking into account the disturbance from vessels, the actual risk is likely to be very low or negligible for all species.

Table 11-83 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels at DBS East and DBS West in Isolation

Species	Collision risk rate	Estimated total number of individuals in UK waters	Number of marine mammals at risk in UK waters	Annual number of vessel transits in UK and RoI for 2015	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with Operation and Maintenance	Number of marine mammals at increased risk (% of reference population)	Magnitude of impact
Harbour porpoise	0.0567	200,714	11,376	3,852,030	0.00295	237	0.7 (0.0002%)	Negligible
Bottlenose dolphin	0.0233	7,545	175	3,852,030	0.00005	237	0.011 (0.00053%)	Negligible
Common Dolphin	0.0750	57,417	4,309	3,852,030	0.00112	237	0.27 (0.00026%)	Negligible
White-beaked dolphin	0.0288	34,025	981.5	3,852,030	0.00025	237	0.06 (0.00014%)	Negligible
Minke Whale	0.0538	10,288	553	3,852,030	0.00014	237	0.034 (0.00017%)	Negligible

Species	Collision risk rate	Estimated total number of individuals in UK waters	Number of marine mammals at risk in UK waters	Annual number of vessel transits in UK and RoI for 2015	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with Operation and Maintenance	Number of marine mammals at increased risk (% of reference population)	Magnitude of impact
Grey Seal	0.0451	170,040	7,662	3,852,030	0.002	237	0.47 (0.0014%)	Low
Harbour Seal	0.0270	43,731	1,182	3,852,030	0.00031	237	0.07 (0.0015%)	Low

11.6.2.5.2 Magnitude of Impact – DBS East and DBS West Together

663. It is estimated that the maximum number of vessels that could be required both array areas at any one-time during operation and maintenance could be 21 at DBS East and DBS West array areas, which is less than the 132 vessels that could be on site during construction (**Table 11-2**). However, as a precautionary approach the assessment for construction has been used for the operation and maintenance assessment, as a worst-case scenario.

664. Based on the information in **Table 11-83** and 473 transits per year for operation and maintenance at DBS East and DBS West together, the potential for increased collision risk with construction or operation and maintenance vessels based on a precautionary worst-case scenario has been assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale. For grey seal from the combined MUs the magnitude is low and negligible for the wider reference population and for the harbour seal the magnitude is low (**Table 11-84**).

Table 11-84 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels at DBS East and DBS West Together

Species	Number annual vessel transits associated with Operation and Maintenance	Number of marine mammals at increased risk (% of reference population)	Magnitude of impact
Harbour porpoise	473	1.40 (0.0004%)	Negligible
Bottlenose dolphin	473	0.02 (0.0011%)	Negligible
Common dolphin	473	0.53 (0.00052%)	Negligible
White-beaked dolphin	473	0.12 (0.00027%)	Negligible
Minke whale	473	0.07 (0.00034%)	Negligible
Grey seal	473	0.94 (0.0027%)	Low
Harbour seal	473	0.15 (0.003%)	Low

11.6.2.5.3 Sensitivity of Receptor

665. As outlined in section 11.6.1.6.3 as a precautionary approach the sensitivity of marine mammals to collision risk with vessels during construction is considered to be high.

11.6.2.5.4 Significance of Effect – DBS East or DBS West in Isolation

666. Taking into account the high marine mammal sensitivity and the potential magnitude of impact, as assessed in **Table 11-83,** the significance of effect for any potential increased collision risk as a result of operation and maintenance vessels has been assessed as **minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale, **moderate adverse** for grey seal and harbour seal (**Table 11-85**).

667. It is unlikely that marine mammals would be at increased collision risk with vessels, in the Project area, as vessels within the array areas would be stationary for much of the time or very slow moving. Taking into account the collision risk from vessels, the actual risk is likely to be very low or negligible for all species.

11.6.2.5.5 Significance of Effect – DBS East and DBS West Together

668. As for the potential impacts from vessels during operation and maintenance for DBS East and DBS West in isolation, any potential increased collision risk as a result of operation and maintenance vessels for DBS East and DBS West together has been assessed as **minor adverse (not significant)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale, **moderate adverse** for grey seal and harbour seal (**Table 11-85**).

Table 11-85 Assessment of Significance of Effect for Increased Collision Risk with Vessels During Operation and Maintenance

Species	Sensitivity	Magnitude	Significance
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale	High	Negligible	Minor adverse
Grey seal and harbour seal	High	Low	Moderate adverse

11.6.2.5.6 Mitigation and Residual Significance of Effect

669. As outlined in section 11.3.3, vessel movements, where possible, will follow set vessel routes and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. These measures will be detailed within the PEMP.

670. Taking into account the mitigation to reduce the risk of collision with vessels, the residual significance of effect would be **minor adverse (not significant in EIA terms)** for all species (section 11.3.3), with the proposed best practice measures.

11.6.2.6 Impact 6 Changes to Prey

671. As outlined in **Chapter 10 Fish and Shellfish Ecology**, the potential impacts on fish species during operation and maintenance can result from:

- Permanent Habitat Loss;
- Temporary Habitat Loss, Physical Disturbance of The Seabed, Increased Suspended Sediment and Sediment Deposition;
- Underwater Noise;
- EMF;
- Barrier Effects from Underwater Noise or EMF;
- Introduction of Hard Substrate; and
- Changes in Fishing Activity.

672. Any impacts on prey species have the potential to affect marine mammals. **Chapter 10 Fish and Shellfish Ecology** found no difference in the significance of effect on receptors when assessed for DBS East or DBS West in isolation or together.

11.6.2.6.1 Magnitude of Impact

11.6.2.6.1.1 Long Term Habitat Loss

673. Habitat loss will occur during the lifetime of DBS East and DBS West as a result of structures, scour and external cable protection installed on the seabed. The introduction of hard substrate, such as wind turbine towers, foundations and associated scour protection and cable protection would increase habitat heterogeneity through the introduction of hard structures in an area predominantly characterised by sediment habitats.

674. Long term habitat loss has not been assessed as a direct impact on marine mammals, as any impacts of habitat loss would only cause an indirect effect in terms of changes in prey availability.

675. As outlined in **Chapter 10 Fish and Shellfish Ecology**, total long term habitat loss would be up to 4.93km^2 for DBS East and the offshore export cable corridor, and up to 5.51km^2 at DBS West and the offshore export cable corridor. This is considered not significant in the context of the amount of similar available habitat in the wider area. Overall, due to the presence of comparable habitats identified throughout the DBS East and DBS West offshore sites and the wider region, and the localised spatial extent of impacts, the magnitude of impact of long term habitat loss is considered to be low.

676. Based on the low sensitivity of prey species and a low magnitude of impact in relation to long term habitat loss during the operational phase of DBS East and DBS West, the significance of effect is assessed as **minor adverse** for prey species. Therefore, the magnitude is negligible for marine mammals.

11.6.2.6.1.2 Temporary Habitat Disturbance Through Maintenance of Wind Turbine Foundations, Scour Protection and Cables

677. The introduction of various man-made structures such as foundations and scour protection in soft sediment areas increases and changes habitat availability and type, potentially resulting in locally altered biodiversity as species are able to establish and thrive in previously hostile environments (Birchenough and Degraer 2020). The colonisation of such species may cause indirect effects on fish and shellfish populations if the structures act as artificial reefs, as well as direct impacts due to the potential of foundations acting as fish aggregation devices (FAD).

678. The introduction of new hard substrate in areas that are predominantly sandy or soft sediments may cause positive effects through potential habitat enhancement (Roach and Cohen 2020).

679. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase is less that assessed for the construction phase. It is expected that there would be a medium-term recovery (1 – 7 years) from any loss of habitat, disturbance to spawning and nursery areas, or the loss of individuals, as a result of activities occurring during the operational phase. The effect would result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low.

680. Based on the low sensitivity of prey species and a low to medium magnitude of impact in relation to temporary habitat disturbance during the operational phase of DBS East and DBS West, the significance of effect is assessed as **negligible** to **minor adverse** for prey species. Therefore, the magnitude is negligible for marine mammals.

11.6.2.6.1.3 Increased SSCs and Sediment Deposition

681. Increases in SSC within the water column and subsequent deposition onto the seabed may occur as a result of operation and maintenance activities. Disturbance caused by jack up vessel legs or anchors, as well as cable reburial and/or repair may result in small volumes of sediment being re-suspended. However, the volumes of sediment disturbed from such activities, as well as the overall duration of the disturbance, would be significantly less compared to construction.

682. Increases in SSCs are expected to cause localised and short-term increases at the point of discharge. Released sediment may then be transported in suspension in the water column by tidal currents. The worst case scenario for volume of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational phase of DBS East is 721,000m³ (325,000m³ for array cable trenching and 396,000m³ for offshore export cable trenching).

683. The worst case scenario for volume of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational phase of DBS West is 997,000m³ (325,000m³ for array cable trenching, 40,000m³ for inter-platform cables, and 632,000m³ for offshore export cable trenching).

684. Increased SSCs and levels of sediment re-deposition will be localised and short term. Therefore, the magnitude of SSC and re-deposition during the operational phase is considered to be negligible for prey species and marine mammals.

11.6.2.6.1.4 Re-Mobilisation of Contaminated Sediments

685. Contaminants in the area have not been reported at significantly elevated levels that would be a cause for concern. The works are not predicted to result in any change that is noticeable from the natural variation in background conditions. Any effects from the remobilisation of contaminated sediments and sediment redeposition are likely to be less than during the construction of DBS East and DBS West, either in isolation or together (**Chapter 8 Marine Physical Environment**).

686. The impact arising from remobilisation of contaminated sediments is considered to be negligible for both DBS East and DBS West in isolation for prey species and marine mammals.

11.6.2.6.1.5 Underwater Noise During Operation and Maintenance

687. Sources of underwater noise during operation and maintenance include operational wind turbines, maintenance activities, such as cable repairs, replacement and protection, and vessels.

688. Underwater noise modelling has been conducted to predict the potential impacts of these noise sources and activities on different types of fish groups (based on Popper *et al.* 2014) (see **Appendix 11-2**).

689. The underwater noise modelling results indicate that the maximum predicted impact ranges for operational turbines, cable laying, trenching, rock placement and vessels is less than 0.05km for all fish species.

690. In **Chapter 10 Fish and Shellfish Ecology** it is expected that during operation there will be only a slight and localised increase above background noise levels, therefore the magnitude of impact for fish species at either DBS East or DBS West is considered to be low. Therefore, there would be no additional impact on marine mammals as a result of any impacts on fish species from underwater noise during operation and maintenance. The magnitude of any potential impact would be negligible for marine mammals.

11.6.2.6.1.6 Electromagnetic Fields (EMF)

691. The Projects will transmit energy produced along the network of inter-array and platform link cables, linking the individual wind turbines and the turbines to the offshore substation. As energy is transmitted, the cables emit low-energy EMF. The electrical and magnetic fields generated increase proportionally to the amount of electricity transmitted.

692. Cables have a minimum burial depth of 0.5m, substantially reducing the levels of EMF in the surrounding area. Where cable burial is not possible due to hard substrate, protection will be added to reduce the levels of EMF.

693. There will be no direct effects of EMF on marine mammals, but EMF has the potential to interfere with the navigation of sensitive migratory and pelagic species by affecting the speed and/or course of their movements (see **Chapter 10 Fish and Shellfish Ecology** for further information).

694. Given the small area around the inter-array cables where the presence of EMF may be detected by fish and shellfish, contact with EMF will be limited and in the context of the wider available habitat the magnitude of this impact is considered to be negligible, and the significance of effect is **negligible** to **minor adverse**.

695. The magnitude of impact for any changes in prey resource for marine mammals from EMF during operation and maintenance would be negligible.

11.6.2.6.1.7 Changes in fishing activity

696. As outlined in **Chapter 13 Commercial Fisheries**, there is potential for commercial fishing activity to be displaced from within the windfarm site, due to presence of the subsurface structures. However, the windfarm site is located in an area with relatively low fishing intensity.

697. Therefore, any changes to prey resources as a result of changes to fishing activity during operational phase of the Project would be negligible to marine mammals.

11.6.2.6.2 Summary of Magnitudes of Impact

698. The magnitude for the potential changes in prey has been based on the assessments in **Chapter 10 Fish and Shellfish Ecology**. The magnitude of effect to marine mammal species is based on the magnitude of effect to prey species, although it should be noted that this is a precautionary approach as marine mammals are generally opportunistic foragers and would be able to prey upon a range of other species (**Table 11-86**).

*Table 11-86 Magnitude of Potential Changes to Prey Resources During Operation, Based on Assessments in **Chapter 10 Fish and Shellfish Ecology***

Potential effect to prey changes	Magnitude as assessed in Chapter 10
Long-term habitat loss	Low (effect significance of negligible to minor adverse)
Temporary habitat disturbance	Low (effect significance of n negligible to minor adverse)
Increased SSCs and sediment deposition	Low (effect significance of negligible to minor adverse)
Re-mobilisation of contaminated sediment	Negligible (effect significance of negligible)
Underwater noise and vibration	Low (effect significance of minor adverse)
Electromagnetic fields	Negligible (effect significance of negligible)
Changes in fishing activity	Low (effect significance of negligible)

11.6.2.6.3 Sensitivity of Receptor

699. As outlined in section 11.6.1.7.13 harbour porpoise are considered to have low to medium sensitivity to changes in prey resources. All dolphin species are considered to have low sensitivity to changes in prey resources. Minke whale are considered to have a low to medium sensitivity to changes in prey resource. Grey seal and harbour seal are considered to have low to medium sensitivity to changes in prey resources.

11.6.2.6.4 Significance of Effect

700. Taking into account the marine mammal sensitivity for each species and the negligible potential magnitude of the impact, the significance for any changes in prey resource during operation and maintenance has been assessed as **minor adverse (not significant in EIA terms)** for all species (**Table 11-87)**

11.6.2.6.5 Mitigation and Residual Significance of Effect

701. No mitigation is required or proposed. Therefore, the residual significance of effect for any changes to prey resource during the operation and maintenance at the windfarm sites would be **minor adverse (not significant in EIA terms)** for all species (**Table 11-87**).

Table 11-87 Assessment of Significance of Effect for the Potential of an Indirect Effect to Marine Mammals Through Changes to Prey Resources During Operation and Maintenance

Potential effect	Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Significance of effect
Long-term habitat loss Temporary habitat disturbance	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Increased SSCs and sediment deposition Re-mobilisation of contaminated sediment	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Underwater noise and vibration Electromagnetic fields	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Changes in fishing activity Long-term habitat loss	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Negligible	Negligible to Minor adverse

Potential effect	Marine mammal species	Sensitivity to potential effect	Magnitude of impact	Significance of effect
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Temporary habitat disturbance Increased SSCs and sediment deposition	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Re-mobilisation of contaminated sediment Underwater noise and vibration	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Negligible	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Electromagnetic Fields	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse

11.6.2.7 Impact 7 Changes to Water Quality

702. As outlined in **Chapter 8 Marine Physical Environment** potential changes in water quality during operation and maintenance are:

- Deterioration in water quality through an increase in suspended sediment due to cable repairs / reburial; and
- Deterioration in water quality through an increase in suspended sediment due to maintenance activities.

11.6.2.7.1 Magnitude of Impact-DBS East or DBS West in Isolation

703. As assessed in **Chapter 8 Marine Physical Environment** any potential changes in water quality at DBS East and DBS West during operation and maintenance would be negligible.

11.6.2.7.2 Magnitude of Impact-DBS East and DBS West Together

704. The magnitude of impact for DBS East and DBS West together is considered to be the same as the Projects in isolation.

11.6.2.7.3 Sensitivity of Receptor

705. As outlined in section 11.6.1.8 marine mammals are considered to have negligible sensitivity to any changes in water quality.

11.6.2.7.4 Significant of effect – DBS East or DBS West in Isolation

706. Taking into account the negligible sensitivity of marine mammals and negligible magnitude the significance of effect for any changes in water quality during operation and maintenance at DBS East and DBS West in isolation has been assessed as **negligible**.

11.6.2.7.5 Significant of effect – DBS East and DBS West Together

707. Taking into account the negligible sensitivity of marine mammals and negligible magnitude the significance of effect for any changes in water quality during operation and maintenance at DBS East and DBS West together has been assessed as **negligible**.

11.6.2.8 Impact 8 Disturbance at seal haul-out sites

11.6.2.8.1 Magnitude of Impact -DBS East or DBS West in Isolation

708. As assessed in section 11.6.1.9 the closest seal haul out sites are Filey brigg, (28km from landfall, 25km from the export cable corridor, 106 km from DBS East and 132km from DBS West); Ravenscar (52km from landfall, 62km from export cable corridor, 140km from DBS East and 150km from DBS West at closest point). Donna Nook (62km from landfall, 65km from export cable corridor, 153km form DBS East and 151km from BDS West at closest point).

709. As outlined in section 11.6.1.9, the studies by Edren *et al.* (2010) and Russel *et al.* (2016), there could be disturbance at seal haul-out sites 4km and 25km, respectively, during operation and maintenance activities. Due to the distances of the haul out sites from the Projects, it is very unlikely that any operation and maintenance activities will cause a disturbance. vessel movement from the Projects to port. The potential for any increase in disturbance to seal haul-out sites as a result of operation activities will be from vessel movements during operation and maintenance.

710. In total, for the operation and maintenance of either DBS East or DBS West, up to 237 round trips to port from the array area each year for five years. This represents a slight significant increase in the current number of vessels in the area.

711. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels. Therefore, the magnitude of impact of grey and harbour seals at haul-out sites to disturbance from vessels during operation is assessed as low.

712. As noted in section 11.6.1.9 it has not been confirmed which ports will be used. However, vessels would use established vessel routes to the port and, where possible, transiting vessels would maintain distances of 600m or more off the coast, particularly in areas near known seal haul-out sites during sensitive periods.

11.6.2.8.2 Magnitude of Impact -DBS East and DBS West Together

713. The impacts for DBS East and DBS West would be similar to that presented for DBS East and DBS West in isolation. While the number of vessels, under the scenario of DBS East and DBS West together, will be an increase in comparison to the DBS East and DBS West scenario, up to 473 round trips to port from the array area each year for five years. The majority will be small vessels, and are unlikely to cause any disturbance to seals at haul-out sites. In addition, this is a small increase in terms of vessel transits per day above baseline levels.

11.6.2.8.3 Sensitivity of Receptor

714. The sensitivity of disturbance to both grey seal and harbour seal at haul-out sites would be the same for the operational period as for the construction period (section 11.6.1.9). Therefore, the sensitivity is low for both species, and is increased to medium during the pupping and moult periods of both species, to account for their increased sensitivity during that period.

11.6.2.8.4 Significance of Effect at DBS East or DBS West in Isolation

715. Taking into account the low to medium sensitivity and negligible magnitude of the temporary impact from maintenance activities, the significance of effect for disturbance at seal haul-out sites has been assessed as **negligible** to **minor adverse** (not significant) for both grey seal and harbour seal (**Table 11-88**). For disturbance from vessels during the O&M phase the magnitude of impact is low and the significance of effect has been assessed as **minor adverse** (not significant) for both grey seal and harbour seal (**Table 11-88**).

11.6.2.8.5 Significance of Effect at DBS East and DBS West Together

716. It is considered the significance of effect of impacts for the Projects in isolation will be equal to the effects of DBS East and DBS West together. As such the significance of effect has been assessed as **minor adverse** (not significant) for both grey seal and harbour seal (**Table 11-88**).

11.6.2.8.6 Mitigation and Residual Significance of Effect

717. No mitigation is required for the disturbance of seals at haul-out sites. However, as best practice where possible and safe to do so, transiting vessels would maintain distances of 600m or more off the coast, particularly in areas near known seal haul-out sites during sensitive periods. See section 11.6.1.9.6 for further information.

Table 11-88 Assessment of Significance of Effect for Disturbance at Seal Haul-Out Sites During Operation and Maintenance

Species	Impact	Sensitivity	Magnitude	Significance
Grey seal	Disturbance from O&M activities	Low to Medium	Negligible	**Negligible to minor adverse**
	Disturbance from vessels		Low	**Minor adverse**
Harbour seal	Disturbance from O&M activities	Low to Medium	Negligible	**Negligible to minor adverse**
	Disturbance from vessels		Low	**Minor adverse**

11.6.3 Potential Effects During Decommissioning

718. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in **Chapter 5 Project Description** and the detail would be agreed with the relevant authorities at the time of decommissioning. Offshore, this is likely to include removal of all the turbine elements, part of the foundations (those above seabed level), removal of some or all of the infield cables, interlink cables, and export cables.

719. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise which would not occur).

720. The potential impacts during decommissioning that will be assessed for marine mammals include:

- Impact 1: Underwater noise and disturbance from decommissioning activities;
- Impact 2: Underwater noise and disturbance from vessels;
- Impact 3: Barrier effects as a result of underwater noise;
- Impact 4: Increased collision risk with vessels;
- Impact 5: Changes to prey resource
- Impact 6: Changes to water quality; and
- Impact 7: Disturbance at seal haul-out sites.

721. Potential impacts on marine mammals associated with decommissioning have not been assessed in detail, as further assessments will be carried out ahead of any decommissioning works to be undertaken taking account of known information at that time, including relevant guidelines and requirements. A detailed decommissioning programme will be provided to and approved by the Secretary of State for Business, Energy and Industrial Strategy (BEIS) prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

722. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction DBS East and DBS West in isolation (with the exception of pile driving noise which would not occur).

723. The potential impacts on marine mammals during decommissioning would be expected to be the same or less than those assessed for construction in section 11.6.1.

11.7 Preliminary Assessment of Cumulative Effect

724. As detailed in section 11.4.4, this section presents a preliminary assessment of cumulative effects in relation to **Chapter 11 Marine Mammal Ecology**. The final CEA will be undertaken within the ES chapter.

11.7.1 Initial Screening for Cumulative Effects

725. **Table 11-89** below details the potential cumulative effects that may occur between the Projects and other plans, projects and activities. Only potential impacts assessed in section 11.4.3.1.4, where the potential for cumulative effects has been identified (minor, moderate or major) will be considered during the final CEA (i.e. those assessed as 'no impact' are not taken forward as there is no potential for them to contribute to a cumulative impact).

726. The first step in the CEA is the identification of the impacts assessed for the Projects that have the potential for a cumulative effect with other plans, projects and activities (described as 'effect screening'). Only potential effects assessed as greater than negligible are considered in the CEA (i.e., those assessed as 'negligible' are not taken forward as there is no potential for them to contribute to a cumulative effect).

Table 11-89 Potential Cumulative Effects

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Construction			
Impact 1: Permanent and temporary auditory injury from underwater noise during piling	Yes	High	If there is the potential for any PTS, from any project, suitable mitigation would be put in place to reduce any risk to marine mammals. Project alone, the effect is expected to be minimal, however this might not be the case for the Projects in-combination. Therefore, the potential risk of PTS in marine mammals from cumulative effects has been screened in for further consideration in the CEA and further information will be given during the assessment at ES.
Impact 2: Disturbance or behavioural effects from underwater noise	Yes	High	There is the potential for cumulative disturbance or TTS / fleeing response due to underwater noise. Disturbance ranges are the widest ranging underwater noise effects assessed, and therefore are used to inform the assessment as a worst-case. Potential TTS ranges have been used to inform the assessment where there is a lack of further relevant information for disturbance. Projects / activities with the potential for cumulative effects due to disturbance from underwater noise: • Piling at OWFs; • Other construction activities at OWFs (other than piling) including vessels, cable installation works, dredging, seabed preparation and rock placement; • geophysical and seismic surveys; • Aggregate extraction and dredging; • Subsea cable and pipelines; and

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
			• UXO clearance.
Impact 3: Barrier effects as a result of underwater noise during construction	Yes	High	There is a possibility of temporal and spatial coincidence of barrier effects from disturbance of other wind farms in the area acting on the same populations due to the number of other wind farms in close proximity.
Impact 6: Increased collision risk with vessels during construction	Yes	High	The significance of effect in this assessment for increased collision risk with vessels during construction (section 11.6.1.6) is assessed as moderate to minor adverse as a precaution for all species assessed. Therefore, there is sufficient likelihood to justify a quantitative cumulative effects assessment.
Impact 7: Changes to prey resources	Yes	Low	Changes to prey resources in this assessment is assessed as negligible to minor adverse (for further information see section 11.6.1.7). Therefore, as a worst-case of minor adverse significance, it is sufficient likelihood to justify a quantitative cumulative effects assessment.
Impact 8: Changes to water quality	No	High	No significant effects with regard to water quality are expected as a result of the Projects. All other projects would be required to have equivalent mitigation and prevention as the Projects and therefore have no significant effects. Any changes to water quality as a result of aggregate extraction and dredging would be very localised and temporary. Changes to water quality (including from aggregate extraction and dredging) have been screened out from the CEA.

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Impact 9: Disturbance of seals at haul-out sites	Yes	High	The significance of effect in this assessment for disturbance of seals at haul-out sites (section 11.6.1.9) is assessed as negligible to minor adverse. Therefore, as a worst-case of minor adverse significance, it is sufficient likelihood to justify a quantitative cumulative effects assessment.
Operation & Maintenance			
Impact 1: Impacts from underwater noise associated with operational wind turbines	No	High	Impacts from underwater noise associated with operational wind turbines for nearby plans / projects could result in a cumulative effect on marine mammal receptors.
Impact 2: Impacts from underwater noise associated with operation and maintenance activities	No	High	Impacts from underwater noise associated with operation and maintenance activities for nearby plans / projects could result in a cumulative effect on marine mammal receptors.
Impact 3: Impacts from underwater noise due to the presence of vessels	No	High	Impacts from underwater noise due to the presence of vessels for nearby plans / projects could result in a cumulative effect on marine mammal receptors.
Impact 4: Barrier effects	No	High	Barrier effects from nearby plans / projects could result in a cumulative effect on marine mammal receptors.

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Impact 5: Increased collision risk with vessels during operational and maintenance	No	High	Increased collision risk with vessels during operational and maintenance activities for nearby plans / projects could result in a cumulative effect on marine mammal receptors.
Impact 6: Changes to prey resources	No	Low	Impacts from changes to prey from nearby plans / projects could result in a cumulative effect on marine mammal receptors.
Impact 7: Changes to water quality	No	High	As mentioned for construction, no significant effects with regard to water quality are expected as a result of the Projects. Therefore, changes to water quality (including from aggregate extraction and dredging) have been screened out from the CEA.
Impact 8: Disturbance at seal haul-out sites	No	High	Impacts from disturbance at seal haul-out sites from nearby plans / projects could result in a cumulative effect on marine mammal receptors.
Decommissioning			
Impact 1: Permanent and temporary auditory injury from underwater noise during piling	No	High	Decommissioning is assumed to be no worse than construction. Decommissioning arrangements will be detailed in a Decommissioning Programme, which will be drawn up and agreed with BEIS prior to construction. It is assumed that the cumulative effects will be similar to the effects during construction. Therefore, as construction will be getting assessed, all decommissioning effects have been screened out.
Impact 2: Disturbance or behavioural	No	High	

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
effects from underwater noise during piling			
Impact 3: TTS and disturbance from underwater noise during other construction activities	No	High	
Impact 4: TTS and disturbance from underwater noise due to the presence of vessels	No	High	
Impact 5: Barrier effects as a result of underwater noise during construction	No	High	
Impact 6: Increased collision risk with vessels during construction	No	High	

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Impact 7: Changes to prey resources	No	Low	
Impact 8: Changes to water quality	No	High	
Impact 9: Disturbance of seals at haul-out sites	No	High	

11.7.2 Plans/Projects Considered for Cumulative Impacts

727. A high-level list of plans/projects that may result in cumulative effects with the Projects will be detailed in a supporting appendix at ES. For marine mammal ecology a search area will be based on the relevant MU for each species and will be used for the assessment to determine the initial list of projects considered for the CEA. Given the extensive area covered by the Marine Mammals Study Area and the high likelihood of change between PIER and ES, the list of plans/projects has not been included at this stage. A high-level list of plans/projects that may result in cumulative effects with the Projects will be detailed in a supporting appendix at ES.

728. For the marine mammal species in the assessments, the following study areas have been defined, based on the relevant MUs (IAMMWG 2022) and current knowledge and understanding of the biology of each species:

- Harbour porpoise: North Sea (NS) MU;
- Bottlenose dolphin: Greater North Seas (GNS) MU;
- Common dolphin: Celtic and Greater North Seas (CGNS) MU;
- White beaked dolphin: CGNS MU;
- Minke whale: CGNS MU;
- Grey seal: South-east (SE) England, and the North-east England (NE) MUs; and
- Harbour seal: SE England MU.

729. Note that, due to the large size of the common dolphin, white-beaked dolphin and minke whale MU, projects and plans will only be considered only if they are located within the NS MU or GNS MU area as appropriate (See **Figure 11-1**), in order to provide a more realistic while still precautionary list of projects that may have an impact on the same population as the Projects.

730. Plans / projects have will be assigned a tier level between 1 and 7, based on the most recent guidance (see **Chapter 6 EIA Methodology**). For the final CEA at ES, the project list will be reviewed and screened to ensure all relevant plans / projects are considered in the final assessment. All listed plans / projects will be re-examined at ES to ensure each assigned tier remains accurate at the time of writing.

731. In addition, other offshore wind farms, the classes of projects that could potentially be considered for the cumulative assessment of marine mammal receptors include (as mentioned in section 11.4.4):

- Marine renewable (wave and tidal) developments
- Geophysical surveys (such as those associated with OWFs)
- Oil and gas installations
  - Construction
  - Operation
  - Decommissioning
- Seismic surveys
- Aggregate extraction and dredging
- Licenced disposal sites
- Sub-sea cables and pipelines
- UXO clearance
- Other industries - gas storage, offshore mines, and carbon capture projects
- Coastal developments, such as ports and harbours
- Shipping
- Commercial fisheries

732. With respect to these activities, the cumulative assessment will take into account the fact that marine mammals are expected to already be habituated to long-term, on-going activities and therefore these may be considered to be part of the baseline conditions. Therefore, it is important to avoid double-counting or exaggeration of potential impacts.

733. The level of data available and the ease with which impacts can be combined across the wind farms is quite variable, reflecting the availability of relevant data for older projects and the approach to assessment taken. Wherever possible the cumulative assessment will be quantitative (i.e. where data in an appropriate format will be obtained). Where this is not possible (e.g. for older projects) a qualitative assessment will be undertaken.

11.8 Potential Monitoring and Mitigation Requirements

734. Monitoring requirements will be described in the In-Principal Monitoring Plan (IPMP) submitted alongside the DCO application and further developed and agreed with stakeholders prior to construction based on the IPMP and taking account of the final detailed design of the Projects.

735. Mitigation will be required for the following activities, and will use the relevant JNCC guidelines as standard (the relevant guidelines are noted below):

- UXO clearance
  - Following the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC 2010a)
- Piling
  - Following the Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC 2010b)

736. While the JNCC guidelines will be used as a standard, they may be adapted to ensure that the predicted instantaneous and cumulative PTS ranges are mitigated against, for all marine mammal species. It is expected that ADDs will be used as part of the mitigation for both UXO clearance and piling. Mitigation and monitoring protocols will be developed for each of the above listed activities.

737. Mitigation and monitoring will be secured through the following management plans (**Table 11-90**). An outline MMMP and Southern North Sea SAC Site Integrity Plan will be submitted with the DCO application.

Table 11-90 Additional Mitigation

Parameter	Additional mitigation measures
MMMP for piling activities	
MMMP for Piling Activities	The MMMP for piling will be developed in the pre-construction period and based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will be developed in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs) and the MMO, detailing the proposed mitigation to reduce the risk of any physical or permanent auditory injury (PTS) to marine mammals during all piling operations.
MMMP for UXO	A detailed MMMP will be prepared for UXO clearance during the pre-construction phase. The MMMP for UXO clearance will ensure there are adequate mitigation to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation, based upon best available information and methodologies at that time, in consultation with the MMO and relevant SNCBs.
Site Integrity Plan	
Southern North Sea SAC Site Integrity Plan (SIP)	In addition to the MMMPs for piling and UXO clearance, a Southern North Sea SAC SIP will be developed. The SIP will set out the approach to deliver any project mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the Southern North Sea SAC conservation objectives. The SIP will be an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the Southern North Sea SAC. The SIP will be developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and MMO.

738. A summary report will be provided following all activities as outlined above, to provide detail on the activities and mitigation undertaken. The summary reports will also provide detail on any marine mammal presence during each of the relevant activities.

11.9 Transboundary Effects

739. The highly mobile nature of marine mammals included within this assessment means that 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 to part of one larger overall population). The MUs (and therefore reference populations) for each species covers an area wider than the UK (**Table 11-91**). This approach has been taken through all of the assessments.

Table 11-91 Other Countries Considered in the Marine Mammal Assessments Through the Relevant MU Reference Populations

Country	Marine mammal species	Inclusion within assessment
Germany	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Netherlands	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.

Country	Marine mammal species	Inclusion within assessment
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Belgium	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
France	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Denmark	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.

Country	Marine mammal species	Inclusion within assessment
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Sweden	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Norway	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for both white-beaked dolphin and minke whale.

Country	Marine mammal species	Inclusion within assessment
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.

740. There is a substantial level of marine development being undertaken, and being planned, by other countries (including Belgium, the Netherlands, Germany and Denmark) in the Southern North Sea. Each of these countries have their own independent environmental assessment requirements and controls. As noted above, marine mammals are highly mobile and there is therefore the potential for transboundary impacts, especially with regard to noise. In addition, if there is the potential for DBS East and DBS West to impact marine mammals from other designated sites, this will be assessed in the RIAA.

11.10 Interactions

741. The effects identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between effects are presented in **Table 11-92**.

742. The worst-case impacts assessed within the chapter take these interactions into account, and therefore the impact assessments are considered conservative and robust. Synergistic impacts of potential disturbance from underwater noise during construction from all potential noise sources have been assessed as potential barrier effects in the following tables.

743. In **Table 11-92** the effects are assessed relative to each development phase to see if multiple effects could increase the significance of the effect upon a receptor. Following this a lifetime assessment is undertaken which considers the potential for an effect to affect receptors across all development phases; (assessment for construction, operation and maintenance or decommissioning) to determine if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor.

744. The significance of each individual impact is determined by the sensitivity of the receptor and the magnitude of impact; the sensitivity is constant whereas the magnitude may differ. Therefore, when considering the potential for impacts to be additive it is the magnitude of impact which is important – the magnitudes of the different effects are combined upon the same sensitivity receptor.

Table 11-92 Interactions Between Impacts - Screening

Potential Interactions between Impacts									
Construction									
	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9
Impact 1: Permanent and Temporary Auditory Injury from Underwater Noise during Piling		Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
Impact 2: Disturbance or Behavioural Effects from Underwater Noise during Piling	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes
Impact 3: TTS and Disturbance from Underwater Noise during other construction activities	Yes	Yes		Yes	Yes	No	Yes	Yes	Yes

Potential Interactions between Impacts									
Impact 4: TTS and Disturbance from Underwear Noise and presence of vessels	Yes	Yes	Yes		Yes	No	Yes	Yes	Yes
Impact 5: Barrier Effects as A Result of Underwater noise	Yes	Yes	Yes	Yes		No	Yes	Yes	Yes
Impact 6: Increased Collision Risk with Vessels	No	No	No	No	No		No	No	No
Impact 7: Changes to Prey Resources	Yes	Yes	Yes	Yes	Yes	No		Yes	Yes
Impact 8: Changes to Water Quality	Yes	Yes	Yes	Yes	Yes	No	Yes		Yes
Impact 9: Disturbance of Seals at Haul-Out Sites	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	

Potential Interactions between Impacts									
Operation									
	Impact 1	Impact 2	Impact 3	Impact 4	Impact 5	Impact 6	Impact 7	Impact 8	Impact 9
Impact 1: Disturbance or Behavioural Effects from Underwater Noise during Piling	Yes		Yes	Yes	Yes	No	Yes	Yes	Yes
Impact 2: TTS and Disturbance from Underwater Noise during other construction activities	Yes	Yes		Yes	Yes	No	Yes	Yes	Yes
Impact 3: TTS and Disturbance from Underwear Noise and presence of vessels	Yes	Yes	Yes		Yes	No	Yes	Yes	Yes
Impact 4: Barrier Effects as A Result of Underwater noise	Yes	Yes	Yes	Yes		No	Yes	Yes	Yes

Potential Interactions between Impacts									
Impact 5: Increased Collision Risk with Vessels	No	No	No	No	Yes		No	No	No
Impact 6: Changes to Prey Resources	Yes	Yes	Yes	Yes	Yes	No		Yes	No
Impact 7: Changes to Water Quality	Yes	Yes	Yes	Yes	Yes	Yes	Yes		No
Impact 8: Disturbance of Seals at Haul-Out Sites	Yes	Yes	Yes	Yes	Yes	No	No	No	
Decommissioning									
It is anticipated that the decommissioning impacts will be no greater than construction									

Table 11-93 Interaction Between Impacts - Phase and Lifetime Assessment

Receptor	Highest Significance Level				
	Construction	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Harbour porpoise, Bottlenose dolphin, Common dolphin, White-beaked dolphin, Minke whale, Grey seal harbour seal	Minor adverse	Minor adverse	Minor adverse	***Construction*** The MMMP (for piling) will reduce the risk of injury for marine mammals and therefore during piling there will be no pathway for interaction of potential injury with disturbance effects (i.e. all individuals are assumed to be disturbed if within range and excluded from the disturbance footprint). Likewise, there is no pathway for vessel interaction or effects on prey resource to interact with noise impacts as it is assumed that individuals will be excluded from the	No greater than individually assessed impact. The greatest magnitude of impact will be the spatial footprint of construction noise (i.e. piling). Once this disturbance impact has ceased all further impact during construction and operation will be small scale, highly localised and episodic. There is no evidence of long term displacement of marine mammals from operational wind farms. It is therefore considered that over the Projects

Receptor	Highest Significance Level				
	Construction	Operation	Decommissioning	Phase Assessment	Lifetime Assessment
				disturbance footprint (i.e. there cannot be a vessel interaction if the individual is excluded from the vicinity of the construction works). Once noisy activities have ceased the footprint of disturbance and changes to prey resource will be highly localised. It is therefore considered that the interaction of these impacts would not represent an increase in the significance level. ***Operation*** Operational noise impacts from wind turbines will be highly localised to within 0.1km of each wind turbine, whilst the majority of	lifetime these impacts would not combine and represent an increase in the significance level.

Receptor	Highest Significance Level				
	Construction	Operation	Decommissioning	Phase Assessment	Lifetime Assessment
				change to habitat for prey species will also be confined to the immediate footprint of wind turbine. The magnitude of impact is negligible and relates to largely the same spatial footprint. Therefore, there is no greater impact as a result of any interaction of these impacts. There is potential for interaction with maintenance noise disturbance and vessel interaction, but given the negligible magnitudes of effect and episodic nature of these impacts it is not considered that that the interaction of these impacts would represent an increase in the significance level.	

11.11 Inter-relationships

745. There are clear inter-relationships between the marine sediment and water quality topic, and several other topics, that have been considered within this PEIR. For marine mammals potential inter-relationships between other topics assessed within this PEIR including underwater noise form vessels, collision risk form vessels, changes to prey availability and changes to water quality. A summary of the potential inter-relationships is provided in **Table 11-94**.

Table 11-94 Marine Mammal Inter-Relationships

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Construction			
Underwater noise from vessels	Chapter 14 Shipping and Navigation	Section 11.6.1.4	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
Increased risk of collision with vessels	Chapter 14 Shipping and Navigation	Section 11.6.1.6	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
Changes to water quality	Chapter 8 Marine Physical Environment	Section 11.6.1.8	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Changes to prey resources	Chapter 11 Fish and Shellfish Ecology	Section 11.6.1.7	Potential effects on fish species could affect the prey resource for marine mammals.
Operation			
Underwater noise from vessels	Chapter 14 Shipping and Navigation	Section 11.6.2.3	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Increased risk of collision with vessels	Chapter 14 Shipping and Navigation	Section 11.6.2.5	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
Changes to water quality	Chapter 8 Marine Physical Environment	Section 11.6.2.7	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Changes to prey resources	Chapter 10 Fish and Shellfish Ecology	Section 11.6.2.6	Potential effects on fish species could affect the prey resource for marine mammals.
Decommissioning			
Underwater noise from vessels	Chapter 14 Shipping and Navigation	Section 11.6.3	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
Increased risk of collision with vessels	Chapter 14 Shipping and Navigation	Section 11.6.3	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
Changes to water quality	Chapter 8 Marine Physical Environment	Section 11.6.3	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Changes to prey resources	Chapter 10 Fish and Shellfish Ecology	Section 11.6.3	Potential effects on fish species could affect the prey resource for marine mammals.

11.12 Marine Wildlife Licence Application

746. A Marine Wildlife Licence application would be made for all activities that have the potential for injury or disturbance on EPS (cetaceans). The activities that may require an EPS licence are:

- Piling;
- UXO clearance; and
- Geophysical surveys.

747. Prior to these activities taking place, an EPS risk assessment will be undertaken, following the staged approach as outlined in 'The protection of Marine European Protected Species from injury and disturbance' (JNCC *et al.* 2010). If it is deemed that an EPS licence is required for any activity, an EPS Risk Assessment document will be produced, and Marine Wildlife Licence applied for.

748. Mitigation will be put in place for piling and any required UXO clearance as per the JNCC guidelines. Where ADDs are required, these will also be considered within the risk assessments.

11.13 Summary

749. This chapter has provided a characterisation of the existing environment for marine mammals based on both existing and site specific survey data which has established that, with the identified mitigation in place, the overall significance of effects will be **minor adverse (not significant in EIA terms)** as summarised in **Table 11-95**.

Table 11-95 Summary of Potential Likely Significant Effects on Marine Mammals

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Construction						
Impact 1a: PTS auditory injury from underwater noise during piling due to a single strike at maximum hammer energy at a single location or at both locations concurrently	All marine mammal species	High	**Negligible**	Minor adverse	MMMP for piling will significantly reduce any potential for marine mammals to be within the PTS effect area	**Minor adverse**
Impact 1a: PTS auditory injury from underwater noise from multiple sequential monopiles or jacket pin piles at a single location	Harbour porpoise and minke whale	High	**Medium**	Major adverse		**Minor adverse**
	Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		**Negligible**	Minor adverse		**Minor adverse**
	Grey seal		**Low**	Moderate adverse		**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 1a: PTS auditory injury from underwater noise from multiple sequential monopiles (or jacket pin piles) at both locations concurrently	Harbour porpoise and minke whale	High	**High**	Major adverse		**Minor adverse**
	Bottlenose dolphin, common dolphin, white-beaked dolphin		**Negligible**	Minor adverse		**Minor adverse**
	Grey seal		**Medium - Low**	Major to moderate adverse		
	Harbour seal		**Negligible**	Minor adverse		
Impact 1b: TTS auditory injury from underwater noise during piling due to a single strike at maximum hammer energy at single location or at both locations concurrently	All marine mammals	Medium	**Negligible**	Minor adverse	MMMP for piling will minimise TTS effects	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 1b: TTS auditory injury from underwater noise during concurrent piling exposure at multiple sequential monopiles at a single location	Harbour porpoise	Medium	**Low**	Minor adverse		**Minor adverse**
	Grey seal		DBS East: **Low (low)** DBS West**: Low (negligible)**	Minor adverse		
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		**Negligible**	Minor adverse		**Minor adverse**
Impact 1b: TTS auditory injury from underwater noise during concurrent piling exposure at	Harbour porpoise	Medium	DBS East: **negligible** DBS West**: low**	Minor adverse		**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
multiple sequential jacket pin piles at a single location	Grey seal		DBS East: **Negligible (negligible)** DBS West**: Low (negligible)**	Minor adverse		
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		**Negligible**	Minor adverse		
Impact 1b: TTS auditory injury from underwater noise from multiple sequential monopiles or jacket pin piles at both locations concurrently	Harbour porpoise	Medium	**Low**	Minor adverse		
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		**Negligible**	Minor adverse		**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
	Grey seal		**Medium (low)**	Moderate adverse		
Impact 2: Disturbance or behavioural effects from underwater noise during piling (single or two simultaneous events) at a single location	Harbour porpoise	Medium	**Negligible to low**	Minor adverse	No Mitigation required	**Minor adverse**
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		**Negligible**	Minor adverse		
	Grey seal		**Low (negligible)**	Minor adverse		
Impact 2: Disturbance or behavioural effects from underwater noise during piling simultaneously at three locations	Harbour porpoise	Medium	**Low to Negligible**	Minor adverse	MMMP for piling will minimise these effects, additional mitigation to be considered if required, such as noise abatement systems	**Minor adverse**
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		**Negligible**	Minor adverse		

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
	Grey seal		**Medium (low)**	Moderate adverse to minor adverse		
	Harbour seal		**Negligible**	Minor adverse		
Impact 2: Reduction in foraging due to noise disturbance for a single piling event and two simultaneous piling events	All marine mammals	Medium	**Low**	Minor adverse	No Mitigation required	**Minor adverse**
Impact 2: Potential for disturbance based on a dose-response curve at a single location	Harbour porpoise and grey seal	Medium	**Low**	Minor adverse	No Mitigation required	**Minor adverse**
	Harbour seal		**Negligible**	Minor adverse		
Impact 2: Potential for disturbance based on a	Harbour porpoise	Medium	**Low (low)**	Minor adverse	MMMP for piling will minimise these	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
dose-response curve for monopiles (or jacket pin piles) at both locations concurrently	Grey seal		**Medium (low)**	Moderate adverse to minor adverse	effects, additional mitigation to be considered if required, such as noise abatement systems	
	Harbour seal		**Negligible (negligible)**	Minor adverse	No Mitigation required	**Minor adverse**
Impact 2: Disturbance or behavioural effects from ADDs	All marine mammal species	Medium	**Negligible**	Minor adverse	No Mitigation required	**Minor adverse**
Impact 3a/b: TTS and Disturbance from underwater noise during other construction activities in isolation and together	All marine mammal species	Medium	**Negligible**	Minor adverse	No Mitigation required	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 4a: TTS from underwater noise and presence of vessels in array areas in isolation and together	All marine mammal species	Medium	**Negligible**	Minor adverse	No Mitigation required	**Minor adverse**
Impact 4b: Disturbance from underwater noise and presence of vessels in array areas in isolation and together	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal	Medium	**Negligible**	Minor adverse	No Mitigation required	**Minor adverse**
	Grey seal		**Low to Negligible (Negligible)**	Minor adverse		**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 5: Barrier effects as a result of underwater noise during construction in isolation and together	All marine mammal species	Medium	**Negligible**	Minor adverse	No mitigation proposed. However, measures in SIP will reduce potential significant disturbance of harbour porpoise (and other marine mammals).	**Minor adverse**
Impact 6: Increased collision risk and vessels during construction at array areas in isolation	White-beaked dolphin and minke whale	High	**Negligible**	Minor adverse	Best Practice Measures in PEMP.	**Minor adverse**
	Harbour porpoise, bottlenose dolphin, common dolphin, grey seal and harbour seal		**Low**	Moderate adverse		

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 6: Increased collision risk and vessels during construction at array areas together	All marine mammals	High	**Low**	Moderate adverse	Best Practice Measures in PEMP.	**Minor adverse**
Impact 7: Changes to prey resources	Bottlenose dolphin, common dolphin and white-beaked dolphin, harbour seal and grey seal	Low	**Low to Negligible**	Minor adverse to negligible	MMMP and SIP to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species.	**Minor adverse**
	Harbour porpoise and minke whale	Low to medium	**Low to Negligible**	Minor adverse to negligible		
Impact 8: Changes to water quality	All marine mammal species	Low	**Negligible**	Negligible	No mitigation required.	**Negligible adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 9: Disturbance to seal at haul-out sites from construction activities and from vessel activity areas at array areas in isolation and together	Grey seal and harbour seal	Low to medium	**Negligible**	Minor adverse to Negligible	No mitigation required.	**Minor adverse**
Operation						
Impact 1a: TTS due to operational wind turbines, from either a single wind turbine or all wind turbiness at array areas in isolation and together	All marine mammal species	Medium	**Negligible**	Minor adverse	No mitigation required	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 1b: Disturbance due to operational WTGs, from either a single WTG or all WTGs at array areas in isolation and together	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	**Negligible**	Negligible	No mitigation required	**Negligible**
	Minke whale	Medium	**Negligible**	Minor adverse		**Minor adverse**
Impact 2a/b: TTS and disturbance due to maintenance activities at array areas in isolation and together	All marine mammals	Medium	**Negligible**	Minor adverse	No mitigation required	**Minor adverse**
Impact 3a TTS from underwater noise and presence of vessels at array areas in isolation	All marine mammals	Medium	**Negligible**	Minor adverse	No mitigation required	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 3b: Disturbance from underwater noise and presence of vessels at array areas in isolation	harbour porpoise, minke whale, bottlenose dolphin, common dolphin and white-beaked dolphin	Medium	**Negligible**	Minor adverse	No mitigation required	**Minor adverse**
	Harbour seal and grey seal	Low	**Negligible**	Negligible		
Impact 4: Barrier effects as a result of underwater noise during construction	Harbour porpoise, minke whale, bottlenose dolphin, common dolphin and white-beaked dolphin, harbour seal and grey seal	Low	**Negligible**	Negligible	No mitigation required	**Negligible**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 5: Increased collision risk and vessels during construction at array areas in isolation	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, and minke whale	High	**Negligible**	Minor adverse	Best Practice Measures in PEMP.	**Minor adverse**
	Grey seal and harbour seal		**Low**	Moderate adverse		
Impact 6: Changes to prey resources	Harbour porpoise minke whale, grey seal and harbour seal	Low to Medium	**Low to negligible**	Minor adverse to Negligible	No mitigation required	**Minor adverse**
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low				
Impact 7: Changes to water quality	All marine mammal species	Negligible	**Negligible**	Negligible	No mitigation required.	**Minor adverse**

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 8: Disturbance to seal haul-out sites from O&M activities	Grey seal and harbour seal	Low to Medium	**Negligible**	Minor adverse to Negligible	No mitigation required.	**Minor adverse**
Impact 8: Disturbance to seal haul-out sites from vessels	Grey seal and harbour seal	Low to Medium	**Low**	Minor adverse		
Decommissioning						
Impact 1: PTS or TTS from underwater noise	All marine mammal species	High	**Low to Negligible**	Minor adverse	No mitigation required.	To be determined prior to decommissioning
Impact 2: Disturbance from underwater noise	All marine mammal species	Medium	**Low to Negligible**	Minor adverse	No mitigation required.	To be determined prior to decommissioning
Impact 3: Disturbance from underwater noise, presence and movements of vessels	All marine mammal species	Medium	**Negligible**	Minor adverse	No mitigation required.	To be determined prior to decommissioning

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 4: Barrier effect from underwater noise	All marine mammal species	Medium	**Negligible**	Minor adverse	No mitigation required.	To be determined prior to decommissioning
Impact 5: Increased collision risk with vessels	All marine mammal species	High	**Medium to Low**	Moderate to Minor adverse	No mitigation required.	To be determined prior to decommissioning
Impact 6: Changes to prey resource	All marine mammal species	Low to Medium	**Low to Negligible**	Minor adverse	No mitigation required.	To be determined prior to decommissioning
Impact 7: Changes to water quality	All marine mammal species	Low	**Negligible**	Negligible	No mitigation required.	To be determined prior to decommissioning
Impact 8: Disturbance of seals at haul-out sites	All marine mammal species	Low to medium	**Negligible**	Minor adverse to Negligible	No mitigation required.	To be determined prior to decommissioning

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