Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Report to Inform Appropriate Assessment (RIAA)

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Glossary of Acronyms

AA	Appropriate Assessment
AC	Alternating Current
ADD	Acoustic Deterrent Device
AfL	Agreement for Lease
AoO	Advice on Operations
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BDC	Broadland District Council
BEIS	Department of Business, Energy and Industrial Strategy
BPP	Bird Protection Plan
BS	British Standard
BSI	British Standards Institution
CBS	Cement Bound Sand
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIA	Cumulative Impact Assessment
cSAC	Candidate SAC
CTV	Crew Transfer Vessel
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
DEFRA	Department for the Environment and Rural Affairs
DEP	Dudgeon Offshore Wind Farm Extension Project
DEP-N	DEP North array area
DEP-S	DEP South array area
DMRB	Design Manual for Roads and Bridges
DOW	Dudgeon Offshore Wind Farm
EC	European Commission
EDR	Effective Deterrent Radius
EIA	Environmental Impact Assessment
EP1HS	Extended Phase 1 Habitat Survey
EPP	Evidence Plan Process
EPS	European Protected Species
EPUK	Environmental Protection United Kingdom
EQS	Environmental Quality Standards
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
FCS	Favourable Conservation Status

GBS	Gravity Base Structure
GIS	Geographical Information System
HAT	Highest Astronomical Tide
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Assessment
HRGN	Habitats Regulations Guidance Note
HVAC	High-Voltage Alternating Current
HVDC	High-Voltage Direct Current
IPC	Infrastructure Planning Commission
IROPI	Imperative Reasons of Overriding Public Interest
ISO	International Standards Organisation
JNCC	Joint Nature Conservation Committee
km	Kilometre
LPA	Local Planning Authority
LSE	Likely Significant Effect
m	Metre
MCZ	Marine Conservation Zone
MMMP	Marine Mammal Mitigation Plan
MPA	Marine Protected Area
MU	Management Unit
MW	Megawatts
NAS	Noise Abatement System
NGET	National Grid Electricity Transmission
NNDC	North Norfolk District Council
NorCC	Norwich City Council
NP	National Park
NPPF	National Planning Policy Framework
NPS	National Policy Statement
NSER	No Significant Effects Report
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and Maintenance
Ofgem	Office of Gas and Electricity Markets
OFTO	Offshore Transmission Owner
OS	Ordnance Survey
OSP	Offshore Substation Platform
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
OWF	Offshore Wind Farm
PCoD	Population Consequences of Disturbance

PEIR	Preliminary Environmental Information Report
PPG	Planning Practice Guidance
PPV	Peak Particle Velocity
PRA	Preliminary Risk Assessment
pSAC	Possible SAC
pSPA	Potential SPA
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SCI	Site of Community Importance
SE	South East
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SIP	Site Integrity Plan
SMRU	Sea Mammal Research Unit
SNC	South Norfolk Council
SNCB	Statutory Nature Conservation Body
SNS	Southern North Sea
SoCG	Statement of Common Ground
SoS	Secretary of State
SOV	Service Operation Vessel
SOW	Sheringham Shoal Offshore Wind Farm
SPA	Special Protection Area
SSC	Suspended Sediment Concentration
TEU	Treaty of the European Union
TP	Transition Piece
UK	United Kingdom
UN	United Nations
UPS	Uninterruptible Power Supply
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator
ZOI	Zone of Influence

Glossary of Terms

Concurrent construction	SEP and DEP are constructed at the same time and there is the potential for simultaneous piling (see below).
Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP onshore site	The Dudgeon Offshore Wind Farm Extension onshore area consisting of the DEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
DEP North array area	The wind farm site area of the DEP offshore site located to the north of the existing Dudgeon Offshore Wind Farm
DEP South array area	The wind farm site area of the DEP offshore site located to the south of the existing Dudgeon Offshore Wind Farm
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation, potential Special Protection Areas, Special Protection Areas, Ramsar sites, proposed Ramsar sites and sites compensating for damage to a European site and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017, although some of the sites listed here are afforded equivalent policy protection under the National Planning Policy Framework (2021) (paragraph 176) and joint Defra/Welsh Government/Natural England/NRW Guidance (February 2021).
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.

Favourable Conservation Status (FCS)	This is a measure of the condition of habitats and species listed in Annex I or II of the Habitats Directive. It is achieved when a habitat or species is maintained in size and range and the conditions for its long-term existence are in place.
Horizontal directional drilling (HDD) zones	The areas within the onshore cable corridor which would house HDD entry or exit points.
Infield cables	Cables which link the wind turbine generators to the offshore substation platforms.
Interlink cables	Cables linking two separate project areas. This can be cables linking: 1) DEP South array area and DEP North array area 2) DEP South array area and SEP 3) DEP North array area and SEP 1 is relevant if DEP is constructed in isolation or first in a phased development. 2 and 3 are relevant where both SEP and DEP are built.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore substation platform (OSP)	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Offshore Temporary Works Area	An Offshore Temporary Works Area within the offshore Order Limits in which vessels are permitted to carry out activities during construction, operation and

	decommissioning encompassing a 200m buffer around the wind farm sites and a 750m buffer around the offshore cable corridors. No permanent infrastructure would be installed within the Offshore Temporary Works Area.
Peak pressure	The highest pressure above or below ambient that is associated with a sound wave.
Permanent Threshold Shift (PTS)	A permanent total or partial loss of hearing sensitivity caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).
SEP onshore site	The Sheringham Shoal Wind Farm Extension onshore area consisting of the SEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
Simultaneous piling	A scenario where two piles are installed at the same time at different locations.
Single piling	A scenario where one pile is installed in a 24 hour period.
Site integrity	The integrity of a site is defined in general terms as the coherence of its ecological structures and function, across its whole area, which enables it to sustain the habitat, complex of habitats and and/or the levels of populations of the species for which it was designated.
Sound Exposure Level (SEL)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Sound Pressure Level (SPL)	The sound pressure level or SPL is an expression of the sound pressure using the decibel (dB) scale, and the standard reference pressures of 1 μPa for water and 20 μPa for air.

Study area	Area where potential impacts from the project could occur, as defined for each individual EIA topic.
The Applicant	Equinor New Energy Limited. As the owners of SEP and DEP, Scira Extension Limited and Dudgeon Extension Limited are the named undertakers that have the benefit of the DCO. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of SEL and DEL as the undertakers of SEP and DEP.
Unweighted sound level	Sound levels which are 'raw' or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a 'weighting envelope' in the frequency domain, typically to make an unweighted level relevant to a particular species. Examples of this are the filters used by Southall *et al*. (2019) for marine mammals.

REPORT TO INFORM APPROPRIATE ASSESSMENT

1 Introduction

1.1 Purpose of this Document

1. The purpose of this 'Report to Inform Appropriate Assessment (RIAA)' is to provide the competent authority with information on the potential for adverse effect on the integrity of European designated sites as a result of the proposed Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP). The Habitats Regulation Assessment (HRA) process derives from the requirements of specific European Union Directives and the UK Regulations that implement their requirements in national law which are outlined in **Section 2** of this report. This report is intended to inform the process of undertaking an Appropriate Assessment and is submitted alongside the Environmental Statement (ES) as part of the Development Consent Order (DCO) application.

2. The HRA process has to be applied as a matter of law or policy to the following sites (referred to as 'Natura 2000' sites in the EU or 'National Site Network' sites in the UK):
   - Special Areas of Conservation (SACs);
   - Special Protection Areas (SPAs);
   - Sites of Community Importance (SCI);
   - Potential SPAs (pSPAs);
   - Possible SACs (pSACs);
   - Candidate SACs (cSACs);
   - Listed and proposed Ramsar sites (internationally important wetlands designated under the Ramsar Convention 1971); and
   - Sites used to deliver compensatory measures under derogation (see the **HRA Derogation: Provision of Evidence** (document reference 5.5)).

3. This report therefore covers potential effects upon the following:
   - Onshore:
     - Terrestrial ecology – features of National Site Network sites (SACs, cSACs and SCIs as appropriate); and
     - Onshore ornithology – features of National Site Network sites (SPAs and SCIs as appropriate).
   - Offshore:
     - Benthic ecology – Habitats Directive Annex I Habitats (SACs, cSACs and SCIs as appropriate);
     - Fish ecology – Habitats Directive Annex II Species (SACs, cSACs and SCIs as appropriate);

- Marine mammals – Habitats Directive Annex II Species (SACs, cSACs and SCIs as appropriate); and
- Offshore ornithology – features of National Site Network sites (SPAs, pSPAs and Ramsar sites), including rare and vulnerable birds (as listed on Annex I of the Birds Directive) and regularly occurring migratory species.

1.2 Structure of this Document

4. The structure of this report is as follows:

- **Section 1** – Introduction (this section): provides an introduction to the report and the structure of the assessment;
- **Section 2** – Legislation, Policy and Guidance: provides the legislative context and details the policy and guidance given by a number of Governmental, statutory and industry bodies in relation to the HRA process;
- **Section 3** – Project Description: provides an outline of SEP and DEP with regard to the location of the project infrastructure and the construction, operation and maintenance (O&M), and decommissioning;
- **Section 4** – Approach to HRA: provides an overview of the HRA process and the approach taken by Equinor New Energy Limited (the Applicant);
- **Section 5** – Screening Conclusions: summarises the screening process and outcomes that have been consulted on through the Evidence Plan Process (EPP). The screening report is provided in **Appendix 1 HRA Screening Report** (document reference 5.4.1) and the screening matrices are provided in **Appendix 2 HRA Screening Matrices** (document reference 5.4.2);
- **Section 6** – Onshore National Site Network Sites;
- **Section 7** – Offshore Annex I Habitats;
- **Section 8** – Offshore Annex II Species (Marine Mammals);
- **Section 9** – Offshore Annex II Species (Ornithology); and
- **Section 10** – Summary of Potential Effects: summarises the conclusions of the potential effects arising from SEP and DEP.

2 Legislation, Policy and Guidance

2.1 Overview

5. The HRA process covers those features designated under the European Council Directive 2009/147/EC on the conservation of wild birds (the ‘Birds Directive’) and Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the ‘Habitats Directive’). These are implemented into UK legislation by the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017, together with the Wildlife and Countryside Act 1981. The UK also has to meet its obligations under relevant international agreements such as the Ramsar Convention.

6. The UK exited the EU on 31st January 2020. The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 provide amendments to the Habitats Regulations to enable their continued operation following the UK's exit from the EU.

2.2 European Legislation

2.2.1 The Birds Directive

7. The Birds Directive provides a framework for the conservation and management of wild birds in Europe. The relevant provisions of the Directive are the identification and classification of SPAs for rare or vulnerable species listed in Annex I of the Directive and for all regularly occurring migratory species (required by Article 4). The Directive requires national Governments to establish SPAs and to have in place mechanisms to protect and manage them. The SPA protection procedures originally set out in Article 4 of the Birds Directive have been replaced by the Article 6 provisions of the Habitats Directive.

2.2.2 The Habitats Directive

8. The Habitats Directive provides a framework for the conservation and management of natural habitats, wild fauna (except birds) and flora in Europe. Its aim is to maintain or restore natural habitats and wild species at a Favourable Conservation Status (FCS). The relevant provisions of the Directive are the identification and classification of Special Areas of Conservation (SAC) (Article 4) and procedures for the protection of SACs and SPAs (Article 6). SACs are identified based on the presence of natural habitat types listed in Annex I and populations of the species listed in Annex II. The Directive requires national Governments to establish SACs and to have in place mechanisms to protect and manage them.

2.2.3 The Ramsar Convention

9. The Convention on Wetlands of International Importance especially as Waterfowl Habitat, as amended in 1982 and 1987 (the 'Ramsar Convention') is an international treaty for the conservation and sustainable use of wetlands of international importance. Ramsar site selection has had an emphasis on wetlands of importance to waterbirds, however non-bird features are increasingly taken into account, both in the selection of new sites and when reviewing existing sites. The UK government and the devolved administrations have issued policy statements relating to Ramsar sites which extend to them the same protection at a policy level as SACs and SPAs. Ramsar sites are therefore included in the HRA process.

2.3 UK National Legislation

2.3.1 The Conservation of Habitats and Species Regulations 2017, the Conservation of Offshore Marine Habitats and Species Regulations 2017, and the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019

10. The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (hereafter the 'Habitats Regulations') together with the Wildlife and Countryside Act 1981 transpose the Habitats and Birds Directives into UK legislation covering terrestrial areas out to and including the UK Offshore Marine Area with the exception of within Scottish territorial waters, where The Conservation (Natural Habitats, &c.) Regulations 1994 continue to apply.

11. The Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 (the EU Exit Regulations) make changes to the 2017 Habitats Regulations so that they continue to work (are operable) following the UK's exit from the EU on 31st January 2020. While the basic legal framework for HRA is maintained, the EU Exit Regulations transfer functions previously undertaken by the European Commission (EC) to UK Ministers. Furthermore, where the Habitats Regulations continue to use the term European sites, those sites now form part of a "National Site Network" and not the European "Natura 2000" site network.

12. The Habitats Regulations place an obligation on 'competent authorities' to carry out an Appropriate Assessment of any proposal likely to significantly affect a designated site, to seek advice from Natural England and not to approve an application that would have an adverse effect on the integrity of a designated site unless certain conditions are met (where there are no alternative solutions, the plan or project can only proceed if there are imperative reasons of over-riding public interest and if the necessary compensatory measures can be secured). The competent authority in the case of SEP and DEP is the Secretary of State (SoS) for Business Energy and Industrial Strategy (BEIS).

2.4 Policy and Guidance

13. In addition to the legislation outlined above, this RIAA gives consideration to all relevant guidance and policies issued by a number of Governmental, statutory and industry bodies.

2.4.1 National Policy Statements

14. National Policy Statements (NPS) are the principal decision-making policy documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to SEP and DEP are:

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

15. It is noted that the NPS for Energy (EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5) are in the process of being revised. A draft version of each NPS was published for consultation in September 2021 (Department for Business Energy and Industrial Strategy (BEIS), (2021a), BEIS, (2021b) and BEIS (2021c) respectively).

2.4.2 Government Guidance

16. Guidance from Government bodies considered in the preparation of this report includes:

- Department for Environment, Food & Rural Affairs: Guidance on Habitats regulations assessments: protecting a European site; how a competent authority must decide if a plan or project proposal that affects a European site can go ahead.
- European Commission: Assessment of Plans and Projects Affecting Natura 2000 Sites.
- European Commission: EU Guidance on wind energy development in accordance with EU nature legislation.
- Department of Communities and Local Government: Guidance on 'Planning for the Protection of European Sites: Appropriate Assessment'.
- The Planning Inspectorate Advice Note Nine: Using the Rochdale Envelope.
- The Planning Inspectorate Advice Note Ten: Habitats Regulations Assessment relevant to nationally significant infrastructure projects.
- The Planning Inspectorate Advice Note Seventeen: Cumulative Effects Assessment.
- Department of Energy and Climate Change: Guidelines on the Assessment of Transboundary Impacts of Energy Developments on Natura 2000 Sites outside the UK.

2.4.3 Statutory Nature Conservation Bodies Guidance

17. Key guidance from Statutory Nature Conservation Bodies (SNCBs) considered in the preparation of this report includes:

- English Nature: Habitats Regulations Guidance Note (HRGN) 1: The Appropriate Assessment (Regulation 48) The Conservation (Natural Habitats &c) Regulations, 1994;
- English Nature: Habitats Regulations Guidance Note (HRGN) 3: The Determination of Likely Significant Effect under the Conservation (Natural Habitats &c) Regulations, 1994;
- English Nature: Habitats Regulations Guidance Note (HRGN) 4: Alone or in-combination;

- Natural England and JNCC: Interim advice on HRA screening for seabirds in the non-breeding season;
- Natural England and JNCC: Advice on HRA screening for seabirds in the breeding season; and
- Natural England and JNCC: Interim Advice Note – Presenting information to inform assessment of the potential magnitude and consequences of displacement of seabirds in relation to offshore wind farm developments.

18. Details of any further topic specific guidance used are provided in **Sections 6** to **9**.

2.4.4 Industry Guidance

19. Industry guidance considered in the preparation of this report includes:
    - Developing Guidance on Ornithological Cumulative Impact Assessment for Offshore Wind Farm Developers (King *et al*., 2009); and
    - Cumulative Impact Assessment Guidelines – Guiding Principles for Cumulative Impacts Assessment in Offshore Wind Farms (RenewableUK, 2013).

3 Project Description

3.1 Status

20. This section provides a description of the key parameters and activities that will be undertaken during the construction, operation and decommissioning of SEP and DEP. The SEP and DEP design envelope has been developed in parallel with the EIA process and influenced by the results of environmental and technical studies and stakeholder consultation.

3.2 Development Scenarios

21. The Applicant is seeking to coordinate the development of SEP and DEP as far as possible. The preferred option is a development scenario with an integrated transmission system, providing transmission infrastructure which serves both of the wind farms, where both Projects are built concurrently. However, given the different commercial ownerships of each Project, alternative development scenarios such as a separated grid option (i.e. transmission infrastructure which allows each Project to transmit electricity entirely separately) will allow SEP and DEP to be constructed in a phased approach, if necessary. Therefore, the DCO application seeks to consent a range of development scenarios in the same overall corridors to allow for separate development if required, and to accommodate either sequential or concurrent build of the two Projects.

22. Reasons for the requirement to retain separate and phased (sequential) development scenarios alongside more coordinated approaches are further described in the **Scenarios Statement** (document reference 9.28).

23. The range of development scenarios considered for SEP and DEP can be broadly categorised as:

- In isolation – where only SEP or DEP is constructed;
- Sequential – where SEP and DEP are both constructed in a phased approach with either SEP or DEP being constructed first; or
- Concurrent – where SEP and DEP are both constructed at the same time.

24. Whilst SEP and DEP are the subject of a single DCO application (with a combined Environmental Impact Assessment (EIA) process and associated submissions), the assessment considers both Projects being developed in isolation, sequentially and concurrently, so that mitigation is specific to each development scenario.

25. Under each scenario where SEP and DEP are both constructed it is possible that the electrical infrastructure could be integrated as described above which would offer benefits to the operation of the electrical infrastructure system.

26. An integrated transmission system would also offer the opportunity to reduce from two OSPs (one for SEP, one for DEP) to a single OSP serving both wind farms (located in SEP).

27. Each of the development scenarios offer a range of benefits, with the preferred option (integrated transmission system built concurrently) particularly benefitting the planning and construction of the Projects, being likely to reduce the overall environmental impact and disruption to local communities, and responding to concerns regarding the lack of a holistic approach to offshore wind development in general. For example, the preferred option would only require one haul road for construction activities, half the number of work fronts, a smaller onshore substation and only one OSP.

3.3 Wind Farm Sites

3.3.1 Lease Area

28. SEP and DEP consist of two extension assets and thus Agreement for Lease (AfL) areas. The key characteristics of each area are summarised in **Table 3-1**.

Table 3-1: SEP and DEP Overview

Area	Parameters	Values
SEP	Wind farm site area	97.0km^2
	Closest distance to shore	15.8km
	Water depth	14 - 25m
DEP	Wind farm site area	114.75km^2
	Closest distance to shore	26.5km
	Water depth	11 - 36m

3.3.2 The DCO Order Limits

29. The offshore DCO Order Limits includes the SEP and DEP wind farm sites as defined by The Crown Estate AfL areas. The DEP wind farm site is divided into two distinct areas: DEP North array area and DEP South array area. The offshore DCO

Order Limits includes the offshore cable corridors that either connect the wind farm sites together (interlink cables) or connect the wind farms to the landfall (export cables).

30. The existing Dudgeon offshore wind farm (DOW) has been included in the offshore DCO Order Limits alongside a mechanism in the **Draft DCO** (document reference 3.1) to enable the release of 'headroom' for the benefit of SEP and/or DEP. This possibility arises as a result of DOW not having been built out to its full consented capacity, meaning that there is a difference between certain of the consented parameters (such as total rotor swept area) and the as built parameters.

31. The inclusion of DOW in the DCO Order Limits together with the DCO mechanism is intended to give the necessary legal certainty to allow that headroom to be accounted for in the environmental assessment process i.e. to allow the assessments to be based on the as built parameters rather than consented. The advantage of this approach is that it enables the assessments to be undertaken on a more realistic basis. It should be noted that the DCO does not provide for any additional works to be undertaken within the existing DOW boundary; its inclusion is solely to enable the release of headroom.

32. For this reason, the assessments set out in this RIAA (and the ES) are focussed on the SEP and DEP boundaries only. However, where the matter of headroom is of relevance to the assessments, specifically ornithology (including this RIAA), both consented and as built parameters have been considered such that the worst-case has been assessed. Further details with regard to the assessment approach for ornithology and the consideration of headroom, are provided in **Section 9.3.3.1.5.2**.

3.3.3 Wind Turbine Generators

33. The current wind turbine design envelope for SEP and DEP is outlined in **Table 3-2**.

Table 3-2: Wind Turbine Design Envelope

Parameters	Minimum and Maximum
Maximum Rotor Diameter	235m to 300m
Number of wind turbines – SEP	13 to 23 turbines
Number of wind turbines – DEP	17 to 30 turbines
Max Tip Height (HAT)	265m to 330m
Air Gap above Highest Astronomical Tide (HAT)	30m
Indicative separation distance between turbines (inter-row), SEP and DEP	1.05km to 3.3km

3.3.4 Wind Turbine Foundations

34. The considered wind turbine foundation types are:

- Piled monopile;
- Suction bucket monopile;

- Piled jacket;
- Suction bucket jacket; and
- Gravity base structure (GBS).

35. Key wind turbine foundation parameters are listed in **Table 3-3**.

Table 3-3: Wind Turbine Foundation Design Envelope

Foundation type	Parameter	Indicative size
Monopile/transition piece	Diameter in the water column and at the sea bed	13m to 16m
	Scour protection and foundation footprint	1,917m^2 to 2,903m^2
	Hammer size	Up to 5,500kJ
Monopile with suction bucket	Diameter at the sea bed	36m to 45m
	Scour protection and foundation footprint (assumes a suction bucket)	14,698m^2 to 22,966m^2
GBS	Diameter at the sea bed (base plate)	45m to 60m
	Scour protection and foundation footprint	14,314m^2 to 25,447m^2
Piled jacket	Leg spacing (width of jacket at tower interface)	23m to 30m
	Hammer size	< 3,000kJ
	Scour protection and foundation footprint	4,072m^2 to 5,027m^2
Suction bucket Jacket	Leg spacing (width of jacket at tower interface)	23m to 30m
	Scour protection and foundation footprint	4,072m^2 to 5,027m^2

3.3.5 Electrical System

36. The electrical transmission system will collect the power produced at the wind turbines and transport it to the UK electricity transmission network. The electrical cables that make up the offshore transmission system include:

- Offshore export cables (linking offshore substation platform(s) (OSP) to the landfall);
- Interlink cables (linking two separate wind farm areas); and
- Infield cables (linking the wind turbines to the OSP(s)).

37. **Table 3-4** describes the main cable parameters.

3.3.6 Offshore Substation Platform(s)

38. The cables from each string of turbines will be brought to an OSP, located appropriately to optimise the infield, interlink and export cable lengths. At the OSP, the generated power will be transformed to a higher AC voltage of up to 220kV.

39. There will be up to two OSPs. In the case that two OSPs are constructed, there will be one located in each extension area, i.e. one in the SEP wind farm site and one in the DEP North array area. The exact location of the OSP(s) will be confirmed during the detailed design process, accounting for the wind turbine layout, but will be within each wind farm site (excluding the offshore temporary works area).

40. The OSP foundation type will be a jacket. The jacket will have up to four legs and will be secured to the sea bed with either up to two piles at each leg, or one suction 'bucket' (termed a caisson) at each leg. In the case of a piled solution, the piles may be either driven or drilled, or a combination of the two.

3.3.7 Infield (Array) Cables

41. Infield cables link the wind turbine generators to the OSP(s). Cable system design will be based on radial strings from the OSP(s) and connecting multiple turbines per string. The number of infield cables will be equal to the number of turbines, whilst the length of each cable, and string, will depend on the distance between the turbines and the distance between the first turbine on the string and the OSP.

42. The infield cables will be 110kV AC, with an indicative external cable diameter of between 110mm and 180mm. Cable circuits (strings) will be optimised according to the electrical load they are required to carry, with up to three different cable dimensions being used. They will be integrated with fibre optic cables.

43. Each infield cable will be installed in its own trench, with the maximum length of infield cables being 225km.

3.3.8 Interlink Cables

44. In the event that one OSP is constructed for SEP and DEP (in the SEP wind farm site), interlink cables will connect the DEP North array area to the SEP wind farm site, and possibly also the DEP South array area to the SEP wind farm site (see the **Scenarios Statement** (document reference 9.28)). If DEP is developed in isolation, an OSP will be constructed in the DEP North array area, and interlink cables would connect the DEP South array area to DEP North array area, assuming that both the DEP North and DEP South array areas are developed. The maximum total interlink cable length (all cables) is up to 154km, although this depends on the development scenario in question.

45. The interlink cable voltage will be up to 110kV AC, with an indicative external cable diameter of between 110 and 180mm. They will be integrated with fibre optic cables.

46. Each interlink cable will be installed in a separate trench with a spacing of up to 100m between the cables. For the purpose of the environmental assessment, interlink cable corridors have been defined in order to encompass the cables and the adjacent area of sea bed that may be subject to temporary works, such as anchoring or the use of jack-up vessels. As with the export cables (see below), the corridor provides space for the installation works and any future operation and maintenance activities such as cable reburial or repairs. The interlink cable corridors are between approximately 1,500m and 2,500m wide which includes an offshore temporary works area buffer of 750m either side of the area in which interlink cables

will be installed (see **Figure 4.2** of **Chapter 4 Project Description** (document reference 6.2.4).

3.3.9 Offshore Export Cables

47. There will be up to two High-Voltage Alternating Current (HVAC) offshore export cables, with each forming a circuit consisting of a 3-core power cable with an integrated fibreoptic cable. The power cable voltage will be between 220kV and 230kV, with an indicative external cable diameter of 235mm to 300mm.

48. The length of the export cables depends on the development scenario in question, with a maximum total length of export cables of 102km (in a scenario with a separate OSP in the DEP North array area, one export cable would run from the DEP North array area via SEP to the landfall (62km) and a second export cable would run from SEP to the landfall (40km)).

49. The offshore export cable/s make landfall at Weybourne, where they will be connected to the onshore cables in a transition joint bay, having been installed under the intertidal zone by horizontal directional drilling (HDD) (see **Section 3.4.5**).

50. Each offshore export cable will be installed in a separate trench with a spacing of up to 100m between the cables, where two export cables are installed in parallel. For the purpose of the DCO application and environmental assessment, an offshore export cable corridor has been defined with a temporary works area either side in order to encompass both cables and the adjacent area of sea bed that may be subject to temporary works, such as anchoring or the use of jack-up vessels. The offshore export cable corridor provides space for the installation works and any future operation and maintenance activities such as cable reburial or repairs. The offshore export cable corridor is up to approximately 2,500m wide but funnels out to up to approximately 3,200m on approach to the landfall and through the Cromer Shoal Chalk Beds (CSCB) Marine Conservation Zone (MCZ). However, the area within which the export cables will be installed is up to 1,000m wide, funnelling out to approximately 1,700m wide on approach to the landfall and through the CSCB MCZ. The greater width of offshore export cable corridor on approach to landfall is designed to provide greater flexibility in the detailed routeing/micro-siting of the export cable/s at the pre-construction stage.

51. There is no planned jointing of cables along the export cable corridor as the required length of cable can be manufactured without the need for offshore joints and can be loaded onboard several installation vessels in the market with sufficient cable loading capacity.

3.3.10 Cable Installation

52. Burial of the offshore cables will be through any combination of ploughing, jetting or mechanical cutting, however infield cable burial is more likely to be undertaken by jetting or mechanical cutting. The export cables will be installed in separate installation campaigns as the installation vessel can only install one cable at a time.

53. The purpose of cable burial is to ensure that the cables are protected from damage by external factors. Typical burial depth is expected to be between 0.5 to 1.5m, but where the required depth of burial may not be achieved, cable protection will also

be considered. The appropriate level of protection will be determined based on an assessment of the risks posed to the Projects in specific areas.

Table 3-4: Offshore Cable Parameters

Item	Indicative parameters
Export cables	• Maximum length all cables: 102km
Infield cables	• Maximum length all cables: 225km
Interlink cables	• Maximum length all cables: 154km • Maximum number of interlink cables: 7
Number of cables per trench	• Up to 1 trench per cable
Fibre optic cables	• Integrated with the power cables
Number of cable crossings (all cables)	• Up to 21

54. There are certain situations where the use of external cable protection may be required. These are:

- Where an adequate degree of protection has not been achieved from the burial process. This may be as a result of challenging ground conditions, or unforeseen circumstances with the burial process, such as break down of the burial tool/s;
- Where the infield cables approach the wind turbines and OSP(s);
- At cable crossings;
- At the HDD exit pits; and
- In the event that cables become unburied as a result of sea bed mobility during the operation of the wind farms or (where necessary) in the event of making a cable repair. If these works were required, they would be the subject of a separate marine licence application and therefore are not included in the project design envelope.

55. It is likely that the export cables will have to cross other cables and/or pipelines. A number of techniques can be utilised, including (but not limited to):

- Pre-lay and post lay concrete mattresses;
- Pre-lay and post lay rock placement; or
- Pre-lay cable with Uraduct shell structure protection and post-lay rock placement / rock bags.

56. The maximum width and length of cable protection for crossings is 21m and 100m, respectively. The maximum height of cable crossings will be 1.7m and all crossings will be designed to be overtrawlable.

3.3.11 Landfall

57. Following consideration of two alternative landfall options (Weybourne and Bacton) a landfall at Weybourne was selected, avoiding the need for the export cables to pass through The Wash and North Norfolk Coast SAC. Cable installation at the landfall will be by HDD. Each export cable will require one HDD i.e. up to two in total. However, one contingency HDD per cable is included in the design envelope (i.e. up to four in total). The HDD is drilled from the onshore construction compound and will exit the sea bed in an exit pit with approximately 8.5m water depth, approximately 1,000m from the coastline (up to 1,150m from the onshore entry point). The exact length of the HDD will depend upon factors such as water depth, sea bed topography, shallow geology/soil conditions and environmental constraints.

58. At the HDD exit point in the subtidal there is a requirement for a transition zone between where the ducts exit the sea bed and the point at which it is possible for the burial tool to start the process of burying the cables. There are two options for the transition zone. The first would involve the excavation of an initial trench up to 20m wide, 30m long and 1m deep (600m^3 excavated material, allowing for up to two cables), with a further transition zone trench of up to 50m in length, 1m wide and up to 1m deep per cable (100m^3 excavated material in total), at the end of which the burial tool would be able to take over the cable burial process. With this option there would be no requirement for external cable protection. This option also provides some flexibility should the Projects be restricted in terms of any potential reduction in navigable water depth.

59. Alternatively, rock bags or concrete half shells would be used for cable protection purposes in the transition zone. This is considered to be the best option from an engineering perspective, provided that any restrictions on the reduction of water depth can be met. In this event, external cable protection would be required along up to 100m of each of the cables i.e. a total length of 200m for both cables. The cable protection would likely be in the form of removable 8 tonne rock bags, up to 3m wide and 0.8m high (accounting for the cables underneath), although some settling into the sea bed after installation would be expected to reduce this over time. The sea bed footprint of the installed rock bags would therefore be up to 600m^2, for both cables. Loose rock type systems will not be used in order to facilitate the possibility of removal on decommissioning.

60. A jack-up barge vessel with backhoe excavator would be used for the excavations and/or installing any necessary external cable protection. All excavated sea bed sediments will be temporarily stored alongside the works location and within the export cable corridor (i.e. sidecast), prior to being backfilled after cable installation (a period of approximately nine months). The sea bed footprint of the deposited material is estimated to be up to approximately 400m^2. Alternatively, the excavated sediment could be stored on a barge.

61. The offshore and onshore cables will be jointed together in one or two underground transition joint bays located onshore within the landfall compound. This would comprise an excavated area of up to 52m x 20m (for the worst-case SEP and DEP sequential scenario) with a reinforced concrete floor to allow winching during cable pulling and a stable surface to allow jointing.

62. Following cable pulling and jointing activities, the pits containing the transition joint bay(s) would be backfilled using stabilised backfill, pre-excavated material or a concrete box. The transition joint bay(s) would be located 1.2m below ground during operation.

63. The onshore construction compound will be temporary in nature and reinstated after completion of SEP and DEP. **Table 3-5** shows the main construction parameters for the landfall site.

Table 3-5: Landfall Construction Parameters

Landfall	Indicative parameters
Number of HDD drills	Up to 4
Number of transition bays	Up to 2
Transition bay dimensions (length x width)	Up to 26m x 10m (or 2 x 26m by 10m)
Transition bay dimensions depth	Up to 3m
Landfall HDD compound size (up to two)	Up 5,750m^2 (up to two)
Length of HDD	Up to 1,150m

3.3.12 Onshore Export System

64. The onshore cable parameters are presented in **Table 3-6**. The width of the onshore cable corridor swathe will be up to 60m. This allows for additional separation of cables buried at depth and accounts for the required construction footprint, including trenches, haul road, spoil storage, drainage etc.

Table 3-6: Onshore Cable Parameters

Onshore cable corridor	Indicative parameters
Cable corridor swathe width	Up to 60m
Cable corridor swathe at trenchless crossings	Up to 100m
Number of cables	Up to 8 (6 HVAC and 2 fibre optic)
Number of ducts	Up to 8
Number of trenches	Up to 2
Depth to top of buried infrastructure (ducts)	Up to 1.2m
Trenchless (HDD) crossings	To be identified
Trenchless (HDD) crossings compound (length x width)	Up to 75m x 60m
Typical jointing bay frequency	Up to every 1,000m
Jointing bay (length x width x height)	Up to 16 x 3.5 x 2m
Depth to top of jointing bay (m)	> 1.2m

65. The onshore underground cable system will be installed in trenches, one circuit per trench. Each circuit consists of three high voltage cables and one fibre optical cable. Each trench holding a single circuit would be up to approximately 1.5m wide (the width of the corridor allows for appropriate separation between trenches).

66. Jointing bays will be used to pull the cables into the ducts and/or to join the cable lengths to each other. Link boxes are used for earthing cables and will be installed inside a protective concrete chamber. The jointing bays are subsurface structures, while the link boxes will require access (for inspections) from the surface during operations and will therefore be located at or above ground level. At the jointing location there will be one link box per circuit. The number of jointing bays will be approximately 120 (every 1,000m).

3.3.13 Onshore Substation

67. The onshore substation site is located approximately 250m south of Norwich Main, immediately west of the Norwich to Ipswich rail line, and approximately 600m north of the nearest village (Swainsthorpe). The HVAC onshore substation site is located in proximity to National Grid's existing Norwich Main substation. It will contain the necessary electrical and auxiliary equipment and components for transforming the power from the wind farm to 400kV and required to meet the UK Grid Code for connection to the transmission grid.

68. The maximum design scenario is set out in the ES, such as the maximum height, footprint, number and type of buildings. **Table 3-7** describes the main onshore substation construction parameters.

Table 3-7: Onshore Substation Construction Parameters

Substation	Indicative parameters
Construction compound	Up to 1ha
Operational compound	Up to 6ha
Building height	Up to 15m
External equipment height	Up to 30m

69. The 400kV cables from the onshore substation to the existing Norwich Main substation would typically be installed by the direct bury method. The cable corridor between the substations will be similar to the export cable corridor in design and width.

3.3.14 Grid Connection

70. SEP and DEP will both connect to the existing transmission grid in National Grid's Norwich Main substation. The requirement for any NGET substation consents necessary to undertake works associated with SEP and DEP at Norwich Main is the responsibility of National Grid. However, the cumulative (in-combination) impacts will be considered as appropriate.

3.4 Offshore and Onshore Construction

3.4.1 Fabrication

71. All elements of SEP and DEP including wind turbines, foundations, substations and electrical infrastructure will be fabricated offsite, stored at a suitable port facility and transported to site as needed. Fabrication contracts have not been placed and the

Applicant will run competitive tendering processes to identify the best suitable contractors to deliver the different elements of the development. Fabrication can take place in the UK, in Europe or elsewhere dependent upon the location of the chosen contractor.

3.4.2 Sea bed Preparation

72. Jacket and monopile foundations would be positioned in such a way to avoid the need for sea bed preparation, however placement of a gravel pad with or without dredging of the sea bed may be required prior to installation of GBS. Other pre-installation activities include sea bed levelling (pre-sweeping) prior to cable installation, and removing surface and subsurface debris such as boulders, fishing nets, lost anchors etc. Any unexploded ordnance (UXO) found with live ammunition may need to be detonated and the remaining debris removed, where practicable.
73. Consent for UXO removal will be sought in a future Marine Licence application, when geophysical and magnetometer survey data of suitable spatial resolution is available to identify and quantify UXO risk prior to the start of construction.

3.4.3 Marine Operations

74. A variety of vessels will be used during the construction phase, although the exact number and specification will not be known until much closer to the time of construction. Similarly, whilst it is expected that both SEP and DEP will be operated from the O&M port at Great Yarmouth, as with the existing DOW, the construction port/s will not be confirmed until nearer the start of construction.
75. A total of 1,196 vessel movements is estimated during construction of both SEP and DEP on a worst-case basis (assuming the Projects are constructed sequentially). Due to construction sequencing, not all types of vessel will be on site at the same time.
76. Safety zones may be used to help ensure safe working during all phases of the project, namely, to ensure a safe distance is maintained between the wind farm structures and vessels. During construction this would typically be up to 500m around each wind turbine foundation or OSP. The implementation of all safety zones will be subject to application and approval prior to the start of construction.

3.4.4 Onshore Cable Corridor

77. **Table 3-6** details the main onshore cable construction parameters.
78. The onshore cable will typically be installed in ducts either using a trenching machine/open-cut trench techniques; or where necessary HDD or other trenchless methods to avoid surface disturbance at sensitive features. The cables may also be direct laid at the bottom of open cut trench(es).
79. The cable burial includes the removal of topsoil, excavating the trench, installing the ducts and backfilling the trench. The cables will be pulled through the ducts after the trench has been backfilled. Cables and ducts are likely to be covered by approximately 1m soil. The cable corridor width of 60m takes account of the need for storing soils during construction.

80. A haul road will be constructed along the cable corridor to allow access to the cable corridor during the construction phase. In the case of a phased development the haul road may be left in situ between construction periods and removed once construction of the phased development has finalised, but should there be a gap between the two construction phases it is assumed that, as a worst-case, the haul road may be removed after the completion of the first project and reinstated at the start of the second project. The cable corridor width of 60m takes account of the need for a haul road.

81. There will be need for several temporary compounds along the onshore cable corridor for material and equipment.

3.4.5 Trenchless Crossings (including Landfall)

82. Where an open trench approach is not possible due to significant obstructions (e.g. a major road or watercourse or at the landfall) non-trenching techniques will be employed. It is anticipated that HDD technique or similar will be used.

83. Use of any trenchless technique will also require temporary construction compounds at the entry and exit points.

3.4.6 Onshore Substation

84. Construction of the onshore substation will include:

- Establishing access roads;
- Site preparation / levelling for the temporary construction compounds and the permanent substation site (depending on the project scenario up to two substation buildings will be built in the same footprint). Dependent upon the onsite ground conditions at the substation location, piling may be required to support the construction of buildings and heavy equipment;
- Installation of underground utility/drainage and foundations for buildings and equipment;
- Construction of building(s) and installation of electrical equipment;
- Installation of permanent perimeter fencing around entire substation; and
- Landscaping to minimise visual impact.

3.5 Construction Programme

85. A high-level indicative construction programme is shown in **Plate 3-1** to **Plate 3-3** below. The earliest any construction works would start is assumed to be 2025, however there would be a two-year period of onshore construction prior to the start of offshore construction. Offshore construction works would require up to two years per project (excluding pre-construction activities such as surveys), assuming SEP and DEP were built at different times. If built at the same time, offshore construction could be completed in two years. Accounting for the development scenarios described in **Section 3.2**, there could be a gap of up to three years between the

completion of offshore construction works on the first Project and the start of offshore construction works on the second Project.

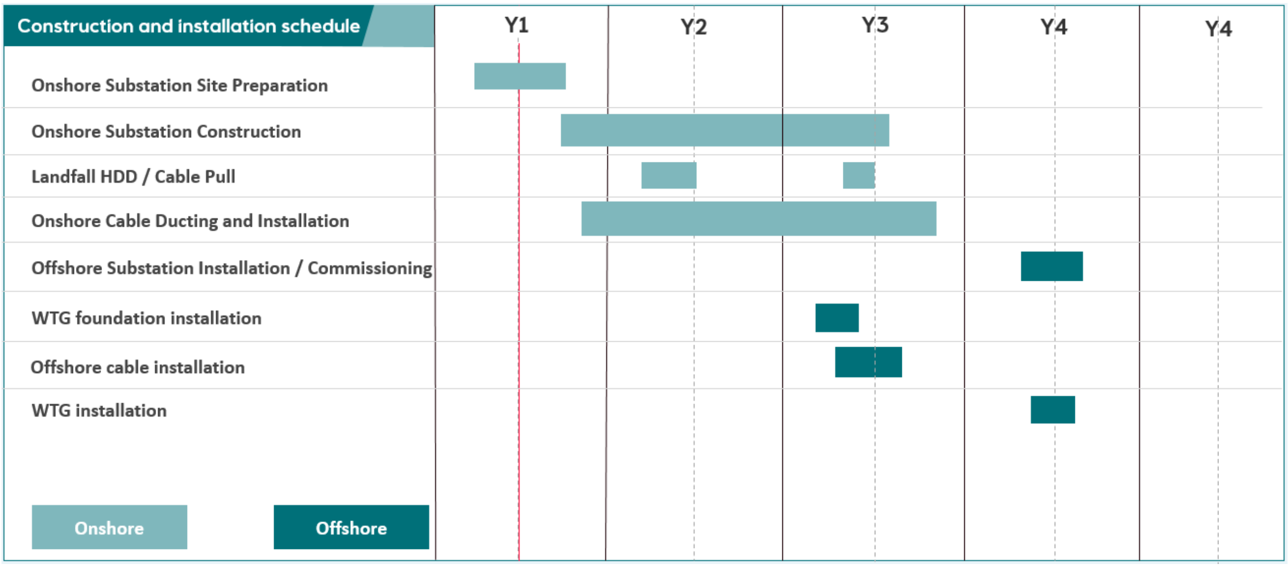


Plate 3-1: Construction Programme – SEP or DEP Built in Isolation

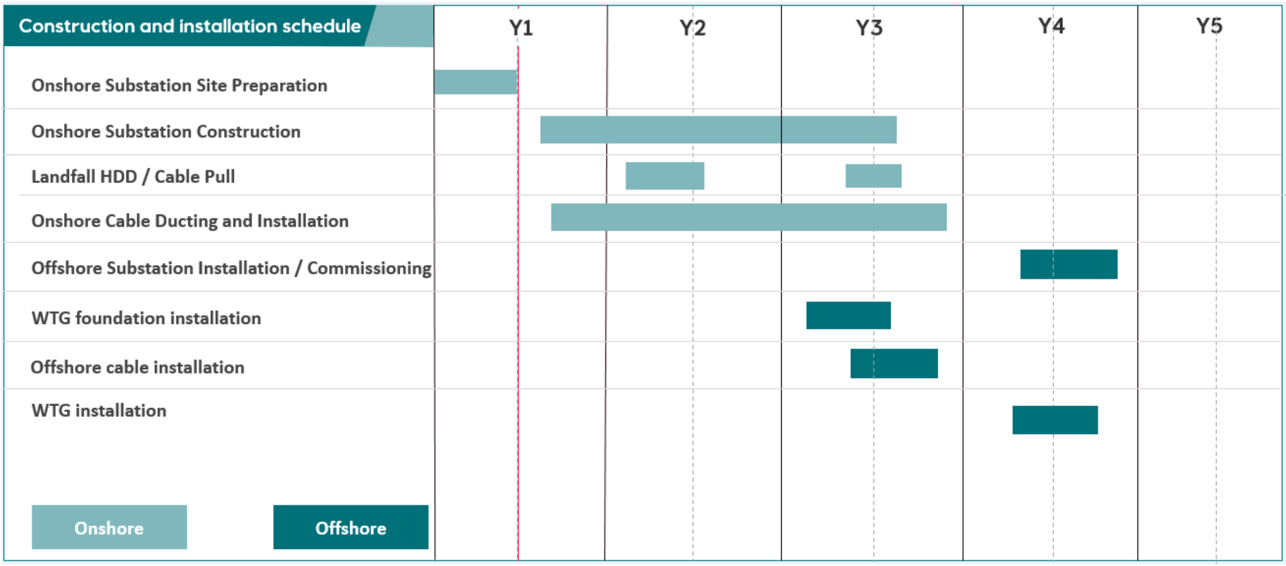


Plate 3-2: Construction Programme – SEP and DEP built concurrently

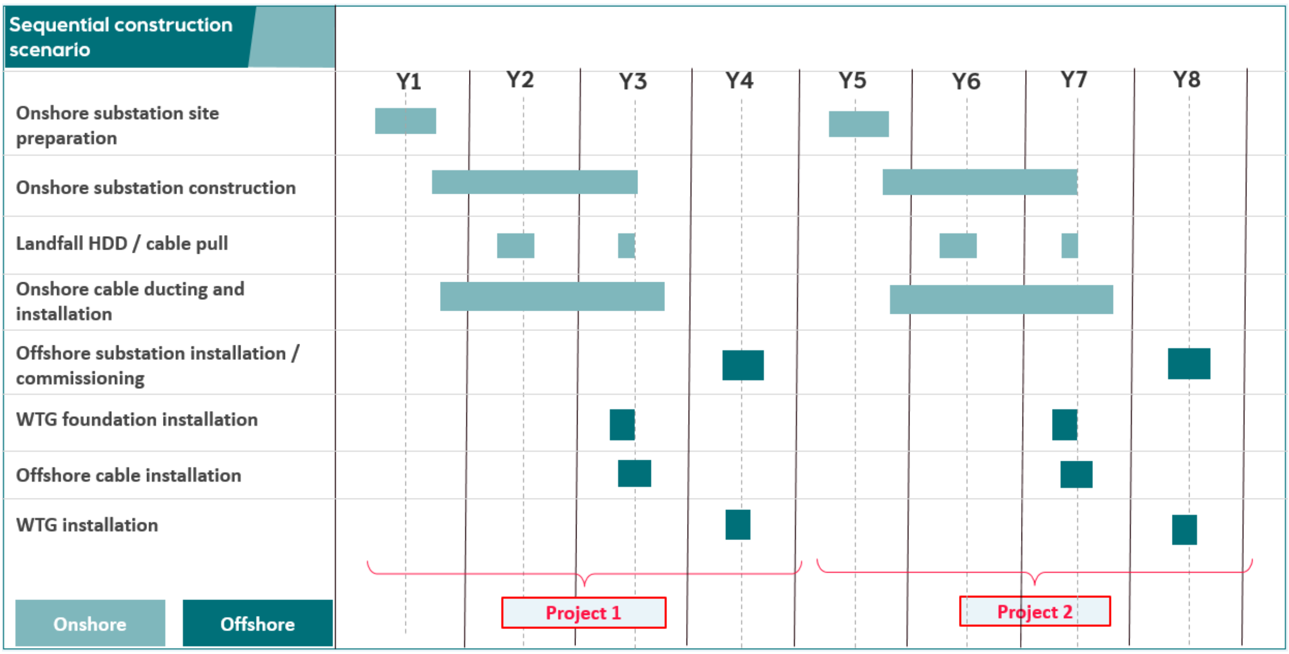


Plate 3-3: Indicative Construction Programme – SEP and DEP Built Sequentially with up to a 4-Year Gap Between Construction Start Dates

3.6 Operation, Maintenance and Decommissioning Phases

86. The intention is that both SEP and DEP will be operated from the existing DOW O&M base at Great Yarmouth. The operation of SEP and DEP over the 40 year design life will require a number of O&M activities.

87. Typical general maintenance activities include:

- Wind turbine service;
- Oil sampling and/or change;
- UPS (uninterruptible power supply) battery change;
- Service and inspections of wind turbine safety equipment, nacelle crane, service lift, high voltage system, blades;
- Foundation inspection and repair;
- Cable repair and replacement;
- Cable remedial reburial;
- Cable crossing inspection and repair; and
- Unplanned and planned corrective work.

88. Vessel visits to the wind farms will be required each year to allow for both the scheduled and unscheduled maintenance activities. The existing DOW vessel provision consists of one Service Operation Vessel (SOV) and one smaller Crew Transfer Vessel (CTV). Taking account of the existing spare capacity in terms of onboard facilities and capability for technician drop-offs, it is anticipated that two

extra support vessels would be sufficient. These could be CTV, daughter craft onboard the SOV or both.

89. There is no ongoing requirement for regular maintenance of the onshore cables following installation, however access to the onshore export cables would be required to conduct emergency repairs, if necessary. Access to each field parcel along the cable corridor would be from existing field entry points where possible or accessing the cable corridor from road crossings.

90. The onshore substation would not be manned, however access would be required periodically for routine maintenance activities, estimated at an average of one visit per week. Normal operating conditions would not require lighting at the onshore substation, although low level movement detecting security lighting may be utilised for health and safety purposes. Temporary lighting during working hours will be provided during maintenance activities only.

91. At the end of the operational lifetime of SEP and DEP (assumed to be 40 years) it is anticipated that all offshore structures above the sea bed (foundations and electrical infrastructure) will be removed, and the site of the onshore substation will be restored. All electrical cables will be left *in-situ* to minimise environmental impacts associated with their removal. It is anticipated that offshore decommissioning would take up to approximately one year for each of SEP and DEP. The decommissioning sequence will be undertaken in reverse of construction, involving similar types and numbers of vessels and equipment. A decommissioning programme will be submitted to BEIS prior to construction and be updated during the Projects' lifespan to take account of changing best-practice and new technologies.

92. The programme for onshore decommissioning is expected to be similar in duration to the construction phase of 24-30 months. The detailed activities and methodology for decommissioning will be determined later within the project lifetime, in line with relevant policies at that time, but would be expected to include:

- Dismantling and removal of electrical equipment;
- Removal of cabling from site;
- Removal of any building services equipment;
- Demolition of the buildings and removal of fences; and
- Landscaping and reinstatement of the site.

4 Approach to HRA

4.1 Overview of HRA Process

93. The HRA process is carried out in a sequential manner by the Planning Inspectorate, acting on behalf of the Secretary of State for BEIS (the competent authority). The HRA process is informed and assisted by Equinor as the Applicant. It is the responsibility of the Applicant to include 'sufficient information' within the DCO application to inform the Habitats Regulations Assessment of SEP and DEP.

94. The HRA process consists of up to four stages (**Plate 4-1**) that are described in more detail in Planning Inspectorate Advice Note 10 (Planning Inspectorate, 2017)

and summarised below. For all plans and projects which are not wholly directly connected with, or necessary to the conservation management of a site's qualifying features, this will include formal screening for any likely significant effect (LSE) either alone or in-combination with other plans or projects. As already noted, the role of the European Commission is now taken by UK Ministers.

4.1.1 Stage 1 – Screening

95. In Stage 1, designated sites are screened for LSE resulting from the 'project alone' scenario (i.e. either SEP or DEP in isolation, or SEP and DEP) and in-combination with other projects. Where it can be determined that there is no potential for LSE to occur to interest features of a designated site and the achievement of the sites' conservation objectives, that site is sought to be 'screened out'.

96. Mitigation measures intended to avoid or reduce the harmful effects of a plan or project are not taken into account at Stage 1, but are identified and applied during the Stage 2 assessment, where they are necessary.

97. The Planning Inspectorate advises that for those projects where no LSE is predicted, this should be reported in the form of a No Significant Effects Report (NSER) and there is no requirement to undertake the Stage 2 assessment (Planning Inspectorate, 2017).

4.1.2 Stage 2 – Appropriate Assessment

98. The purpose of the HRA process is to identify where potential LSE may occur and to provide information to the competent authority so that they can determine whether LSE is expected to occur, through an Appropriate Assessment (this report).

99. For those sites where LSE cannot be excluded in Stage 1 screening, further information to inform the assessment is prepared. This assessment will determine whether the Projects, alone or in-combination, could adversely affect the integrity of the site in view of its conservation objectives. This assessment includes a description of any mitigation measures proposed that avoid or reduce each effect, and any remaining residual effects.

100. Where the appropriate assessment identifies the potential for an adverse effect on the integrity of a designated site (or cannot rule one out), the assessment will proceed to Stage 3.

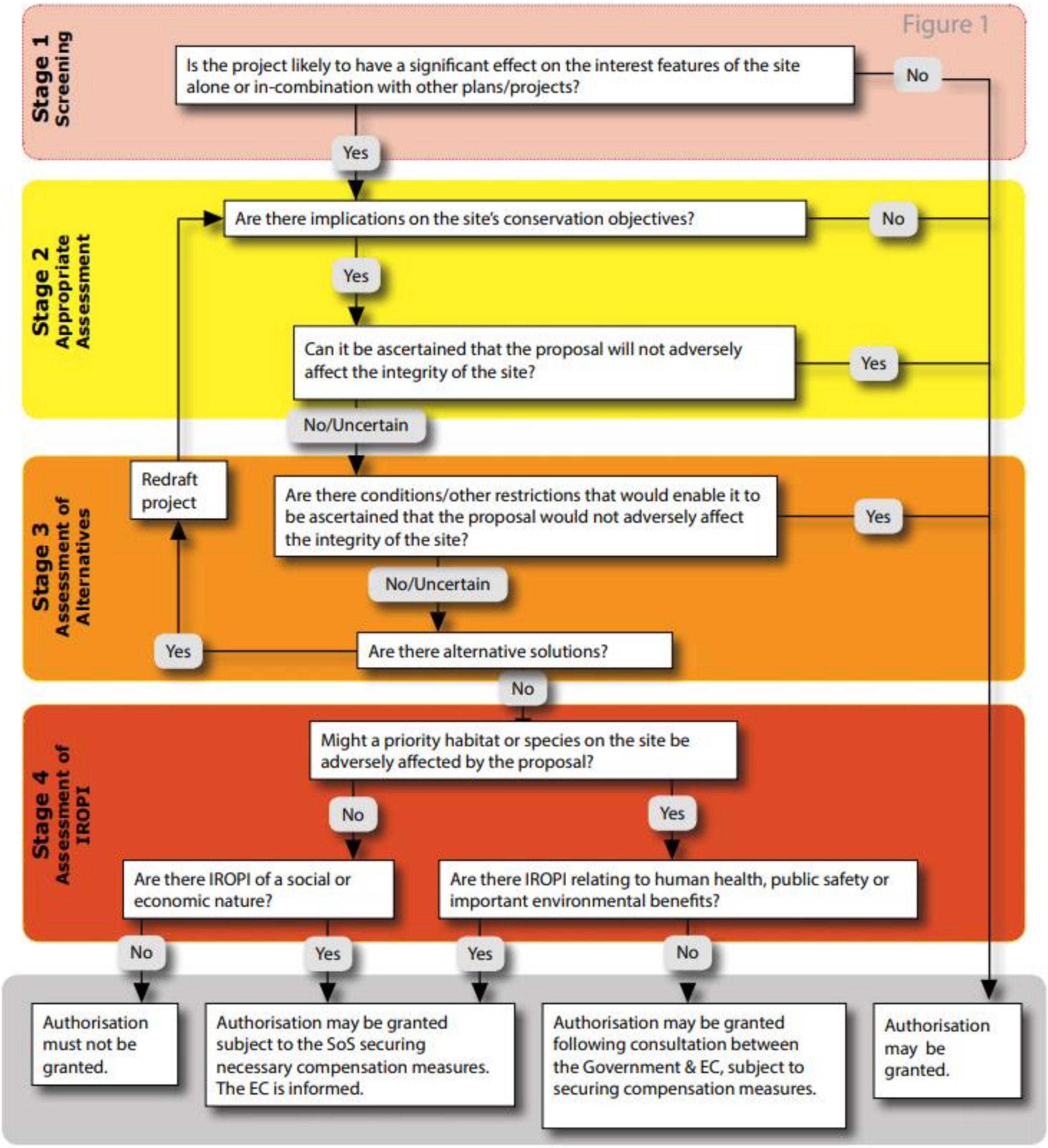


Plate 4-1: HRA Process (Planning Inspectorate, 2017)

4.1.3 Stage 3 – Assessment of Alternatives

101. Stage 3 investigates alternatives that could be applied to reduce the potential for effects. The Planning Inspectorate advises that alternative solutions can include a proposal of a different scale, a different location and an option of not having the scheme at all – the 'do nothing' approach. If it is concluded that there are no alternative solutions, then the HRA will proceed to Stage 4.

4.1.4 Stage 4 – Assessment of Imperative Reasons of Overriding Public Interest (IROPI)

102. If it is demonstrated that there are no alternative solutions to the proposal that would have a lesser effect or avoid an adverse effect on the integrity of the site(s), then a case will be prepared that the scheme should be carried out for IROPI. The IROPI justification must relate to either:

- human health, public safety or beneficial consequences of primary importance to the environment; or
- having due regard to any opinion from the appropriate authority, any other imperative reasons of overriding public interest.

103. If the conclusion of Stages 3 and 4 is that there is no alternative and that the project has demonstrated IROPI, then the project may proceed subject to a requirement that the appropriate authority must secure that any compensatory measures are taken to ensure that the overall coherence of the National Site Network is protected.

4.1.5 Compensatory Measures

104. If HRA Stage 2 identifies an adverse effect on the integrity of a designated site, an assessment of necessary compensatory measures to ensure that the overall coherence of the National Site Network is secured must also be included in the HRA Report. Compensatory measures should be determined through consultation with the relevant stakeholders, including SNCBs and landowners.

105. The Applicant's RIAA has concluded that, with respect to Sandwich tern (North Norfolk Coast SPA and Greater Wash SPA) and kittiwake (Flamborough and Filey Coast SPA), an adverse effect on integrity cannot be ruled out when considered in-combination with other OWF. As such, the Applicant has provided compensatory measures as part of its consent application to compensate for the predicted impacts from SEP and DEP, which for Sandwich tern are described in **Habitats Regulations Derogation: Provision of Evidence** (document reference 5.5) **Appendix 2 Sandwich Tern Compensation Document** (document reference 5.5.2) and for kittiwake in **Appendix 3 Kittiwake Compensation Document** (document reference 5.5.3).

106. With respect to gannet, guillemot and razorbill from the Flamborough and Filey Coast SPA, the Applicant's appropriate assessment has concluded that there will be no adverse effect on integrity, either from SEP and DEP alone, or in-combination with other OWF. In the event that the SoS is unable to reach a conclusion of no adverse effect on integrity with respect to gannet, guillemot and razorbill, the

Applicant has developed *without prejudice* compensatory measures that could be applied to provide compensation for the predicted impacts (**Habitats Regulations Derogation: Provision of Evidence** (document reference 5.5) **Appendix 4 Gannet, Guillemot and Razorbill Compensation Document** (document reference 5.5.4)).

107. In the case of gannet, guillemot and razorbill the provision of evidence regarding without prejudice compensatory measures is entirely without prejudice to the Applicant's position that there will be no adverse effect on integrity.

4.2 Consultation

108. This report has been informed by consultation with SNCBs and other stakeholders over a number of stages. The key elements of consultation have been:

- The scoping report (submitted October 2019) and request for a Scoping Opinion (received November 2019);
- The EPP, which has been ongoing through the pre-application phase, including consultation on the draft HRA Screening (requested July 2020); and
- The draft 'Information for HRA Report', submitted for consultation in April 2021 alongside the Preliminary Environmental Information Report (PEIR).

109. Full details are provided in the **Consultation Report** (document reference 5.1).

4.2.1 EIA Scoping and HRA Screening

110. Consultation has been undertaken with the appropriate authorities as part of the scoping stage of the EIA process. The scoping report for the Projects was submitted to PINS on 8th October 2019 and a Scoping Opinion received on 19th November 2019. Scoping established the potential effects of SEP and DEP that are assessed by the EIA and, where applicable, the HRA.

111. **Appendix 1 HRA Screening Report**, details the HRA screening exercise that was undertaken in April 2021. The Applicant first submitted the HRA Screening Report for consultation in June 2020. Responses from consultees were provided in writing, as well as being discussed through the relevant ETG. As a 'point in time' document, **Appendix 1 HRA Screening Report** has only been submitted for reference purposes as much of the supporting text remains valid. However, a small number of screening outcomes have changed since April 2021, as the consultation on likely significant effects and associated assessments have developed through the pre-application period. As such it should be read in conjunction with RIAA **Appendix 2 HRA Screening Matrices**, as well as this RIAA, which together reflect the final screening outcomes and provide a narrative explaining the changes. Since the initial HRA screening exercise was undertaken in April 2021, there have been a number of changes to the original screening conclusions (which are not reflected in **Appendix 1 HRA Screening Report**). The following changes to screening conclusions have been reflected in the **RIAA**:

- SPAs:

  - Pentland Firth proposed SPA (pSPA) was screened out as it was withdrawn as a pSPA following NatureScot's and JNCC's final advice and recommendations to Scottish Ministers on the proposals to classify a network of marine pSPAs (NatureScot, 2019);
  - Fetlar SPA was screened out because no relevant qualifying features have connectivity with SEP and DEP;
  - Outer Thames Estuary SPA (red-throated diver feature) was screened in because project vessels will transit through its northern extremity between SEP and DEP and the port at Great Yarmouth.
- Moray Firth SAC: During the HRA screening undertaken in April 2021, it was considered that no bottlenose dolphin designated sites had the potential for connectivity with SEP and DEP, and therefore were not screened in for further assessment. However, since the HRA screening undertaken in April 2021, there has been a recent increase in presence of the bottlenose dolphin along the north-east coast of England. Therefore, as a precautionary approach, it has been assumed that bottlenose dolphin off the east coast of England could be from the Moray Firth SAC and as such this designated site has been assessed further.
- Broadland Ramsar: This site is screened in for migratory waterbird features which are at potential risk of collision. However, following further consideration with respect to potential disturbance effects on qualifying features, the Zone of Influence (ZoI) for potential disturbance effects associated with the Broadland Ramsar would be no greater than 5km. As Broadland Ramsar is 8.9km from the Order limits, no LSE has been concluded for this site and it was screened out from further assessment (see **Table 3-2** of **Appendix 1 HRA Screening Report** for definitions of the potential ZoI).

4.2.2 Draft Information for HRA Report

112. A draft Information for HRA Report was made available for consultation alongside the PEIR in April 2021, under Sections 42, 47 and 48 of the Planning Act 2008 and Regulation 13 of the EIA Regulations. Where feedback from this consultation was received, it has been taken into consideration and, where appropriate, incorporated into this RIAA within **Sections 6** to **9**.

4.2.3 Evidence Plan

113. The EPP is a non-statutory, voluntary process that aims to encourage upfront agreement on what information an applicant needs to supply to the PINS as part of a DCO application. It aims to ensure EIA and HRA requirements are met and to reduce the risk of major infrastructure projects being delayed at (or before) the examination phase.

114. The EPP aims to identify and agree the scope of the assessment, the baseline used, methodologies used to collect and analyse data, the interpretation of information, and the conclusions presented (including any LSE). The EPP also enables consultation on proposed mitigation and/or compensation measures. Agreements

and areas where disputes remain between the Applicant and the relevant SNCB are documented in Statements of Common Ground (SoCG).

115. SEP and DEP's EPP includes consultation through several Expert Topic Groups (ETGs) for key EIA topics. Those which are relevant to the HRA process are summarised in **Table 4-1**.

116. As described in **Section 9**, the Applicant has provided an HRA derogation case (see the **Habitats Regulations Derogation: Provision of Evidence** (document reference 5.5) which includes compensation proposals outlined in **Appendix 2 Sandwich Tern Compensation Document** (document reference 5.5.2) and **Appendix 3 Kittiwake Compensation Document** (document reference 5.5.3)) for these species.

117. Additionally, in response to feedback from consultation undertaken during the pre-application period (including on the draft Information for HRA provided as part of the section 42 consultation) and discussions with the offshore ornithology HRA compensation ETG, a derogation case has also been provided with respect to the gannet, guillemot and razorbill features of the Flamborough and Filey Coast SPA. A detailed description of the consultation process with respect to HRA compensation is provided within **Annex 1D: Record of HRA Derogation Consultation** (document reference 5.5.1.4).

Table 4-1: HRA-Related Expert Topic Groups and Members

ETG	Members
Terrestrial Ecology and Ornithology	Equinor, Royal HaskoningDHV, Norwich City Council Natural England, Norfolk Wildlife Trust, Environment Agency, Norfolk County Council, Royal Society for the Protection of Birds (RSPB)
Sea bed (including benthic ecology, fish and shellfish ecology, marine geology, oceanography and physical processes and marine water and sediment quality)	Equinor, Royal HaskoningDHV, Natural England, Marine Management Organisation (MMO), Cefas, Eastern Inshore Fisheries and Conservation Authority (IFCA), the Wildlife Trusts
Marine Mammal Ecology	Equinor, Royal HaskoningDHV, Natural England, MMO, Cefas, the Wildlife Trusts
Offshore Ornithology	Equinor, Royal HaskoningDHV, Natural England, MMO, RSPB
Offshore Ornithology HRA Compensation	Equinor, Royal HaskoningDHV, Natural England, MMO, RSPB, National Trust, The Planning Inspectorate.

5 Screening Conclusions

118. The Projects' HRA Screening process has been undertaken in consultation with relevant stakeholders through the EPP, as detailed in **Appendix 1 HRA Screening Report**.

119. The screening assessment presented in **Appendix 1 HRA Screening Report** was based on the understanding of the baseline environment and the scope and nature

of the proposed project activities at the time of writing the screening assessment (April 2021). Further environmental survey and assessment work, changes to designated sites, consultee responses and refinements to the Project design have been taken into consideration and any such changes reflected within this RIAA and **Appendix 2 HRA Screening Matrices**.

120. The following sub-sections identify the sites and features screened into the assessment in relation to the Projects alone or in-combination, with the features and sites screened in summarised in **Table 5-2**.

5.1 Onshore National Site Network Sites

121. A 20km buffer zone around all project elements was used for the screening exercise for terrestrial ecology features, within which eleven sites were identified. A 20km buffer for the screening exercise is considered to be conservative and it is not expected that there are any pathways of effect that could extend beyond this. **Table 3-2** of **Appendix 1 HRA Screening Report** presents the Zone of Influence (ZoI) for different environmental parameters considered for the screening exercise.

122. The outcome of the screening exercise (and subsequent consultation) in April 2021 concluded that the following sites were screened in for Appropriate Assessment:

- River Wensum SAC;
- North Norfolk Coast Ramsar;
- North Norfolk Coast SPA; and
- Broadland Ramsar.

123. The sites screened out of the need for an Appropriate Assessment due to the conclusion of no LSE are listed in **Appendix 1 HRA Screening Report** and **Appendix 2 HRA Screening Matrices**.

124. As noted above, following further consideration, the ZoI for potential disturbance effects to the qualifying features associated with Broadland Ramsar would be no greater than 5km. As Broadland Ramsar is 8.9km from the Order limits, no LSE has also been concluded for this site and it was also screened out from further assessment at this stage. However, this site is screened in for migratory waterbird features which are at potential risk of collision (see **Section 9.10**).

125. A summary of consultation with respect to onshore national network sites is provided in **Section 6.1**.

5.2 Offshore Annex I Habitats

126. A 100km buffer zone around all project elements was used for the screening exercise for benthic ecology features, within which eight sites were identified. Impacts to benthic habitats are expected to be restricted to direct and indirect physical effects at a relatively localised scale and it is considered that, based on expert judgement, there is no potential pathway for impacts to sites in the wider North Sea or beyond 100km from source. Consideration of sites within the southern North Sea is based on the sensitivities of site specific interest features (receptors) and whether there is a potential pathway for habitats to receive direct or indirect

effects (source). Potential impacts to benthic habitats from the Projects are generally considered small scale and are mainly driven by localised physical disturbance to the sea bed, or localised effects on physical processes.

127. The outcome of the screening exercise (and subsequent consultation) concluded that the following sites are within the zone of influence of sediment redeposition and bedload sediment transport effects :

- The Wash and North Norfolk Coast SAC (bedload sediment transport only); and
- Inner Dowsing, Race Bank and North Ridge SAC.

128. The sites screened out of the need for an Appropriate Assessment due to the conclusion of no LSE are listed in **Appendix 1 HRA Screening Report** and **Appendix 2 HRA Screening Matrices**.

129. A summary of consultation with respect to offshore Annex I habitats is provided in **Section 7.1**.

5.3 Offshore Annex II Sites Designated for Fish

130. Based on the known Annex II species (Atlantic salmon *Salmo salar*, allis shad *Alosa alosa*, twaite shad *Alosa fallax*, sea lamprey *Petromyzon marinus* and river lamprey *Lampetra fluviatilis*) that are known to either migrate through or spend part of their lifecycle in the North Sea, the screening considered all designated sites within the Southern North Sea (and within 250km of the Projects) which have migratory fish species listed in Annex II of the Habitats Directive as an interest feature. Four sites were identified in this zone.

131. The outcome of the screening exercise (and subsequent consultation) concluded no LSE for any of the sites identified, screening out all of the sites from the need for Appropriate Assessment.

5.4 Offshore Annex II Species (Marine Mammals)

132. For marine mammals (harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus,* grey seal *Halichoerus grypus* and harbour seal *Phoca vitulina*), the approach to HRA screening focused on the potential for connectivity between individual marine mammals from designated populations and the offshore sites (i.e. demonstration of a clear source-pathway-receptor relationship). This was based on the distance of the offshore sites from the designated site, the range of each effect and the potential for animals from a site to be within range of an effect.

133. The area over which sites were considered varied for each species. For harbour porpoise, connectivity was considered to be possible between SEP and DEP, and designated sites within the North Sea Management Unit (MU). For bottlenose dolphin connectivity was considered for the east coast of Scotland population and the Greater North Sea (GNS) MU. For both grey seal and harbour seal, all designated sites within the Greater North Sea Oslo and Paris Convention for the Protection of the Marine Environment (OSPAR) regions were considered to have the potential for connectivity. See **Appendix 1 HRA Screening Report** and **Appendix 2 HRA Screening Matrices** for more information on the screening process for marine mammals.

134. The outcome of the screening exercise, recent information and subsequent consultation, concluded that the following four designated sites were screened in for marine mammals (as agreed with Natural England – see **Table 8-2**):

- Southern North Sea SAC for harbour porpoise;
- Moray Firth SAC for bottlenose dolphin;
- Humber Estuary SAC for grey seal; and
- The Wash and North Norfolk Coast SAC for harbour seal.

135. During the HRA screening, it was considered that no bottlenose dolphin designated sites had the potential for connectivity with the Projects, and therefore were not screened in for further assessment. However, since the HRA screening, there has been a recent increase in presence of the bottlenose dolphin along the north-east coast of England. Therefore, as a precautionary approach, it has been assumed that bottlenose dolphin off the east coast of England could be from the Moray Firth SAC and as such this designated site has been assessed further (see **Section 8.4.2**).

136. The designated sites that have been screened out of Appropriate Assessment due to the conclusion of no LSE are listed in **Appendix 1 HRA Screening Report** (noting the changes described in **Section 4.2.1**) and **Appendix 2 HRA Screening Matrices**.

137. For the four marine mammal designated sites screened in for further assessment, the screening exercise concluded the potential for LSE for the effects as listed in **Table 5-1** (as agreed with Natural England – see **Table 8-2**).

Table 5-1: Summary of Potential Effects for Marine Mammals (✓ = Potential for LSE and Therefore Screened in for Further Assessment, ✗ = No Potential for LSE and Therefore Screened Out of Further Assessment)

Potential Effects	Construction	Operation	Decommissioning
Underwater noise (including, piling and other construction activities, vessels, operation and maintenance (O&M) activities, operational turbines and decommissioning activities)	✓	✓	✓
Any barrier effects from underwater noise	✓	✓	✓
Vessel interaction (increased collision risk)	✓	✓	✓
Disturbance at seal haul-out sites	✓	✓	✓
Disturbance of foraging seals at sea	✓	✓	✓
Changes to water quality	✓	✓	✓
Changes to prey availability	✓	✓	✓
Any barrier effects from physical presence	✗	✗	✗
Direct effects electromagnetic fields (EMF)	✗	✗	✗
In-combination effects	✓	✗	✗

138. As agreed with stakeholders at the marine mammals ETG 3 on the 20th of July 2021, the potential effects from Unexploded Ordnance (UXO) clearance will be assessed in a separate Marine Licence (ML) and not as part of the DCO submission (however, marine mammal assessments for potential UXO clearance impacts have been provided in **ES Appendix 10.4 Marine Mammal UXO Assessment** (document reference 6.3.10.4) for information). The potential in-combination effects from UXO clearance at other OWFs during piling at SEP and DEP are assessed.

5.5 Offshore Annex II Species (Ornithology)

139. Birds present in offshore waters and potentially affected by the Projects are predominantly seabirds (defined for this report as auks, gulls, terns, gannets, skuas, shearwaters, petrels and divers). These species have the potential to be present during the breeding season, non-breeding season and the spring / autumn migration/passage periods. Other bird species that may be affected by the Projects include waterfowl (swans, geese, ducks and waders) and other bird species which may fly through the Project areas during spring and/or autumn migration/passage periods.

140. For offshore ornithology receptors during the breeding season, the HRA screening focused primarily on the potential for connectivity between seabirds breeding at colonies which are classified as SPAs, and the Projects.

141. Outside the breeding season, seabirds breeding at SPAs located beyond the breeding season foraging range of the Projects may spend part or all of the non-breeding season in the vicinity of the Project, either wintering or migrating through on spring and/or autumn passage to wintering areas. During this time the number of SPAs with potential connectivity to the Projects will increase.

142. The HRA screening exercise considered sites which either overlap with the Projects' elements, or are within range of the relevant species' foraging range during breeding and non-breeding, or associated foraging areas.[1]

143. The outcome of the screening exercise (and subsequent consultation with Natural England) concluded that the following sites were screened in for Appropriate Assessment:

- Greater Wash SPA;
- North Norfolk Coast SPA and Ramsar;
- Outer Thames Estuary SPA;
- Breydon Water SPA and Ramsar;
- The Wash SPA and Ramsar;
- Gibraltar Point SPA and Ramsar;
- Humber Estuary SPA and Ramsar;

[1] For seabirds during the breeding season this element of the screening process is informed by published information on foraging ranges (Woodward *et al*., 2019). For seabirds during the non-breeding season, screening is informed by reference to the Furness (2015) report on non-breeding population sizes of birds in the UK, whilst for non-breeding birds, populations within 100km of the Projects are considered.

- Broadland SPA and Ramsar;
- Ouse Washes SPA and Ramsar;
- Minsmere-Walberswick SPA and Ramsar;
- Nene Washes SPA and Ramsar;
- Alde-Ore Estuary SPA and Ramsar;
- Flamborough and Filey Coast SPA;
- Coquet Island SPA;
- Farne Islands SPA;
- St Abbs Head to Fast Castle SPA;
- Forth Islands SPA;
- Imperial Dock Lock, Leith SPA;
- Fowlsheugh SPA;
- Ythan Estuary, Sands of Forvie and Meikle Loch SPA (and pSPA extension) and Ramsar;
- Troup, Pennan and Lion's Heads SPA;
- East Caithness Cliffs SPA;
- North Caithness Cliffs SPA;
- Hoy SPA;
- Auskerry SPA;
- Marwick Head SPA;
- West Westray SPA;
- Fair Isle SPA;
- Noss SPA;
- East Mainland Coast, Shetland pSPA;
- Foula SPA;
- Papa Stour SPA;
- Ronas Hill – North Roe and Tingon SPA; and
- Hermaness, Saxa Vord and Valla Field SPA.

144. Changes from the original screening conclusions (i.e. those submitted with PEIR in April 2021) include:

- Pentland Firth pSPA was screened out as it was withdrawn as a pSPA following NatureScot's and JNCC's final advice and recommendations to Scottish Ministers on the proposals to classify a network of marine pSPAs (NatureScot, 2019);
- Fetlar SPA was screened out because no relevant qualifying features have connectivity with SEP and DEP;

- Outer Thames Estuary SPA (red-throated diver feature) was screened in because project vessels will transit through its northern extremity between SEP and DEP and the port of Great Yarmouth.

145. The sites and features screened out of the need for an Appropriate Assessment due to the conclusion of no LSE are listed in **Appendix 1 HRA Screening Report** and **2 HRA Screening Matrices**.

146. The approach to consultation with respect to offshore ornithology is described in **Section 9.1**.

Table 5-2: Summary of Designated Sites and Features Screened In

Site	Features	Rationale
SACs		
River Wensum SAC	• H3260 Watercourses of plain to montane levels with *R. fluitantis* • S1016 Desmoulin's whorl snail	There is potential for both direct and indirect effects upon both the features of the sites and the supporting habitats.
Inner Dowsing, Race Bank and North Ridge SAC	Sandbanks which are slightly covered by sea water all the time	Potential effects from changes to bedload sediment transport from SEP OWF infrastructure.
Southern North Sea SAC	Harbour porpoise	Potential effects from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • changes to water quality; • changes to prey availability; and • in-combination effects.
Moray Firth SAC	Bottlenose dolphin	Potential effects from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • changes to water quality; • changes to prey availability; and • in-combination effects.
Humber Estuary SAC	Grey seal	Potential effects from: • underwater noise; • barrier effects from underwater noise; • vessel interactions;

Site	Features	Rationale
		• disturbance at seal haul-out sites; • disturbance of foraging seals at sea; • changes to water quality; • changes to prey availability; and • in-combination effects.
The Wash and North Norfolk Coast SAC	• Sandbanks which are slightly covered by sea water all the time • Harbour seal	Potential effects on sandbanks from: • changes to bedload sediment transport from cable protection Potential effects on harbour seal from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • disturbance at seal haul-out sites; • disturbance of foraging seals at sea; • changes to water quality; • changes to prey availability; and • in-combination effects.
SPAs		
Greater Wash SPA	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the breeding season
	Common tern, breeding	Potential risk of collision during the breeding season
	Red-throated diver, non-breeding	Potential risk of displacement and barrier effects during the non-breeding season
	Little gull, non-breeding	Potential risk of collision during the non-breeding season

Site	Features	Rationale
North Norfolk Coast SPA and Ramsar Site	Sandwich tern (SPA and Ramsar site), breeding	Potential risk of collision and displacement/barrier effects during the breeding and non-breeding (spring and autumn migration) seasons
	Common tern (SPA and Ramsar site), breeding	Potential risk of collision from SEP and DEP during the breeding season
	Pink-footed goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Dark-bellied brent goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Wigeon (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Knot (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Pintail (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
Outer Thames Estuary SPA	Red-throated diver, non-breeding	Potential risk of displacement and barrier effects during the non-breeding season
Breydon Water SPA and Ramsar Site	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Avocet (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Golden plover (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Lapwing (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site

Site	Features	Rationale
	Waterbird assemblage (SPA and Ramsar site)	Potential risk of collision during migratory flights to and from the site
The Wash SPA and Ramsar Site	Bar-tailed godwit (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Black-tailed godwit (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Common scoter (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Curlew (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Dark-bellied brent goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Dunlin (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Gadwall (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Goldeneye (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Golden plover (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Grey plover (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Knot (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site

Site	Features	Rationale
	Lapwing (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Oystercatcher (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Pink-footed goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Pintail (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Redshank (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Ringed plover (Ramsar site)	Potential risk of collision during migratory flights to and from the site
	Sanderling (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Shelduck (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Turnstone (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Wigeon (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Waterbird assemblage (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
Gibraltar Point SPA and Ramsar Site	Bar-tailed godwit (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Dark-bellied brent goose (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site

Site	Features	Rationale
	Grey plover (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Sanderling (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Waterbird assemblage (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
Humber Estuary SPA and Ramsar Site	Avocet (SPA), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site
	Bar-tailed godwit (SPA and Ramsar site), non-breeding*	Potential risk of collision during migratory flights to and from the site
	Bittern (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Black-tailed godwit (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Dunlin (SPA and Ramsar site), non-breeding*	Potential risk of collision during migratory flights to and from the site
	Golden plover (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Knot (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Redshank (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Shelduck (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site

Site	Features	Rationale
	Waterbird assemblage (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
Broadland SPA and Ramsar Site	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Gadwall (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Shoveler (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Whooper swan (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Wigeon (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
Ouse Washes SPA and Ramsar Site	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Black-tailed godwit (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Gadwall (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site
	Garganey (SPA), breeding	Potential risk of collision during migratory flights to and from the site
	Pintail (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Pochard (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site

Site	Features	Rationale
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Shoveler (SPA and Ramsar), non-breeding	Potential risk of collision during migratory flights to and from the site
	Teal, (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Whooper swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Wigeon (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Waterbird assemblage (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
Minsmere-Walberswick SPA and Ramsar Site	Avocet (SPA), breeding	Potential risk of collision during migratory flights to and from the site
	European white-fronted goose (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Gadwall (SPA), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site
	Shoveler (SPA), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site
	Teal (SPA), breeding	Potential risk of collision during migratory flights to and from the site
	Breeding bird assemblage (SPA and Ramsar site)	Potential risk of collision during migratory flights to and from the site
Nene Washes SPA and Ramsar Site	Bewick’s swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site

Site	Features	Rationale
	Black-tailed godwit (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site
	Shoveler (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site
	Teal (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
	Whooper Swan (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site
	Wigeon (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site
Alde-Ore Estuary SPA and Ramsar Site	Lesser black-backed gull (SPA and Ramsar site), breeding	Potential risk of collision during the breeding and non-breeding (autumn migration, winter and spring migration) seasons
Flamborough and Filey Coast SPA	Kittiwake, breeding	Potential risk of collision during the breeding and non-breeding (autumn migration and spring migration) seasons
	Gannet, breeding	Potential risk of collision and displacement/barrier effects during the breeding and non-breeding (autumn migration and spring migration) seasons
	Guillemot, breeding	Potential risk of displacement/barrier effects during the breeding and non-breeding seasons
	Razorbill, breeding	Potential risk of displacement/barrier effects during the breeding and non-breeding (autumn migration, winter and spring migration) seasons
Coquet Island SPA	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)

Site	Features	Rationale
	Common tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
Farne Islands SPA	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)
	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
	Seabird assemblage, breeding (kittiwake, puffin)	Potential risk of collision and/or displacement and barrier effects during the non-breeding season (autumn migration, spring migration and non-breeding season)
St Abbs Head to Fast Castle SPA	Seabird assemblage, breeding (guillemot)	Potential risk of displacement during the non-breeding season
Forth Islands SPA	Gannet, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)
	Lesser black-backed gull, breeding	Potential risk of collision during the non-breeding season (autumn migration, winter and spring migration)
	Puffin, breeding	Potential risk of displacement/barrier effects during the non-breeding season
Imperial Dock Lock, Leith, SPA	Common tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)

Site	Features	Rationale
Fowlsheugh SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
	Kittiwake, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
Ythan Estuary, Sands of Forvie and Meikle Loch SPA and Ramsar Site	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)
Troup, Pennan and Lion's Heads SPA	Kittiwake, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
East Caithness Cliffs SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
	Kittiwake, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
	Razorbill, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)
North Caithness Cliffs SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
Hoy SPA	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)
Auskerry SPA	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
Marwick Head SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season

Site	Features	Rationale
West Westray SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
Fair Isle SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
Noss SPA	Gannet, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)
	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
East Mainland Coast, Shetland, pSPA	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)
Foula SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season
	Puffin, breeding	Potential risk of displacement/barrier effects during the non-breeding season
	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)
Papa Stour SPA	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)
Ronas Hill – North Roe and Tingon SPA	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)
Hermaness, Saxa Vord and Valla Field SPA	Gannet, breeding	Potential risk of collision and displacement/barrier from SEP and DEP during the non-breeding season (autumn migration and spring migration)

6 Onshore National Site Network Sites

147. This section provides information in order to determine the potential for SEP and DEP to have an adverse effect on the integrity of onshore ecological designated sites, namely the River Wensum SAC and North Norfolk Coast Ramsar and SPA.

148. For each onshore ecology designated site the following has been provided:

- A description of the site's designation and reasons for protection;
- An assessment of the potential effects during the construction, operation, maintenance and decommissioning phases (where relevant) of SEP and DEP;
- An assessment of the potential for in-combination effects for SEP and DEP alongside other relevant developments and projects.

1. Additional information to support and inform this section is presented in:

- **ES Chapter 4 Project Description** (document reference 6.1.4)
- **ES Chapter 18 Water Resources and Flood Risk** (document reference 6.1.18)
- **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20)
- **ES Chapter 22 Air Quality** (document reference 6.1.22)
- **ES Chapter 23 Noise and Vibration** (document reference 6.1.23)
- **ES Chapter 26 Landscape and Visual Impact Assessment** (document reference 6.1.26)
- **Appendix 20.1 Extended Phase 1 Habitat Survey Report** (document reference 6.3.20.1)
- **Appendix 20.4 Wintering Bird Survey Report** (document reference 6.3.20.4)
- **Appendix 20.5 Breeding Bird Survey Report** (document reference 6.3.20.5)
- **Appendix 20.7 Onshore Ecology Desk Study** (document reference 6.3.20.7)
- **Appendix 20.9 White Clawed Crayfish Survey Report** (document reference 6.3.20.9)
- **Appendix 20.11 Invertebrate Survey Report** (document reference 6.3.20.11)
- **Appendix 20.12 National Vegetation Classification (NVC) Survey Report** (document reference 6.3.20.12)
- **Appendix 20.13 Riparian Mammals (Water Vole and Otter) Survey Report** (document reference 6.3.20.13)

6.1 Consultation

2. Consultation with regard to onshore ecology features of designated sites considered in this assessment has been undertaken in accordance with the general process described in **Section 4.2**. The feedback received through the EPP has been considered in preparing this RIAA. **Table 6-1** provides a summary of how the consultation responses received have influenced the approach that has been taken.

Table 6-1: Consultation Responses in Relation to Onshore Ecology and Ornithology Features of Designated Sites

Consultee	Date/ Document	Comment	Project Response / Where Addressed
Section 42 Responses – the following comments were made in response to the draft Information for HRA (submitted in April 2021 with PEIR) and were taken into account in the production of this RIAA.			
Natural England	Section 42 response	No comments received on the onshore conclusions of the draft HRA.	No action required.
Natural England	Section 42 response	Extended Phase 1 Habitat Survey (EP1HS) recorded habitats on accessible land parcels within the former (mostly wider) PEIR boundary. Features were classified according to their total footprints within that boundary e.g. hedgerow classifications were based on all features of hedgerow within the relevant area (the same for other habitats such as grasslands and woodlands); there is a chance that some of these classifications are slightly inaccurate (post-PEIR boundary change). Is the surveying data being used to support the HRA, because this potential inaccuracy could have a knock-on effect?	Where relevant, information obtained from the 2020 and 2021 onshore ecology baseline surveys have been used to inform and support the onshore considerations within the HRA. The Applicant presented and agreed the approach to EP1HS to Natural England at the ETG meetings held on the 28th of January 2020, and agreement was made on the proposed scope and methodology (Agreement ID 1.1 and 1.2) (see the **Consultation Report Appendix 1 Evidence Plan** (document reference 5.2.1). The Applicant presented and agreed the scope and methodology for all species specific surveys at the ETG meeting held on the 28th of January 2020 and on the 10th of December 2020) (Agreement ID's 1.3, 2.1, 2.2, 2.3, 2.4 and 2.5). Constraints and limitations encountered during the baseline ecological surveys undertaken to date are acknowledged and presented in the respective accompanying survey reports.
ETG Meetings			
RSPB, Natural England,	ETG Meeting 1 and Evidence Plan Agreement Log for	RSPB recommended that breeding bird surveys should be extended beyond June at least until end of July, but	The Applicant confirmed and agreed that the scope of the breeding bird surveys will include to the end of July and over-wintering surveys will include pink-footed

Consultee	Date/ Document	Comment	Project Response / Where Addressed
South Norfolk Council (SNC), Broadland District Council (BDC)	onshore ecology and ornithology, 2020	possibly into August depending on the species identified. RSPB recommended that wintering bird surveys are extended throughout October (pink-footed geese will be arriving, and their presence could influence timing of works). Recommend that two years survey effort would be good, unless additional information that would allow for a continuous run of data to be presented. Data should be available from Hornsea Project Three but appreciate challenge of data sharing. SNC and BDC recommended the upcoming hedgerows and trees surveys should also be undertaken in accordance with the Hedgerow Regulations and associated methodology. Natural England raised no additional comments to those raised by the other Interested Parties. However, advised that they will ensure their advice remains aligned with other projects in the area.	geese. A full suite of over-wintering bird surveys has been undertaken, the findings of which will inform further site selection/route planning process and presented in the PEIR and ES. Agreement on the proposed scope and methodology of the breeding birds and wintering bird surveys was made at the ETG meeting (Agreement ID 1.1 and 1.2) (see the **Consultation Report Appendix 1 Evidence Plan** (document reference 5.2.1). The Applicant confirmed that all onshore ecology surveys will be undertaken in accordance with industry accepted guidance and considering the points raised by ETG attendees. The Applicant confirmed that all surveys of hedgerows will be undertaken in accordance with the Hedgerow Regulations methodology. The scope and methodology for all species-specific surveys at the ETG meeting was made (Agreement ID 1.3).
Natural England, RSPB, Norfolk Wildlife trust (NWT) North Norfolk District Council (NNDC),	ETG Meeting 2 and Evidence Plan Agreement Log for onshore ecology and ornithology, 2021	ETG attendees did not have comments on the overall survey methodology and agreed to the methodologies that will be followed. However, it was advised that Natural England reserves the right to change their advice dependent on the information provided in the Application. RSPB advised that the results of previous over-wintering bird studies that cover the same footprint as SEP and DEP should be considered where possible	The applicant and ETG agreed that where other data sets were available these will be obtained and reviewed to inform the conclusions presented in the PEIR. Agreement on the scope and methodology for the over-wintering and breeding bird surveys was made at the ETG meeting (Agreement ID's 2.1, 2.2 and 2.3) (see the **Consultation Report Appendix 1 Evidence Plan** (document reference 5.2.1).

Consultee	Date/ Document	Comment	Project Response / Where Addressed
Norfolk County Council (NCC)		and available to understand the usage of the relevant fields over a longer period of time. The breeding bird survey approach using extrapolation would be acceptable for arable habitats and associated species (given the wide extent of this habitat and anticipated access restrictions, full survey coverage will be difficult to achieve). The approach would involve surveying a selection of representative sites across the DCO boundary, from which it would be possible to extrapolate likely levels of bird nesting throughout the rest of the un-surveyed arable habitats. Natural England advised the approach is fine for the ES application, but the approach for management of nesting breeding birds, will need to be included in the Outline Ecological Management Plan to be taken forwards for pre-construction.	

6.2 Baseline and Current Conservation Status

6.2.1 River Wensum SAC

6.2.1.1 Description of Designation

3. The River Wensum SAC covers approximately 382ha and includes the river and certain adjacent floodplain habitats from its source near Fakenham to its confluence with the River Tud at Norwich.

4. *Ranunculus* vegetation have been recorded throughout much of the river's length. Stream water-crowfoot *R. penicillatus ssp. pseudofluitans* is the dominant *Ranunculus* species but thread-leaved watercrowfoot *R. trichophyllus* and fan-leaved water-crowfoot *R. circinatus* also occur in association with the wide range of aquatic and emergent species that contribute to this vegetation type. The river supports an abundant and rich invertebrate fauna including the native freshwater crayfish *Austropotamobius pallipes* as well as a diverse fish community, including bullhead *Cottus gobio* and brook lamprey *Lampetra planeri*. The site has an abundant and diverse mollusc fauna which includes Desmoulin's whorl-snail *Vertigo moulinsiana*, which is associated with aquatic vegetation at the river edge and adjacent fens.

5. The primary channel of the River Wensum within where the DCO Order Limits crosses the watercourse is characterised by a straight to sinuous planform which is wide, deep and slow flowing in places and dominated by glide flow habitat, with good marginal vegetation comprised of sedges, bladed grasses – iris and reeds. There is good floodplain connection as evident by small wetlands, back waters and an overall wetted floodplain.

6. The banks and margins of both channels of the River Wensum are well vegetated, with the secondary channel encroached by dense vegetation in places such as grasses, reducing flow velocities. However, there was limited in-channel aquatic plants (macrophytes) along both channels.

6.2.1.2 Qualifying Features

7. The qualifying features of the River Wensum SAC are summarised below:
   - Annex I habitats that are a primary reason for selection of this site;
     - 3260 Watercourses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. The Wensum represents sub-type 1 in lowland eastern England. Although the river is extensively regulated by weirs, *Ranunculus* vegetation occurs sporadically throughout much of the river's length. Stream water-crowfoot *R. penicillatus* ssp. *pseudofluitans* is the dominant *Ranunculus* species but thread-leaved water-crowfoot *R. trichophyllus* and fan-leaved water-crowfoot *R. circinatus* also occur.
   - Annex II species that are a primary reason for selection of this site;
     - 1092 White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes*. The Wensum is a chalk-fed river in eastern England, and is an eastern example of riverine white-clawed crayfish *A. pallipes* populations. As with most of the remaining crayfish populations in the south and east of England,

the threats from non-native crayfish species and crayfish plague are severe. Designation of the river as a SAC provides as much protection as can be afforded to such vulnerable populations.

- Annex II species present as a qualifying feature, but not a primary reason for site selection:
  - 1016 Desmoulin's whorl snail *Vertigo moulinsiana*;
  - 1096 Brook lamprey *Lampetra planeri*; and
  - 1163 Bullhead *Cottus gobio.*

8. Potential effects upon white-clawed crayfish, brook lamprey and bullhead have been screened out due to the Applicant's commitment to use trenchless crossing techniques at the River Wensum, thereby avoiding direct effects upon the SAC boundary and the qualifying features it supports.

6.2.1.3 Conservation Objectives

9. The conservation objectives of the River Wensum SAC are in place to ensure that the integrity of the site is maintained or restored as appropriate (Natural England, 2018d). The objectives to ensure the site contributes towards achieving FCS include:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species.
- The structure and function (including typical species) of qualifying natural habitats.
- The structure and function of the habitats of qualifying species.
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
- The populations of qualifying species.
- The distribution of qualifying species within the site.

6.2.1.4 Conditions Assessment

10. Recent water quality measurements for the River Wensum show phosphorus concentrations to be exceeding the targets for all units where there is monitoring data. Any nutrients entering the catchment upstream of the locations which are exceeding their nutrient targets, will make their way downstream and have the potential to further add to the current exceedance (Wood *et al*, 2022).

11. The River Wensum SAC is legally underpinned by the River Wensum SSSI Site of Special Scientific Interest (SSSI). There is a total of 55 SSSI units associated with this site, 13 of which are assessed by Natural England (most recently in 2010) as unfavourable (no change), six are assessed as favourable and the remaining 36 are assessed as being unfavourable (recovering).

6.2.2 North Norfolk Coast Ramsar

6.2.2.1 Description of Designation

12. North Norfolk Coast Ramsar compromises a low-lying barrier coast site extending for 40km from Holme to Weybourne. The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish-water lagoons and extensive areas of freshwater grazing marsh and reed beds.

13. The site supports internationally important numbers of wildfowl in winter and several nationally rare breeding birds.

6.2.2.2 Qualifying Features

14. Ramsar criterion 6 species/populations occurring at levels of international importance (as identified at designation):

- Sandwich tern Sterna *(Thalasseus) sandvicensis*;
- Common tern *Sterna hirundo*;
- Little tern *Sterna albifrons*;
- Red knot *Calidris canutus islandica*;
- Pink-footed goose *Anser brachyrhynchus*;
- Dark-bellied brent goose *Branta bernicla*;
- Eurasian wigeon *Anas penelope*; and
- Northern pintail *Anas acuta*.

15. Species/populations identified subsequent to designation for possible future consideration under criterion 6:

- Ringed plover *Charadrius hiaticula*;
- Sanderling *Calidris alba*; and
- Bar-tailed godwit *Limosa lapponica lapponica.*

6.2.2.3 Conditions Assessment

16. The North Norfolk Coast Ramsar is legally underpinned by the North Norfolk Coast SSSI. There is a total of 70 SSSI units associated with this site, 68 of which are assessed by Natural England (most recently in 2010) as favourable and two assessed as being unfavourable (recovering).

6.2.3 North Norfolk Coast SPA

6.2.3.1 Description of Designation

17. The site qualifies under Article 4(2) of the Birds Directive as an internationally important wetland, regularly supporting, in winter, over 10,000 wildfowl (average over 20,000) and internationally important numbers of the following waterfowl species:

6.2.3.2 Qualifying Features

18. The qualifying species of the North Norfolk Coast SPA are:

- Avocet *Recurvirostra avosetta*;
- Bittern *Botaurus stellaris*;
- Common tern *Sterna hirundo*;
- Dark-bellied Brent goose *Branta bernicla*;
- Knot *Calidris canutus*;
- Little tern *Sterna albifrons*;
- Marsh Harrier *Circus aeruginosus*;
- Montagu's harrier *Circus pygargus*;
- Pink-footed goose *Anser brachyrhynchus*;
- Sandwich tern *Sterna sandvicensis*; and
- Wigeon *Anas penelope*.

6.2.3.3 Conservation Objectives

19. With regard to the SPA and the natural habitats and/or species for which the site has been designated (as listed above), and subject to natural change the conservation objectives are as follow by ensuring that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the FCS of its Qualifying Features, by maintaining or restoring:

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

6.2.3.4 Conditions Assessment

20. The North Norfolk Coast SPA is legally underpinned by the North Norfolk Coast SSSI. There is a total of 70 SSSI units associated with this site, 68 of which are assessed by Natural England (most recently in 2010) as favourable and two assessed as being unfavourable (recovering).

6.3 Assessment Scenarios

6.3.1 Embedded Mitigation

21. This section outlines the embedded mitigation relevant to the ecological assessment, which has been incorporated into the design of SEP and DEP (**Table 6-2**) as presented in **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20). The **Schedule of Mitigation and Mitigation Routemap** (document reference 6.5) details how and where these mitigation measures are secured within the **Draft DCO** (document reference 3.1).

Table 6-2: Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
Valued Habitats	
Designated nature conservation sites	SEP and DEP has undergone an extensive site selection process which has involved incorporating environmental considerations in collaboration with the engineering design requirements. The onshore cable corridor has been routed to avoid designated nature conservation sites (e.g. SPA, SSSI etc) where possible. Trenchless installation methods (e.g. HDD) for the export cables have been proposed to avoid direct impacts to any designated sites and/or ex-situ habitats that currently fall within the DCO Order Limits. Consequently, they are being avoided through the use of this trenchless technique.
Woodland and hedgerows	Where the onshore cable corridor crosses through woodland and hedgerows, the working corridor width would be reduced to a typical working width of 20m. This is on the basis that a large part of the 45m (for a single project) or 60m (for both SEP and DEP) corridor is for soil storage/management, and trees and hedgerows would not be removed for this purpose and would be retained outside the 20m working corridor. The reduced 20m working width at woodland and hedgerow crossing applies to all scenarios; in reality, it is likely to be less for a single project but not for the purposes of the assessment. Hedgerows would be replanted. Trees and woodland would be replanted within the construction corridor but outside the final cable easement of 20m width if both SEP and DEP are constructed and 12m if only SEP or DEP is constructed, where tree planting would be prohibited. Planting would be implemented during the first planting season following completion of construction of either SEP or DEP (subject to landowner agreements), whether constructed concurrently or sequentially. Further details on hedgerow and tree removal, retention, replacement and management are presented in the **Outline Landscape Management Plan** (document reference 9.18) and the **Outline Ecological Management Plan** (document reference 9.19). The DCO Order Limits has been routed to avoid woodland habitat wherever possible, as demonstrated by the boundary alignment around woodlands such as Mossymere Wood (in the Civil Parishes of Itteringham and Corpusty and Saxthorpe), Colton Wood (in the Civil Parish of Marlingford and Colton) and Smeeth Wood (in the Civil Parish of Ketteringham). Colton Wood and Smeeth Wood are the only Ancient Woodlands in close proximity to the DCO Order Limits.
Watercourse crossings	
Cable crossings over watercourses	All Main Rivers and Internal Drainage Board (IDB) maintained Ordinary Watercourses would be crossed using trenchless techniques such as HDD to avoid direct interaction with these watercourses. The cable entry and exit

Parameter	Mitigation Measures Embedded into the Project Design
	pits would be at least 9m from the banks of the watercourse, and the cable would be at least 2m below the channel bed.
Temporary access across watercourse	Temporary bridges (Bailey bridges) or similar may be used as options to traverse Main Rivers and IDB-maintained Ordinary Watercourses where direct access is not readily available from both sides. Selection of crossing technique for all other Ordinary Watercourses will be dependent on local site conditions and may include the use of temporary culverts.

6.3.2 Worst-Case Scenario

22. The final design of SEP and DEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. These are presented in **Table 6-3**.

Table 6-3: Realistic Worst-Case Scenarios

Potential Effect	SEP or DEP in isolation	SEP and DEP concurrently	SEP and DEP sequentially	Notes and Rationale
Construction				
Habitat destruction or damage, or disturbance to statutory designated nature conservation sites and their qualifying features.	**Landfall:** • HDD drills: Number: 2, Length: 1,150m. • Transition joint bays: Number: 1, Dimensions: 26m (L) x 10m (W) x 3m (D) • HDD compound area: 75m x 75m • Total works area: 48,955.1m^2 • Approximate quantity of excavated material: Total: 3,250m^3 • Duration: Landfall HDD: 4 months, Landfall cable pull: 2 months	**Landfall:** • HDD drills: Number: 4, Length: 1,150m. • Transition joint bays: Number: 2, Dimensions: 26m (L) x 12m (W) x 3m (D) • HDD compound area: 75m x 75m • Total works area: 48,955.1m^2 • Approximate quantity of excavated material: Total: 3,450m^3 • Duration: Landfall HDD: 5 months, Landfall cable pull: 4 months	**Landfall:** • HDD drills: Number: 4, Length: 1,150m. • Transition joint bays: Number: 2 (adjacent to each other), Dimensions: 26m (L) x 10m (W) x 3m (D) • HDD compound area: 75m x 75m (per project) • Total works area: 48,955.1m^2 • Approximate quantity of excavated material: Total: 6,500m^3 • Duration: Landfall HDD: 4 months, Landfall cable pull: 2 months (per project)	These parameters represent the maximum footprint of disturbance within the DCO Order Limits at the landfall, in which the potential disturbance to onshore ecology and ornithology receptors could occur. Works at the landfall are not expected to cause direct disturbance as HDD would be used. Furthermore, the HDD works should not require any prolonged periods of restrictions or closures to the beach for public access, although it is possible that some work activities would be required to be performed on the beach that may require short periods of restricted access. It is considered that construction of both SEP and DEP in all scenarios will result in a similar scale of impacts on ecological receptors once the embedded mitigation measures are taken into account and due to the fact that all working areas will be reinstated on completion of the construction works.
	Onshore Cable Corridor: • Construction corridor: Length: 60km, Width: 45m (100m at trenchless crossings). • Main construction compound: Number: 1, Area: 30,000m^2. • Secondary construction compounds with cement bound sand (CBS): 2, Area 7,500m^2, Duration 18-24 months (actively in operation ~14 months) • Secondary construction compounds without CBS: 6, Area 2,500m^2, Duration 12-18 months (actively in operation ~6 months). • Trenchless crossing compounds: Area: 1,500m2 – 4,500m^2. • Total works area (incl. compounds and accesses): 4,566,250.6m^2 • Cable trench: Number: 1, Width at base: 0.85m, Width at surface: 3m, Depth: 2m. • Haul road: Number :1, Length: 55km, Width: 5m (8m at passing places), Total area: 315,640m^2. • Jointing bays: Typical frequency: Every 1000m, Approximate number: 60, Dimensions: 16m (L) x 3.5m (W) x 2m (D). • Link boxes: Typical frequency: Every 1000m, Approximate number: 60, Dimensions: 2.6m (L) x 2m (W) x 1.5m (D).	**Onshore Cable Corridor:** • Construction corridor: Length: 60km, Width: 60m (100m at trenchless crossings). • Main construction compound: Number: 1, Area: 30,000m^2. • Secondary construction compounds with CBS: 2, Area 7,500m^2, Duration 18-24 months (actively in operation ~14 months) • Secondary construction compounds without CBS: 6, Area 2,500m^2, Duration 12-18 months (actively in operation ~6 months). • Trenchless crossing compounds: Area: 1,500m2 – 4,500m^2. • Total works area (incl. compounds and accesses): 4,566,250.6m^2 • Cable trench: Number: 2, Width at base: 0.85m, Width at surface: 3m, Depth: 2m. • Haul road: Number :1, Length: 55km, Width: 5m (8m at passing places), Total area: 315,640m^2. • Jointing bays: Typical frequency: Every 1000m, Approximate number: 120, Dimensions: 16m (L) x 3.5m (W) x 2m (D) (per circuit). • Link boxes: Typical frequency: Every 1000m, Approximate number: 120, Dimensions: 2.6m (L) x 2m (W) x 1.5m (D) (per circuit).	**Onshore Cable Corridor:** • Construction corridor: Length: 60km, Width: 60m (100m at trenchless crossings). • Main construction compound: Number: 1, Area: 30,000m^2 (for each project). • Secondary construction compounds with CBS: 2, Area 7,500m^2, Duration 18-24 months (actively in operation ~14 months) • Secondary construction compounds without CBS: 8, Area 2,500m^2, Duration 12-18 months (actively in operation ~6 months). • Trenchless crossing compounds: Area: 1,500m^2 – 4,500m^2. • Total works area (incl. compounds and accesses): 4,566,250.6m^2 • Cable trench: Number: 2, Width at base: 0.85m, Width at surface: 3m, Depth: 2m. • Haul road: Number :1 (for each project), Length: 55km, Width: 5m (8m at passing places), Total area: 315,640m^2. • Jointing bays: Typical frequency: Every 1000m, Approximate number: 120, Dimensions: 16m (L) x 3.5m (W) x 2m (D) (per circuit). • Link boxes: Typical frequency: Every 1000m, Approximate number: 120, Dimensions: 2.6m (L) x 2m (W) x 1.5m (D) (per circuit).	The onshore cable duct would be installed in sections of up to 1km at a time, with a typical construction presence of up to four weeks along each 1km section. It is considered that construction of both SEP and DEP in all scenarios will result in a similar scale of impacts on ecological receptors once the embedded mitigation measures are taken into account and due to the fact that all working areas will be reinstated on completion of the construction works

Potential Effect	SEP or DEP in isolation	SEP and DEP concurrently	SEP and DEP sequentially	Notes and Rationale
	• Approximate quantities of excavated material: Cable trench: 360,000m^3, Haul Road: 123,00m^3, Jointing bays and link boxes: 36,720 m^3, Temporary Compounds: 21,450m^3, **Total: 541,710m^3** • Main construction compound: Duration: 48 months. • Secondary construction compounds: Duration: 12 - 24 months • Trenchless crossing compounds: Duration: 7 weeks. • Duration: Onshore cable ducting and installation (incl. reinstatement): 24 months.	• Approximate quantities of excavated material: Cable trench: 360,000m^3, Haul Road: 123,00m^3, Jointing bays and link boxes: 36,720 m^3, Temporary Compounds: 21,450m^3, **Total: 541,710m^3** • Main construction compound: Duration: 48 months. • Secondary construction compounds: Duration: 12 - 24 months • Trenchless crossing compounds: Duration: 7 weeks. • Duration: Onshore cable ducting and installation (incl. reinstatement): 26 months.	• Approximate quantities of excavated material: Cable trench: 360,000m^3, Haul Road: 123,00m^3, Jointing bays and link boxes: 36,720 m^3, Temporary Compounds: 21,450m^3, **Total: 541,710m^3** • Main construction compound: Duration: 48 months. • Secondary construction compounds: Duration: 12 - 24 months • Trenchless crossing compounds: Duration: 7 weeks. • Duration: Onshore cable ducting and installation (incl. reinstatement): 24 months.	
	Onshore Substation: • Substation platform: Area: 3.25ha • Substation compound: Total area: 10,000m^2 • Permanent access road: Number: 1, Length: 850m: Width: 6m, Area: 5,100m^2 • Foundations: Subject to detailed design. Potential for Continuous Flight Auger (CFA) piles is assumed. • Total works area: 445,653.3m^2; • 400kv connection: Approximate length: 600m, Width: 2m, Cable trench depth: 1.2m. Construction easement 38m, Permanent easement 10m. • Duration: 32 months	**Onshore Substation:** • Substation platform: Area: 6.0ha, Depth of topsoil strip: 300mm • Substation compound: Total area: 10,000m^{2,} , Topsoil strip: 12,500^2 • Permanent access road: Number: 1, Length: 850m: Width: 6m, Area: 5,100m^2 • Total works area: 445,653.3m^2; • Foundations: Subject to detailed design. Potential for CFA piles is assumed. • 400kv connection: Approximate length: 600m, Width: 2m, Cable trench depth: 1.2m. Construction easement 38m, Permanent easement 20m • Duration: 36 months	**Onshore Substation:** • Substation platform: Area: 6.0ha, Depth of topsoil strip: 300mm • Substation compound: Total area: 10,000m^2, , Topsoil strip: 12,500^2 • Permanent access road: Number: 1, Length: 850m: Width: 6m, Area: 5,100m2 • Total works area: 445,653.3m^2; • Foundations: Subject to detailed design. Potential for CFA piles is assumed. • 400kv connection: Approximate length: 600m, Width: 2m, Cable trench depth: 1.2m. Construction easement 45m, Permanent easement 20m • Duration: 36 months	Whilst a larger area of land take would be required for SEP and DEP to be constructed concurrently or sequentially, it is considered that construction of both SEP and DEP in all scenarios will result in a similar scale of impacts on ecological receptors once the embedded mitigation measures are taken into account and due to the fact that all working areas will be reinstated on completion of the construction works
Operation				
No operational impacts to onshore national site network sites have been screened in and so a worst-case scenario for this project phase is not presented here.				
Decommissioning				
No final decision has yet been made regarding the final decommissioning policy for the onshore project infrastructure including landfall, onshore cable corridor and onshore substation. It is also recognised that legislation and industry best practice change over time. However, it is likely that the onshore project equipment, including the cable, would be removed, reused or recycled where possible and the transition bays and cable ducts being left in place. The detail and scope of the decommissioning works would be determined by the relevant legislation and guidance at the time of decommissioning and would be agreed with the regulator. It is anticipated that for the purposes of a worst-case scenario, the impacts would be no greater than those identified for the construction phase.				

6.4 Assessment of Potential Effects

6.4.1 River Wensum SAC

23. The potential effects of SEP and DEP that have been assessed as part of the HRA process for the River Wensum SAC are listed in **Table 6-4**.

24. No potential effects during operation or decommissioning were screened into the assessment. Therefore, this section presents only those potential effects that have been identified during construction of SEP and DEP.

Table 6-4: Summary of Potential Effects Screened Into the HRA

Qualifying feature	Potential effects
Ranunculion fluitantis and *Callitricho-Batrachion* vegetation	Direct effects on *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation present within ex-situ habitats of the SAC during the construction phase.
	Indirect effects on *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation present within the SAC boundary arising from geology / contamination and groundwater / hydrology effects during the construction phase.
	Indirect effects on *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation present within ex-situ habitats of the SAC arising from geology / contamination and groundwater / hydrology effects during the construction phase.
Desmoulin's whorl snail	Direct effects on Desmoulin's whorl snail present within ex-situ habitats of the SAC during the construction phase.
	Indirect effects on Desmoulin's whorl snail present within the SAC boundary arising from geology / contamination and groundwater / hydrology effects during the construction phase.
	Indirect effects on Desmoulin's whorl snail present within ex-situ habitats of the SAC arising from geology / contamination and groundwater / hydrology effect during the construction phase.

6.4.1.1 Potential Effects of SEP and DEP

6.4.1.1.1 *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation

25. The 2019, 2020 and 2021 EPH1 surveys concluded that the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation for which the River Wensum SAC is designated, is not present within the River Wensum SAC boundary within the DCO Order Limits. However, these species may be present further up or downstream of the River Wensum that is outwith the DCO Order Limits, and therefore for the purposes of this assessment it has been assumed that they are present within these reaches of the River Wensum.

26. Direct effects would be avoided as a result of the Project commitment to cross the River Wensum using trenchless techniques, as detailed in the embedded mitigation above.

27. Potential changes to local hydrological conditions from the construction of SEP and DEP have the potential to change the structure and function of the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation habitat downstream of the proposed works. The 2019, 2020 and 2021 Extended Phase 1 Habitat surveys concluded that there are no springs or seepages located within the floodplain habitats (see **ES**

Chapter 18 Water Resources and Flood Risk (document reference 6.1.18)). Therefore, works in this area will not result in direct changes to any springs directly connected to the River Wensum. Furthermore, areas of hardstanding are not required within the River Wensum floodplain as part of the proposed works, and therefore there will not be changes to the runoff rates associated with the proposed works.

28. The introduction of cable ducts is not anticipated to have any effect upon groundwater flows for the River Wensum (see **ES Chapter 18 Water Resources and Flood Risk** (document reference 6.1.18)). Furthermore, for a river crossing, HDD ducts would be installed 5m to 15m below the floodplain, and at least 2m below the river bed. As a result, the buried ducts will have no effect upon surface water flows.

29. The potential exists for the accidental release of lubricants, fuels, oils and drilling fluid from construction machinery working in and adjacent to surface watercourses, through spillage, leakage and in-wash from vehicle storage areas after rainfall / sediment runoff due the proposed works in these locations. Furthermore, these activities have the potential to increase the potential for the erosion of soil particulates, resulting in an increase in the supply of fine sediment to surface watercourses through surface runoff and the erosion of exposed soils if unmitigated.

30. The proposed works will entail vehicle tracking and earthworks associated with trenchless crossing techniques at the River Wensum. Plant, including a drilling rig, haulage vehicles earth-moving equipment will be operating within the floodplain adjacent to the watercourse for approximately 2 months. The land would be levelled, topsoil removed and stored within the mobilisation area.

31. The following mitigation measures (secured in the **Outline Code of Construction Practice** – document refence 9.17) will be put in place to minimise the risk of sediment or pollutant release into the watercourses which are functionally connected to the River Wensum:

- Sediment management – works within the functional floodplain:
  - The preferred way of working within the functional floodplain will be to establish the trenchless crossing compounds by placing geotextile on top of the existing pasture grassland. Whilst it is accepted that grass covered by geotextile for 8 weeks will die back, it will not expose bare soils beneath, and the grass will recover more quickly than re-seeding or natural regeneration in the case of topsoil stripping. Where a topsoil strip is required, for existing grassland located within the functional floodplain, this will be undertaken using a turf cutter. Turf rolls will be retained and reinstated after the works are complete (approximately eight weeks) to maximise the potential for reinstatement / restoration to be effective.
  - Removed topsoil and turf will be stored outside of the functional floodplain.
  - Any damage to ground conditions caused by vehicle tracking will be rectified prior to the reinstatement of topsoil/turf. Land reinstatement will be undertaken in adherence to Defra's Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (2009). These measures will be secured through the final Code of Construction Practice (CoCP) produced

post-consent, which will be in accordance with the certified **Outline CoCP** (document reference 9.17).

- Construction drainage will be introduced along the onshore cable corridor in advance of the works. The drainage will be designed to minimise water entering works areas and to ensure ongoing drainage of surrounding land. A surface water drainage plan will be included within the final CoCP produced post-consent, which will be in accordance with the certified **Outline CoCP** (document reference 9.17). This will include the following measures:
    - The surface water drainage introduced in advance of construction will include interceptor drains for surface water flows. The interceptor drains will include areas for the settlement of sediment (sediment traps).
    - Sediment traps are locally wider/deeper areas of the drains that will encourage passive sediment deposition.
    - Sediment traps will be monitored weekly (visual inspection) during the trenchless crossing works (with increased monitoring during inclement weather). If required these traps can be pumped via settling tanks to remove sediment, based on a pre-defined level / depth of sediment.
    - Where water enters the construction areas, this will be pumped via settling tanks or ponds to remove sediment before being discharged into local ditches or drains via the interceptor drains in order to prevent increases in fine sediment supply to the watercourses.
    - When the interceptor drains and associated sediment traps are decommissioned any standing water within the drains would be pumped out to settling tanks as described above. Sediment that has settled out within the interceptor drain would be left in place. Soils would be replaced in the reverse order that they were removed and turf reinstated.
    - Existing tracks and roadways will be utilised for access where possible.
    - Any topsoil removal and subsequent post-construction reinstatement will follow the steps outlined above.

- Sediment management – measures to be applied throughout the DCO Order Limits:
    - Topsoil would be stripped from the entire width of the onshore cable corridor for the length of each approximately 150m work front and stored and capped to minimise wind and water erosion within the onshore cable corridor.
    - Once all the trenching is completed and back-filled within each work front, the stored topsoil will be re-distributed over the area of the work front, with the exception of the running track and any associated drainage.
    - Mobilisation areas within the onshore project area will comprise hardstanding of permeable gravel aggregate underlain by geotextile, or other suitable material.
    - Subsoil exposure will be minimised and strips of undisturbed vegetation will be retained on the edge of the working area where possible.

  - Within the functional floodplain, where surface vegetation has been removed (with the exception of arable crops), turf stripping and reinstatement of grassland for all grassland habitats located within 10m of any watercourse within the River Wensum catchment will be undertaken. This mitigation measure is being proposed to ensure that grassland adjacent to all watercourses is managed so as to reduce the risk of sediment release into the tributaries of the River Wensum by reinstating a 10m buffer strip of re-laid turf adjacent to each watercourse
  - On-site retention of sediment will be maximised by routing all drainage through the site drainage systems.
  - The drainage system will include silt fences at the foot of soil storage areas to intercept sediment runoff at source. Where practicable, runoff will be routed into swales, which incorporate check dams to further intercept sediment and/or attenuation ponds which incorporate sediment forebays. Suitable filters will be used to remove sediment from any water discharged into the surface drainage network.
  - Additional silt fences will be included in parts of the working area that are in proximity to surface drainage channels. It is not intended that silt fences will be used where works are located in the functional floodplain as spoil will not be stored in these locations. Sediment traps would be incorporated into the design of the surface water drainage.
- Soil and sediment will not be allowed to accumulate on roads. Traffic movement would be restricted to minimise the potential for surface disturbance. Pollution prevention:
  - The working methodology will follow construction industry good practice guidance, as detailed in the Environment Agency's Pollution Prevention Guidance (PPG) notes (including PPG01, PPG05, PPG08 and PPG21)22, and CIRIA's 'Control of water pollution from construction sites – A guide to good practice' (2001), including:
    - Spill kits will be available on site at all times and staff will be trained in their use.
    - Sand bags or stop logs will also be available for deployment on the outlets from the site drainage system in case of emergency spillages.
    - Equipment will be regularly checked to ensure leakages do not occur.
    - Refuelling of construction plant will be restricted to designated impermeable areas.
    - All fuels, oils, lubricants and other chemicals will be stored in an impermeable bund with at least 110% of the stored capacity.
    - Suitable biosecurity protocols (such as those outlined by the Non-Native Species Secretariat (NNSS)) would be put in place during the works in order to minimise the risk of contamination and the spread of the invasive non-native species.
- Bentonite breakout:

- Bentonite is an inert clay-based material used as a lubricant at the drill head during trenchless crossing techniques – comprising 95% water and 5% clay. It does not represent a pollutant but can cause smothering of habitats if not contained.
- For small breakouts it may cause more damage to the sensitive habitats to attempt to contain the breakout and remove the escaped material, i.e. trampling of grassland associated with responding to the breakout and the potential for exposing bare ground. A break-out contingency plan will be developed and will be included in the final CoCP, which will define the approach for responding to breakouts. The steps of the contingency plan will include:
    - Measures to ensure drilling stops once a breakout is reported (there will be a drop in pressure at the drill head).
    - Measures to contain the breakout, for example sand bags, to minimise the extent of any smothering.
    - Measures to remove the released bentonite if a significant volume of material is contained – for example pumped back to the bentonite lagoon within the trenchless crossing compound, or pumped to the interceptor drains, or pumped to the mobile settling tanks that will be used for managing sediment traps.
    - The exact specification for the contingency plan will be informed by further ground investigation and the specific design of the trenchless crossing.

32. These mitigation measures are considered suitable for minimising the risk of sediment / pollutant release into watercourses functionally connected with the River Wensum down to a negligible level.
33. In light of the negligible risk of the proposed works affecting local groundwater and hydrology following implementation of the mitigation measures outlined above, and the commitment to cross the River Wensum using trenchless techniques, there would be **no adverse effect on the integrity of the River Wensum SAC in relation to the conservation objectives for *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation**.

6.4.1.1.2 Desmoulin's Whorl Snail

34. The 2019, 2020 and 2021 Extended Phase 1 Habitat surveys concluded that this species is not present within the banks of the River Wensum or within the drains and ditches of the floodplain habitats of the river.
35. As the qualifying feature is not present within the DCO Order limits no direct effects are expected. However, this species may be present further up or downstream of the River Wensum that is outwith the DCO Order Limits, and therefore for the purposes of this assessment it has been assumed that they are present within these reaches of the River Wensum.
36. The potential for SEP and DEP to change local groundwater and hydrological conditions, during its construction phase is covered above for indirect effects on

Ranunculion fluitantis and *Callitricho-Batrachion*. The conclusions and mitigation for potential effects are the same for Desmoulin's whorl snail.

37. Following implementation of the mitigation measures outlined above, for *Ranunculion fluitantis* and *Callitricho-Batrachion* there would be **no adverse effect on the integrity of the River Wensum SAC in relation to the conservation objectives for Desmoulin's whorl snail**.

6.4.1.2 Potential Effects of SEP and DEP In-Combination with Other Plans and Projects

38. Hornsea Project Three, Norfolk Vanguard, Norfolk Boreas and the Norwich Western Link Road projects also propose to cross the River Wensum. Further details of the projects and plans considered as part of a cumulative assessment is presented in **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20) (section 20.7) including a more detailed explanation of the potential in-combination impacts from each of the above projects. All of these projects have also committed to avoid direct impacts by either using trenchless techniques or, in the case of the Norwich Western Link, by bridging over the river. All of these projects commit to a similar suite of measures to minimise potential effects to no greater than negligible. With the implementation of this suite of measures indirect effects from each project would be very localised and it is not expected that these localised effects would combine to be any greater than that for each project individually. As such, there would be **no adverse effect on the integrity of the River Wensum SAC, in-combination with other plans and projects**.

6.4.1.3 Summary of Effects on Site Integrity

39. Following adherence to the mitigation measures presented in the **Outline Ecological Management Plan** (document reference: 9.19) and/or the control measures presented in the **Outline Code of Construction Practice** (document reference: 9.17) there would be **no adverse effect on site integrity of the River Wensum SAC due to SEP and DEP alone, or in-combination with any other plans or projects**.

6.4.2 North Norfolk Coast Ramsar

40. The potential effects of SEP and DEP that have been assessed as part of the HRA process for the North Norfolk Coast Ramsar are listed in **Table 6-5**.

41. No potential effects during operation or decommissioning were screened into the assessment. Therefore, this section presents only those potential effects that have been identified during construction of SEP and DEP.

Table 6-5: Summary of Potential Effects Screened Into the HRA

Qualifying feature	Potential effects
• Red knot *Calidris canutus islandica*; • Pink-footed goose *Anser brachyrhynchus*; • Dark-bellied brent goose *Branta bernicla*; • Pintail *Anas acuta;*	Direct effects on ex-situ habitats during the installation of the cables and/or construction of access tracks.
	Indirect effects within the Ramsar site boundary:

Qualifying feature	Potential effects
• Eurasian wigeon *Anas Penelope.*	• The qualifying features of the North Norfolk Coast Ramsar are sensitive to noise, visual or air quality disturbance during the construction phase, so indirect effects upon these qualifying features might occur and these effects have been screened in for further assessment. • Watercourses and arable land which might be supporting wintering birds identified as qualifying features of the Ramsar site could be subject to trenching works during the construction phase, and as such there may be effects upon this ex-situ habitat.

6.4.2.1 Potential Effects of SEP and DEP

6.4.2.1.1 Direct Effects on Wintering Birds Present in Ex-Situ Habitats of the Ramsar Site

42. The 2019/2020 and 2020/2021 wintering birds surveys confirmed presence of suitable feeding/foraging habitat, namely harvested sugar beet fields or fields with stubble (harvested but not ploughed-in cereal crops), was closely associated with the presence of over-wintering bird activity. Full details relating to each wintering bird survey effort is presented in **Appendix 20.4 Wintering Birds Survey Report** (document reference 6.3.20.4).

43. No significant flocks of wintering wildfowl or wader species were recorded within the DCO Order Limits, with pink-footed geese being the only Ramsar qualifying species recorded. The peak flock count of pink-footed geese recorded was 3,500 birds within an area to the east of the landfall location, that is outwith the DCO Order Limits (approximately 800m east at its closest point from the DCO Order Limits at Weybourne).

44. Whilst the 2019-20 over-wintering bird survey effort recorded a flock of up to 3,500 pink-footed geese foraging within a harvested sugar beet field south of Weybourne cliffs, this area is over 800m from where works associated with SEP and DEP would be undertaken. In addition, HDD will be adopted at the landfall location and therefore direct (e.g. habitat loss) or indirect (e.g. noise from HDD operations) impacts to pink-footed geese are unlikely to occur, However, given that this species are linked to the location of sugar beet fields, it may be likely that should sugar beet crops be present at the time of construction, temporary habitat loss and/or disturbance impacts to this (and potentially other non-Ramsar qualifying bird species) may occur. It is, however, considered that birds may habituate to construction activities and/or associated noise levels. Nevertheless, and should construction works take place over winter and sugar beet fields are present within the onshore cable corridor, there remains the potential for disturbance, albeit temporary and of short-term duration, to occur.

45. Given the wide ranges of most over-wintering wildfowl and waders, the specific and localised land-take requirements for SEP and DEP and that HDD will be adopted at the landfall, wintering bird species (and in this case specifically pink-footed geese as the only Ramsar qualifying species as being recorded during the surveys

undertaken to date) are considered to be of low sensitivity to any effects arising from SEP and DEP. Nevertheless, mitigation measures in respect to these species (and where required, specifically pink footed geese) are presented (and secured) in the **Outline Ecological Management Plan** (document reference: 9.19).

46. As concluded in **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20), through the implementation and adherence to the identified mitigation measures, the impact on over-wintering birds as a result of SEP and DEP is predicted to be of negligible significance. In addition, it is considered that there is an abundant supply of suitable fields for foraging over-wintering birds throughout Norfolk and surrounding counties, which would have capacity and availability to support any displaced foraging demands.

47. As presented (and secured) in the **Outline Ecological Management Plan** (document reference: 9.19), where construction works are undertaken within sugar beet fields or functionally linked habitat between November and January, a pre-construction survey will be undertaken to record the distribution and abundance of pink-footed geese and the distribution of harvested sugar beet likely to be affected during the winter season within which construction works will be undertaken. The findings of these pre-construction surveys will determine whether mitigation measures to reduce disturbance will be required; however, such mitigation measures may comprise pre-work habitat manipulation works to actively discourage bird species from using the fields where works are required and subsequently installing exclusion fencing to deter birds from the area as well as ensuring all lighting (if required) is only directed onto the construction works area.

48. During the construction works and should pink-footed geese be present, the Ecological Clerk of Works (ECoW) will be responsible for advising on the appropriate levels of mitigation, e.g. watching briefs, tool box talks to the construction personnel etc, as presented in the **Outline Ecological Management Plan** (document reference: 9.19).

49. As presented in the **Outline Ecological Management Plan** (document reference: 9.19), these mitigation measures are considered suitable for minimising the risk to wintering birds. Therefore, there would be **no adverse effect on the integrity of the North Norfolk Coast Ramsar in relation to direct impacts to wintering birds present in *ex-situ* habitats**.

6.4.2.1.2 Indirect Effects on Wintering Birds Present in Ex-Situ Habitats

50. The qualifying bird species of the North Norfolk Coast Ramsar are sensitive to noise, visual or air quality disturbance, so indirect effects upon these species may occur and these effects have been screened in for further assessment.

51. Wintering birds are associated with arable land and watercourse habitats which will not be affected by changes to the geology. Therefore, these effects have been screened out of further assessment.

52. Watercourses and arable land which might be supporting wintering birds identified as qualifying features of the Ramsar site could be subject to trenching works during the construction phase, and as such there may be effects upon this ex-situ habitat through accidental release of pollutants when crossing watercourses. It is anticipated, however, that through the implementation of appropriate construction

techniques and adherence to good environmental practice and where required the implementation of control measures, risks associated with accidental release of contaminants would be negligible.

53. Onshore construction activities could result in the temporary loss of foraging territory which in turn may reduce the nesting capacity within certain areas for certain species. Furthermore, the onshore construction activities may result in temporary short-term increased noise levels which in combination with the presence of construction personnel, operating machinery, lighting and ground vibration levels may result in potential wintering grounds to not be used and/or abandoned.

54. Mitigation measures that would be adopted include temporary screening around the work area or construction compound so that the noise levels from machinery will be attenuated to an acceptable level. It is generally considered that screening can provided approximately 5dB – 10dB of attenuation but the effectiveness is dependent on the distance to the noise source, and the height and length of the screening.

55. Prior to construction a Construction Noise Management Plan (CNMP) will be prepared detailing site specific noise control measures for construction activities will be identified and implemented to reduce potential construction noise.

56. An **Outline Code of Construction Practice** (document reference: 9.17) has been prepared which sets out the management measures for all onshore construction works associated with SEP and DEP and will include measures to suppress the generation of dust, including:

- Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the logbook.
- Carry out regular site inspections, record inspection results, and make an inspection log available to the local authority when asked.
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
- Erect solid screens or barriers around dusty activities (e.g. excavations during dry weather conditions) or the site boundary that are at least as high as any stockpiles on site.
- Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period.
- Avoid site runoff of water or mud.
- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
- Cover, seed or fence stockpiles to prevent wind whipping.

- –Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
- No burning of waste materials.

57. The implementation of these mitigation measures will control and minimise the risk to wintering birds. Therefore, there would be **no adverse effect on the integrity of the North Norfolk Coast Ramsar in relation to indirect impacts to wintering birds present in *ex-situ* habitats**.

6.4.2.2 Potential Effects of SEP and DEP In-Combination with Other Plans and Projects

58. Hornsea Project Three will also make landfall and bury cables within *ex-situ* habitats to the North Norfolk Coast Ramsar. Further details of the projects and plans considered as part of a cumulative assessment is presented in **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20) (section 20.7) including a more detailed explanation of the potential in-combination impacts from each of the above projects. Hornsea Project Three commits to a similar suite of measures to minimise potential effects and similarly concludes no adverse effect on integrity. With the implementation of these measures effects from each project would be very localised and it is not expected that these localised effects would combine to be any greater than that for each project individually. As such, there would be **no adverse effect on the integrity of the North Norfolk Coast Ramsar, in-combination with other plans and projects in relation to wintering birds present in *ex-situ* habitats**.

6.4.2.3 Summary of Effects on Site Integrity

59. Following adherence to the mitigation measures presented in the **Outline Ecological Management Plan** (document reference: 9.19) and the **Outline Code of Construction Practice** (document reference: 9.17) there would be no adverse effect on site integrity of the North Norfolk Coast Ramsar due to SEP and DEP alone, or in-combination with any other plans or projects.

6.4.3 North Norfolk Coast SPA

60. The potential effects of SEP and DEP that have been assessed as part of the HRA process for the North Norfolk Coast SPA are listed in **Table 6-6**.

61. No potential effects during operation or decommissioning were screened into the assessment. Therefore, this section presents only those potential effects that have been identified during construction of SEP and DEP.

Table 6-6: Summary of Potential Effects Screened Into the HRA

Qualifying feature	Potential effects
• Avocet *Recurvirostra avosetta*; • Bittern *Botaurus stellaris*; • Dark-bellied Brent goose *Branta bernicla*; • Knot *Calidris canutus*; • Marsh Harrier *Circus aeruginosus*; • Montagu's harrier *Circus pygargus*; • Pink-footed goose *Anser brachyrhynchus brachyrhynchus*; • Pintail *Anas acuta;* and • Wigeon *Anas maraca penelope*.	Direct effects on ex-situ habitats during the installation of the cables and/or construction of access tracks.
	Indirect effects within the SPA site boundary: • The qualifying features of the North Norfolk Coast SPA are sensitive to noise, visual or air quality disturbance during the construction phase, so indirect effects upon these qualifying features might occur and these effects have been screened in for further assessment. • Watercourses and arable land which might be supporting wintering birds identified as qualifying features of the SPA could be subject to trenching works during the construction phase, and as such there may be effects upon this ex-situ habitat.

6.4.3.1 Potential Effects of SEP and DEP

6.4.3.1.1 Direct Effects on Wintering Birds Present in Ex-Situ Habitats of the SPA

62. The 2019/2020 and 2020/2021 wintering birds surveys confirmed presence of suitable feeding/foraging habitat, namely harvested sugar beet fields or fields with stubble (harvested but not ploughed-in cereal crops), was closely associated with the presence of over-wintering bird activity. Full details relating to each wintering bird survey effort is presented in **Appendix 20.4 Wintering Birds Survey Report** (document reference 6.3.20.4).

63. No significant flocks of wintering wildfowl or wader species were recorded within the DCO Order Limits, with only pink-footed geese being the only SPA qualifying species recorded. The peak flock count of pink-footed geese recorded was 3,500 birds within an area to the east of the landfall location, that is outwith the DCO Order Limits (approximately 800m east at its closest point from the DCO Order Limits at Weybourne).

64. Whilst the 2019-20 over-wintering bird survey effort recorded a flock of up to 3,500 pink-footed geese foraging within a harvested sugar beet field south of Weybourne cliffs, this area is over 800m from where works associated with SEP and DEP would be undertaken. In addition, HDD will be adopted at the landfall location and therefore direct (e.g. habitat loss) or indirect (e.g. noise from HDD operations) impacts to pink-footed geese are unlikely to occur, However, given that this species are linked to the location of sugar beet fields, it may be likely that should sugar beet crops be present at the time of construction, temporary habitat loss and/or disturbance

impacts to this (and potentially other non-SPA qualifying bird species) may occur. It is, however, considered that birds may habituate to construction activities and/or associated noise levels. Nevertheless, and should construction works take place over winter and sugar beet fields are present within the onshore cable corridor, there remains the potential for disturbance, albeit temporary and of short-term duration, to occur.

65. Given the wide ranges of most over-wintering wildfowl and waders, the specific and localised land-take requirements for SEP and DEP and that HDD will be adopted at the landfall, wintering bird species (and in this case specifically pink-footed geese as the only Ramsar qualifying species as being recorded during the surveys undertaken to date) are considered to be of low sensitivity to any effects arising from SEP and DEP. Nevertheless, mitigation measures in respect to these species (and where required, specifically pink footed geese) are presented (and secured) in the **Outline Ecological Management Plan** (document reference: 9.19).

66. As concluded in **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20), through the implementation and adherence to the identified mitigation measures, the impact on over-wintering birds as a result of SEP and DEP is predicted to be of negligible significance. In addition, it is considered that there is an abundant supply of suitable fields for foraging over-wintering birds throughout Norfolk and surrounding counties, which would have capacity and availability to support any displaced foraging demands.

67. As presented (and secured) in the **Outline Ecological Management Plan** (document reference: 9.19), where construction works are undertaken within sugar beet fields or functionally linked habitat between November and January, a pre-construction survey will be undertaken to record the distribution and abundance of pink-footed geese and the distribution of harvested sugar beet likely to be affected during the winter season within which construction works will be undertaken. The findings of these pre-construction surveys will determine whether mitigation measures to reduce disturbance will be required; however, such mitigation measures may comprise pre-work habitat manipulation works to actively discourage bird species from using the fields where works are required and subsequently installing exclusion fencing to deter birds from the area as well as ensuring all lighting (if required) is only directed onto the construction works area.

68. During the construction works and should pink-footed geese be present, the Ecological Clerk of Works (ECoW) will be responsible for advising on the appropriate levels of mitigation, e.g. watching briefs, tool box talks to the construction personnel etc, as presented in the **Outline Ecological Management Plan** (document reference: 9.19).

69. With these measures in place there would be **no adverse effect on the integrity of the North Norfolk Coast SPA in relation to direct impacts to wintering birds present in *ex-situ* habitats**.

6.4.3.1.2 Indirect Effects on Wintering Birds Present in Ex-Situ Habitats

70. The qualifying bird features of the North Norfolk Coast SPA are sensitive to noise, visual or air quality disturbance, so indirect effects upon these species may occur and these effects have been screened in for further assessment.

71. Wintering birds are associated with arable land and watercourse habitats which will not be affected by changes to the geology. Therefore, these effects have been screened out of further assessment.

72. Watercourses and arable land which might be supporting wintering birds identified as qualifying features of the SPA could be subject to trenching works during the construction phase, and as such there may be effects upon this ex-situ habitat through accidental release of pollutants when crossing watercourses. It is anticipated, however, that through the implementation of appropriate construction techniques and adherence to good environmental practice set out within the **Outline Code of Construction Practice** (document reference: 9.17), risks associated with accidental release of contaminants would be negligible.

73. Onshore construction activities may result in temporary short-term increased noise levels which in combination with the presence of construction personnel, operating machinery, lighting and ground vibration levels may result in potential wintering grounds to not be used and/or abandoned. Or lead to dust deposition across feeding grounds.

74. Mitigation measures that would be adopted temporary screening around the work area or construction compound so that the noise levels from machinery will be attenuated to an acceptable level. It is generally considered that screening can provided approximately 5dB - 10dB of attenuation but the effectiveness is dependent on the distance to the noise source, and the height and length of the screening.

75. Prior to construction, a Construction Noise Management Plan (CNMP) will be prepared detailing site specific noise control measures for construction activities will be identified and implemented to reduce potential construction noise.

76. An **Outline Code of Construction Practice** (document reference: 9.17) has been prepared which sets out the management measures for all onshore construction works associated with SEP and DEP and will include measures to suppress the generation of dust.

- Record any exceptional incidents that cause dust and/or air emissions, either on- or off-site, and the action taken to resolve the situation in the logbook.
- Carry out regular site inspections, record inspection results, and make an inspection log available to the local authority when asked.
- Increase the frequency of site inspections by the person accountable for air quality and dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged dry or windy conditions.
- Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.
- Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.
- Fully enclose site or specific operations where there is a high potential for dust production and the site is actives for an extensive period.
- Avoid site runoff of water or mud.

- Keep site fencing, barriers and scaffolding clean using wet methods.
- Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover as described below.
- Cover, seed or fence stockpiles to prevent wind whipping.
- Only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, e.g., suitable local exhaust ventilation systems.
- Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.
- Use enclosed chutes and conveyors and covered skips.
- Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.
- Ensure equipment is readily available on site to clean any dry spillages and clean up spillages as soon as reasonably practicable after the event using wet cleaning methods.
- No burning of waste materials.

77. With these measures in place there would be **no adverse effect on the integrity of the North Norfolk Coast SPA in relation to indirect impacts to wintering birds present in *ex-situ* habitats**.

6.4.3.2 Potential Effects of SEP and DEP In-Combination with Other Plans and Projects

78. Hornsea Project Three will also make landfall and bury cables within *ex-situ* habitats to the North Norfolk Coast SPA. Further details of the projects and plans considered as part of a cumulative assessment is presented in **ES Chapter 20 Onshore Ecology and Ornithology** (document reference 6.1.20) (**Section 20.7**) including a more detailed explanation of the potential in-combination impacts from each of the above projects. Hornsea Project Three commits to a similar suite of measures to minimise potential effects and similarly concludes no adverse effect on integrity. With the implementation of these measures effects from each project would be very localised and it is not expected that these localised effects would combine to be any greater than that for each project individually. As such, there would be **no adverse effect on the integrity of the North Norfolk Coast SPA, in-combination with other plans and projects in relation to wintering birds present in *ex-situ* habitats**.

6.4.3.3 Summary of Effects on Site Integrity

79. Following adherence to the mitigation measures presented in the **Outline Ecological Management Plan** (document reference: 9.19) and the **Outline Code of Construction Practice** (document reference: 9.17) there would be **no adverse**

effect on site integrity of the North Norfolk Coast SPA due to SEP and DEP alone, or in-combination with any other plans or projects.

7 Offshore Annex 1 Habitats

80. This section provides information in order to determine the potential for SEP and DEP to have an adverse effect on the integrity of Annex I Habitats that are qualifying features of The Wash and North Norfolk Coast SAC and Inner Dowsing, Race Bank and North Ridge SAC.

81. Additional information to support and inform this section is presented in:

- **ES Chapter 4 Project Description** (document reference 6.1.4);
- **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6); and
- **ES Chapter 8 Benthic Ecology** (document reference 6.1.8).

82. A summary of the worst-case scenario relevant to Annex I habitats is provided in **Section 7.3** below (also see **ES Chapter 8 Benthic Ecology** (document reference 6.1.8).

83. For each SAC screened into the HRA for further assessment, the following is provided:

- A summary of the relevant qualifying features of the SAC screened into the assessment;
- An assessment of the potential effects to Annex I habitats from SEP and DEP; and
- An assessment of the potential for in-combination effects from SEP and DEP alongside other relevant plans and projects.

84. The assessment considers a scenario where SEP and DEP are both built (see **Section 3.2**) as this represents a worst-case scenario with regard to Annex I habitats, therefore any impacts associated with SEP or DEP in isolation will be of smaller magnitude than SEP and DEP.

7.1 Consultation

85. Consultation with regard to Annex I habitats designated as qualifying features of the SACs considered during the HRA Screening (**Appendix 1 HRA Screening Report**) has been undertaken in line with the general process described in **Section 4.2**. The feedback received through the EPP has been considered in preparing this RIAA. **Table 7-1** provides a summary of how the consultation responses received have influenced the approach that has been taken.

Table 7-1: Consultation Responses on the HRA Screening in Relation to Annex I Habitats

Consultee	Date/ Document	Comment	Project Response / where Addressed
Natural England	DAS 28/08/2020	Natural England agrees that there is a high probability that impacts to benthic SACs can be screened out. However, Natural England raised some concerns in relation to the original Environmental Statement for DOW and potential changes to coastal processes within designated sites. Therefore, until further	Natural England provided the Applicant with the DOW advice on 11th March 2021. Where relevant, these points have been considered during production of the

Consultee	Date/ Document	Comment	Project Response / where Addressed
		evidence can be presented we are unable to support the screening out of SACs. If considered helpful Natural England are happy to forward our advice on the original application.	assessment provided in **Section 7.4**.
MMO	Dudgeon & Sheringham Extension Projects: Benthic Survey Design 21/08/2020	The MMO agree with the approach to screening and the screening outcomes in relation to benthic features. The projects do not directly correspond with any SACs protected for benthic habitats or species off the North Norfolk coast, therefore there will not be any direct impacts from the works. There may be secondary impacts from any finer sediment released as part of the works and subsequent sediment deposition. The report (point 4) states that the worst-case extent of suspended sediment dispersion is predicted to be up to 10km based on modelled data used for the Dudgeon and Sheringham Wind farm application. This would coincide with the Inner Dowsing Race Bank and North Ridge SAC, the Wash and North Norfolk Coast SAC and North Norfolk Coast SAC. The report also states that any chalk fines released are not expected to settle but are also not anticipated to be more than 1 milligrams per litre ("mg/l") above background level after one tidal cycle. For other sediment types with a high proportion of fines the dispersion footprint is not expected to extend beyond 1km from Dudgeon and less than 2km from Sheringham, with coarser sediment carried only a few metres from point of disturbance. Deposition of finer sediment is not expected to exceed 0.5 millimetres ("mm") over a six tide simulation based on information from modelled data. The Wash and North Norfolk Coast SAC and North Norfolk Coast SAC are the only Marine Protected Areas that partially fall within the 2km zone of influence. Both SACs have been screened out due to the lack of evidence for LSEs. The MMO agree with the scoping out of all SACs within close proximity to the development based on the evidence provided.	Noted. As a precautionary approach and following Natural England's advice (see above), an AA has been undertaken on the relevant protected features of the Wash and North Norfolk Coast SAC and Inner Dowsing Race Bank and North Ridge SAC in relation to in-direct effects (**Section 7.4**)

7.2 Baseline and Current Conservation Status

7.2.1 The Wash and North Norfolk Coast SAC

7.2.1.1 Description of Designation

86. This section relates to The Wash and North Norfolk Coast SAC designated Annex I habitats only, with other designated species and habitats considered in **Section 8**. The Wash and North Norfolk Coast SAC is 1,078km^2 and protects a number of habitats and species. At the closest point, the boundary of the SEP and DEP offshore export cable corridor is 1.26km east of the SAC. Together, the Wash and North Norfolk Coast form one of the most important marine areas in the UK and European North Sea coast, and include extensive areas of varying, but predominantly sandy, sediments subject to a range of conditions. The SAC protects The Wash which is the largest embayment in the UK and is connected via a sediment transfer system to the north Norfolk coast. The site protects sandbanks and biogenic reef in an inshore setting with a strong coastal influence, as well as estuarine, intertidal and shoreline habitats.

87. Features designated under the SAC include extensive intertidal sand and mudflats, subtidal sandbanks, biogenic and geogenic reef, saltmarsh and a barrier beach system unique in the UK. Sandy sediments occupy most of the subtidal area, resulting in one of the largest expanses of subtidal sandbanks in the UK. The subtidal sandbanks vary in composition and include coarse sand through to mixed sediment at the mouth of the embayment.

7.2.1.2 Qualifying Features

88. The site is designated under article 4(4) of the Habitats Directive (92/43/EEC) as it hosts a number of Annex I habitats, which are qualifying habitats of the SAC, specifically:

- Atlantic salt meadows *Glauco-Puccinellietalia maritimae*;
- Coastal lagoons;
- Large shallow inlets and bays;
- Mediterranean and thermo-Atlantic *halophilous* scrubs *Sarcocornetea fruticosi*. (Mediterranean saltmarsh scrub);
- Mudflats and sandflats not covered by seawater at low tide (Intertidal mudflats and sandflats);
- Reefs;
- *Salicornia* and other annuals colonising mud and sand (Glasswort and other annuals colonising mud and sand); and
- Sandbanks which are slightly covered by sea water all the time (Subtidal sandbanks).

89. The only habitat which has been screened into the assessment is ‘Sandbanks which are slightly covered by sea water all the time (subtidal sandbanks)’. These are located near the eastern boundary of the SAC in closest proximity to the SEP and /

or DEP offshore export cable corridor and are within the potential ZoI of indirect impacts from changes to sediment transport.

7.2.1.3 Conservation Objectives

90. The conservation objectives of the SAC are to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the FCS of its Qualifying Features, by maintaining or restoring;

- The extent and distribution of qualifying natural habitats and habitats of qualifying species;
- The structure and function (including typical species) of qualifying natural habitats;
- The structure and function of the habitats of qualifying species;
- The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- The populations of qualifying species; and
- The distribution of qualifying species within the site.

7.2.1.4 Conditions Assessment

91. Natural England conducts a condition assessment that provides robust results and information on the condition of marine features within Marine Protected Areas (MPA). Under the EC Habitats Directive, which is relevant for SACs, the UK has been obliged to report on the conservation status of the habitats and species listed under Annexes I and II of the Directive every six years. Post EU Exit, the submission of these reports every six years is to the Secretary of State, rather than the European Commission.

92. The condition assessment for the qualifying features screened into the assessment is provided in **Table 7-2**. The condition assessment shows that the majority of the sandbank features are in favourable condition, with only 28% in an unfavourable condition.

93. It should be noted that the assessment of unfavourable condition does not relate to the sandbank features as a whole, rather the constituent subfeature sediment types (including subtidal coarse sediment, subtidal mixed sediment and subtidal mud) with the percentage of the feature in unfavourable condition being based on subfeature extents calculated by Natural England (Natural England, 2019a). The reason for the feature being in unfavourable condition is due to the attribute 'Structure: species composition of component communities' which failed due to anthropogenic factors including fishing and cabling (Natural England, 2019b).

Table 7-2: Natural England Feature Condition Assessment for The Wash and North Norfolk Coast SAC Features Screened into the Information for HRA (Natural England, 2019a)

Feature	Conditions assessment date	Favourable	Unfavourable Recovering	Unfavourable No change
Sandbanks which are slightly covered by sea water all the time	25/01/2019	72%	28%	-

7.2.2 Inner Dowsing, Race Bank and North Ridge SAC

7.2.2.1 Description of Designation

94. The Inner Dowsing, Race Bank and North Ridge SAC 845km^2 is located off the south Lincolnshire coast in the vicinity of Skegness, extending eastwards and north from Burnham Flats on the North Norfolk coast, occupying The Wash Approaches. At the closest point, the boundary of the SEP wind farm site is approximately 2.2km east of the SAC (and the DEP North array area is approximately 10.3km to the east).

95. The area encompasses a wide range of sandbank types (banks bordering channels, linear relict banks, sinusoidal banks with distinctive 'comb-like' subsidiary banks) and biogenic reef of the worm *Sabellaria spinulosa*.

96. The group of banks within the Wash Approaches are generally between 15km to 20km long and 1.5km to 3km wide. The sedimentary component of the banks is fine to medium sands. The tops of the sandbanks are characterised by low-diversity communities dominated by polychaete worms and mobile amphipod crustaceans. The trough areas between these sandbank features are composed of mixed and gravelly sands, predominantly as veneers over glacial till. In these areas diverse mosaics of biotopes occur, which are dominated by the ascidian *Molgula* sp. along with a number of nemertean worms and polychaetes. Due to the mobile nature of the sandbanks, the distribution and presence of the associated benthic communities appears to be dynamic, fluctuating over time, although coarser sediments may be more stable than the subtidal sand present on the crests of sandbanks (Natural England, 2018).

97. Abundant *S. spinulosa* agglomerations have consistently been recorded within the boundary of the SAC (Foster-Smith & Hendrick, 2003). Survey data indicate that reef structures are concentrated in certain areas of the site, with a patchy distribution of crust-forming aggregations across the site. The main areas of *S. spinulosa* reef are found along the Lincolnshire coast south of Skegness at Lynn Knock and Skegness Middle Ground (south-east part of the site); just north of Docking Shoal bank (Woo, 2008; Foster-Smith & Hendrick, 2003; Brutto, 2009; Limpenny *et al.*, 2010).

7.2.2.2 Qualifying Features

98. The following Annex I habitats are qualifying features of the Inner Dowsing, Race Bank and North Ridge SAC:

- Sandbanks which are slightly covered by sea water all the time; and
- Reefs.

99. The only feature which has been screened into this assessment is 'sandbanks which are slightly covered by seawater at all time' (subtidal sandbanks). These are located in closest proximity to the SEP wind farm site and are within the potential ZoI of increases in suspended sediment concentrations and deposition and sediment transport effects.

7.2.2.3 Conservation Objectives

100. The conservation objectives of the SAC are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the FCS of its qualifying features, by maintaining or restoring:

- the extent and distribution of qualifying natural habitats and habitats of the qualifying species;
- the structure and function (including typical species) of qualifying natural habitats;
- the structure and function of the habitats of the qualifying species;
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- the populations of each of the qualifying species; and
- the distribution of qualifying species within the site.

7.2.2.4 Conditions Assessment

101. The condition assessment for the qualifying feature screened into the assessment is provided in **Table 7-3**. The condition assessment shows that the majority of the sandbank feature, has not been assessed however 33% of it is considered to be in unfavourable condition based on the failure of the subfeature attributes' extent and distribution, sediment composition and distribution, presence and spatial distribution of biological communities and non-native species and pathogens due to anthropogenic activities occurring in the site which the subfeatures are sensitive to (i.e. offshore windfarm developments and fisheries using bottom towed gear). However, it should be noted that the confidence in these assessments is low (Natural England, 2019b).

Table 7-3: Natural England Feature Condition Assessment for the Inner Dowsing, Race Bank and North Ridge SAC Features Screened into the RIAA (Natural England, 2019b)

Feature	Conditions assessment date	Unfavourable No change	Not assessed
Sandbanks which are slightly covered by sea water all the time	01/08/2019	33%	67%

7.3 Assessment Scenarios

7.3.1.1 Embedded Mitigation

102. This section outlines the embedded mitigation relevant to the ecological assessment, which has been incorporated into the design of SEP and DEP (**Table 7-4**) as presented in **ES Chapter 8 Benthic Ecology** (document reference 6.1.8). The **Schedule of Mitigation and Mitigation Routemap** (document reference 6.5) details how and where these mitigation measures are secured within the **Draft DCO** (document reference 3.1).

Table 7-4: Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
Site selection	The offshore cable corridor takes the shortest, most direct route possible from the SEP and DEP wind farm sites to landfall, whilst avoiding as many known sensitive benthic species and habitats as possible therefore reducing impacts to benthic ecology and avoiding the Wash and North Norfolk Coast SAC.
Landfall	HDD will be used to install the export cables at the landfall, with the HDD exit point located approximately 1,000m offshore. This increases the distance between the HDD exit point and the Wash and Norfolk Coast SAC,
Export cable	The Applicant will make reasonable endeavours to bury offshore cables, minimising the requirement for external cable protection measures and thus minimising impacts on benthic ecology receptors.
Cables	The Applicant will make reasonable endeavours to bury offshore cables, minimising the requirement for external cable protection measures and thus minimising habitat loss impacts on benthic ecology receptors. The minimum amount of pre-sweeping (sand wave levelling) that is required to assist with the cable installation process will be undertaken and only in relation to the interlink cables and wind farm sites.
Cable protection	The allowance for external cable protection within the Cromer Shoal Chalk Beds MCZ boundary is minimised. All external cable protection used within the Cromer Shoal Chalk Beds MCZ will be designed to be removable (i.e. no loose rock) with a commitment to remove, if required, at decommissioning.
Sediment disposal	All sea bed material arising from the Cromer Shoal Chalk Beds MCZ during cable installation (namely at the HDD exit point) would be placed back within the MCZ at or close to the source, using an approach, to be agreed with the MMO in consultation with the relevant SNCB. Sediment would not be disposed of in or nearby known sensitive benthic habitats and where possible will be redeposited within areas of similar sediment type.
Pre-construction surveys and micro-siting	Pre-construction surveys will be undertaken to determine if potential Annex I / UK BAP Priority Habitat *S. spinulosa* reef[2] and UK BAP priority habitat ‘peat and clay exposures with piddocks’ are present within the proposed wind turbine locations or offshore cable routes. The pre-construction survey methodology would be agreed with the MMO in consultation with Natural England. The survey design would be based on best practice at the time and is anticipated to consist of a mixture of geophysical, drop-down video (DDV) and grab surveys (as applicable) to ensure a comprehensive ground-truthing of the proposed final wind turbine locations and cable route design. If potential Annex I / UK BAP priority habitat *S. spinulosa* reef or UK BAP priority habitat ‘peat and clay exposures with piddocks’ are identified, the results of the survey will be discussed at that time with the MMO and Natural England to agree whether the features constitute Annex I / UK BAP priority habitat features and the requirement for avoidance

[2] Note any Annex I *S. spinulosa* reef identified would not be associated with an SAC for which *S. spinulosa* reef is a qualifying feature since the SEP and DEP offshore sites do not overlap with any SACs.

7.3.1.2 Worst-Case Scenario

103. The final design of SEP and DEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This includes consideration of the different offshore design scenarios for SEP and DEP (i.e. one OSP or two OSPs), of which the worst-case has been included in **Table 7-5**.

104. The realistic worst-case scenarios for the assessment are summarised in **Table 7-5**. These are based on the project parameters described in **Chapter 4 Project Description** (document reference 6.1.4), which provides further details regarding specific activities and their durations.

105. In addition to the design parameters set out in **Table 7-5**, consideration is also given to:

- How SEP and DEP will be built out as described for marine mammals in **Section 8.3.2.1** to **Section 8.3.2.3** below. This accounts for the fact that whilst SEP and DEP are the subject of one DCO application, it is possible that only one Project could be built out (i.e. build SEP or DEP in isolation) or that both of the Projects could be developed. If both are developed, construction may be undertaken either concurrently or sequentially.
- A number of further development options which either depend on pre-investment or anticipatory investment, or that relate to the final design of the wind farms.
- Whether one OSP or two OSPs are required.
- The design option of whether to use all of the DEP North and DEP South array areas, or whether to use the DEP North array area only.

106. 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 **ES Chapter 4 Project Description** (document reference 6.1.4).

107. The realistic worst-case scenarios relevant for the Annex I habitats assessment are summarised in **Table 7-5**.

Table 7-5: Realistic Worst-Case Scenarios for Assessment of Offshore Annex I Habitats

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North wind farm site)	One OSP (located in SEP wind farm site)	
Construction					
Increased suspended sediment and deposition	Sea bed preparation for 24 conical GBS foundations for 18MW turbines. Total worst-case sea bed preparation volume: **407,150m³**	Sea bed preparation for 19 conical GBS foundations for 18MW turbines. Total worst-case sea bed preparation volume: **322,327m³**	Sea bed preparation for up 43 conical GBS foundations for 18MW turbines. **Total** worst-case sea bed preparation volume = **729,477m³***		The worst-case for a single 18 MW GBS foundation with a 60m base plate diameter = 16,964.60m³. Worst-case for a single 15MW GBS foundation with a 45m base plate diameter = 9,543m³. Therefore, the overall worst-case is associated with 24 18MW GBS foundations at DEP and 19 18MW GBS foundations at SEP. Sea bed preparation (dredging using a trailing suction hopper dredger and installation of a bedding and levelling layer) may be required up to a sediment depth of 5m. The worst-case scenario represents the greatest potential for increased SSC across the study area as a result of changes to physical processes which could result in impacts on fish and shellfish ecology receptors.
	Displaced sediment during export cable installation Export cable = 31,000m³ HDD exit point = 650m³ (600m³ initial exit point trench and 50m³ further transition zone) Sand wave levelling = 144,200m³ **Total = 175,850m³**	Displaced sediment during export cable installation Export cable = 20,000m³ HDD exit point = 650m³ (600m³ initial exit point trench and 50m³ further transition zone) Sand wave levelling = 0m³ **Total = 20,650m³**	Displaced sediment during export cable installation Export cable = 51,000m³ HDD exit point = 700m³ (600m³ initial exit point trench and 100m³ further transition zone) Sand wave levelling = 144,200m³ **Total = 195,900m³***	Displaced sediment during export cable installation Export cable = 40,000m³ HDD exit point = 700m³ (600m³ initial exit point trench and 100m³ further transition zone) Sand wave levelling = 0m³ **Total = 40,700m³**	Offshore export cables would be buried up to 1m below the sea bed. Calculations are based on an indicative sediment displacement width of 1m for jetting and assume a v-shaped trench. For the HDD exit pit, if SEP and DEP are both built it is assumed that both export cables are within the same initial trench meaning the volume of disturbance is the same as SEP or DEP in isolation scenarios. However, for the transition zone it assumes two trenches and therefore the area of disturbance is double the SEP or DEP in isolation scenarios. Sand wave levelling (pre-sweeping) is potentially required in particular areas prior to infield and interlink cable installation (**Figure 4.9** of **ES Chapter 4 Project Description** (document reference 6.1.4)). Any excavated sediment due to sand wave levelling would be disposed of within the vicinity of the removal location, meaning there will be no net loss of sediment from the site(s). The WCS is based on a two OSP scenario and is estimated based on analysis of existing geophysical data to determine where sand wave clearance is likely

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP		Notes and Rationale
			Two OSPs (one in SEP wind farm site and one in DEP North wind farm site)	One OSP (located in SEP wind farm site)	
					to be required (details provided in **ES Chapter 4 Project Description** (document reference 6.1.4)). No sand wave levelling (pre-sweeping) is required in SEP as no sand waves are present.
	Displaced sediment during infield and interlink cable installation Infield = 151,875m³ Interlink = 74,250m³ Sand wave levelling = 232,200m³ (216,000m³ infield and 16,200m³ interlink) **Total = 458,325m³**	Displaced sediment during infield and interlink cable v Infield = 101,250m³ Interlink = 0m³ Sand wave levelling = 0m³ **Total = 101,250m³**	Displaced sediment during infield and interlink cable installation Infield = 253,125m³ Interlink = 74,250m³ Sand wave levelling = 232,200m³ (216,000m³ infield and 16,200m³ interlink) **Total = 559,575m³**	Displaced sediment during infield and interlink cable installation Infield = 253,125m³ Interlink = 160,875m³* Sand wave levelling = 360,200m³* (216,000m³ infield and 144,200m³ interlink) **Total = 774,200m³***	As above for sand wave levelling (pre-sweeping) Infield and interlink cables would be buried up to 1.5m below the sea bed. Calculations are based on an indicative sediment displacement width of 1m for jetting and assume a v-shaped trench.
Operation					
Morphological and sediment transport effects due to cable protection measures along the export cable	Subsea cable surface protection **Export cables** up to **0.5km** (including 100m in the MCZ) of cable protection 6m wide = **3,000m²**. Crossings **Export**: **4** crossings = 8,400m² HDD Exit point HDD exit transition zone (100m x 3m): **300m²** **Total** area for all types of cable protection = **11,700m²**	Same as for a DEP in isolation scenario	Subsea cable surface protection Same as for a DEP in isolation scenario Crossings **Export: 8** crossings = **16,800m²** HDD Exit point HDD exit transition zone (100m length x 3m width for up to 2 export cables) = 6**00m²** **Total** area for all types of cable protection = **20,400m²***	Same as for two OSP scenario	Export cable protection for crossings will be up to 21m wide and 100m long and consist of either concrete mattressing or rock dumping. **SEP and DEP worst-case crossing locations** • Export cable, up to four crossings (two at Dudgeon export cables, two for Hornsea Three export cables). One disused subsea cable crosses the export cable, but no crossing required. • All crossings will be outside the Cromer Shoal Chalk Beds MCZ.

7.4 Assessment of Potential Effects

7.4.1 The Wash and North Norfolk Coast SAC

108. The only impact that was screened into this assessment in relation to the subtidal sandbanks feature is changes to tidal currents affecting sediment transport during the operational phase, from the installation of external export cable protection. The following sections therefore refer to this impact only.

7.4.1.1 Potential Effects of SEP and DEP

109. As described in **Section 3**, the quantities of external export cable protection have been minimised by the Applicant, alongside the further commitment within the boundaries of the Cromer Shoal Chalk Beds MCZ to use removable forms of cable protection only (and thus limit any potential sediment transport effects as a result of external cable protection installation to within the operational lifetime of the Projects). As such the maximum quantities of external cable protection that will be used on the export cables are a total length of 200m for both cables at the HDD exit (600m^2) and up to 500m for both export cables themselves (3,000m^2). There may also be eight export cable crossings (up to two SEP and DEP cables crossing two export cables for each of Dudgeon and Hornsea Project Three OWFs), totalling 16,800m^2.

110. Mean spring tide current velocities of about 1m/s occur at the wind farm sites, although velocities are lower closer to the coast across the export cable corridor. Impacts on bedload sediment transport are likely to be localised to the areas immediately surrounding the cable protection in the form of sea bed scour where the sediment is soft enough to be mobilised. For example, a scour assessment undertaken for Sheringham Shoal offshore wind farm (SOW) concluded that the worst-case export cable scour may extend up to 10m either side of the unburied cable (Scira Offshore Energy, 2006). Due to the close proximity of the SEP and DEP export cable corridor to the SOW export cable, the scour assessment undertaken for SOW has been used as an appropriate proxy as the site conditions are very similar.

111. Where the export cables are buried there would be no effect on bedload sediment transport. However, if cable protection is required there is potential for it to create an obstacle that interrupts bedload sediment transport. Firstly, it should be noted that the potential magnitude of the effect will depend on the local sediment transport rates; a lower rate would reduce the potential effect on sediment supply to wider areas. There would be a range of sediment transport potentials across the export cables. If chalk or Pleistocene geological units are exposed at the sea bed or covered by a thin lag, then they are static and have zero transport potential (i.e. no mobile sediment). If the cable protection is laid in these areas, then sediment transport is not an issue as no sediment is being transported.

112. Where the sea bed is composed of mobile sand, it can be transported under existing tidal conditions. N*et a*longshore sediment transport is directed to the west around

the Weybourne landfall. Mobile sediment would first accumulate on one side or both sides of the obstacle (depending on the gross and net transport) to the height of the protrusion. Theoretically, and with continued build-up, it would then form a ‘ramp’ over which sediment transport would eventually continue by bedload processes, thereby eventually bypassing the protection. Therefore, in the unlikely event that there were interruptions to sediment supply to the Wash and North Norfolk Coast SAC Annex I sandbanks, they would be small scale, localised and temporary.

113. With respect to the HDD exit point, this is located approximately 1,000m offshore and there will be no cable protection inshore of this point. Although the net sediment transport is to the west inshore which is wave driven along the coastline, wave driven sediment transport ceases at the ‘closure depth’ which marks the effective boundary of wave-driven sediment transport. Offshore of the closure depth, sediment transport is tidally driven. Tidal currents are the main driving force of sediment transport and off the North Norfolk coast move sediments in a net direction of transport to the south-east.

114. The closure depth is inshore of the HDD exit point, therefore where the net direction of sediment transport is wave driven and to the west there is no cable protection and therefore there will be no interruption to sediment supply inshore to the sandbank features of the Wash and Norfolk Coast SAC. Further offshore of the HDD exit point where there may be cable protection, the net sediment transport is tidally driven and to the south-east, and is travelling away from the Wash and North Norfolk Coast SAC. Consequently, there will be no interruption of sediment supply to the Annex I sandbanks of the Wash and North Norfolk Coast SAC, which will be supplied by sediment further up the coast from the north west. Therefore, there will be **no adverse effect on integrity of the subtidal sandbanks feature of the Wash and North Norfolk Coast SAC from changes to physical processes due to cable protection.**

7.4.1.2 Potential Effects of SEP and DEP in-combination with Other Plans and Projects

115. As there will be no impact to the subtidal sandbanks of the Wash and North Norfolk Coast SAC from potential changes to physical processes due to external export cable protection should this be required for SEP and DEP. As such, there is no impact pathway for in-combination effects with other plans and projects.

7.4.1.3 Summary of Effects on Site Integrity

116. There will be **no adverse effect on site integrity for the Wash and North Norfolk Coast SAC due to SEP and DEP alone, or in-combination with other plans or projects**. The conservation objectives of maintaining or restoring the extent, distribution or structure and function of qualifying natural habitats will not be hindered, and the supporting processes on which the qualifying natural habitats rely on will not be changed.

117. The current condition of the Annex I sandbanks of the Wash and North Norfolk Coast SAC is largely favourable (72%). SEP and DEP will not result in a change to the condition assessment or the potential for recovery of the interest feature.

7.4.2 Inner Dowsing, Race Bank and North Ridge SAC

118. The following two impacts were screened into the assessment in relation to Annex I habitats designated under the Inner Dowsing, Race Bank and North Ridge SAC:

- Increased SSC and deposition during construction, operation and decommissioning; and
- Changes to physical processes resulting in changes to sediment supply (i.e. sediment transport effects) during operation, but in relation to the SEP wind farm site only.

7.4.2.1 Potential Effects of SEP and DEP

7.4.2.1.1 Increased SSC and Deposition

119. Waves will be modified in the immediate vicinity of the SEP and DEP wind turbines and their foundation structures. Project specific wave modelling undertaken for GBS foundations at SEP and DEP (see **ES Appendix 6.2 Wave Climate Model** (document reference 6.3.6.2)) showed that SEP and DEP are predicted to have only a localised impact on wave climate, where reflection from the wind turbines results in a slight reduction in wave conditions, up to 0.05m significant wave height. There is no impact on the nearshore wave conditions along the East Anglian coast. This is supported by research which shows that changes to waves become negligible within 200m from wind turbines (Ohl *et al*., 2001) based on the effects of cylinders of 20m diameter. Therefore, changes to wave conditions are not expected at the Inner Dowsing, Race Bank and North Ridge SAC given it is approximately 2.2km away from SEP at its closest point.

120. Gravity base foundations (the worst-case scenario) cause changes to tidal currents across the SEP and DEP wind farm sites. **Figure 7-1** shows the potential changes to tidal currents represented by a ZOI. This shows that the ZOI for tidal change overlaps with the Inner Dowsing, Race Bank and North Ridge SAC.

121. Impacts on bedload sediment transport are likely to be localised to the areas immediately surrounding the individual foundations in the form of sea bed scour where the sediment is soft enough to be mobilised. The extent of these effects in relation to offshore wind turbines and foundations will be limited to the extent of changes to waves and currents as described above. This means that when sediments are disturbed in the wind farm sites during construction, operation or decommissioning there is a chance suspended sediments will enter the Inner Dowsing, Race Bank and North Ridge SAC. As the SEP and DEP export cable corridor is approximately 14km from the Inner Dowsing, Race Bank and North Ridge

SAC it is determined this is outside the ZOI and any increased SSC from cable installation activities would not enter the SAC.

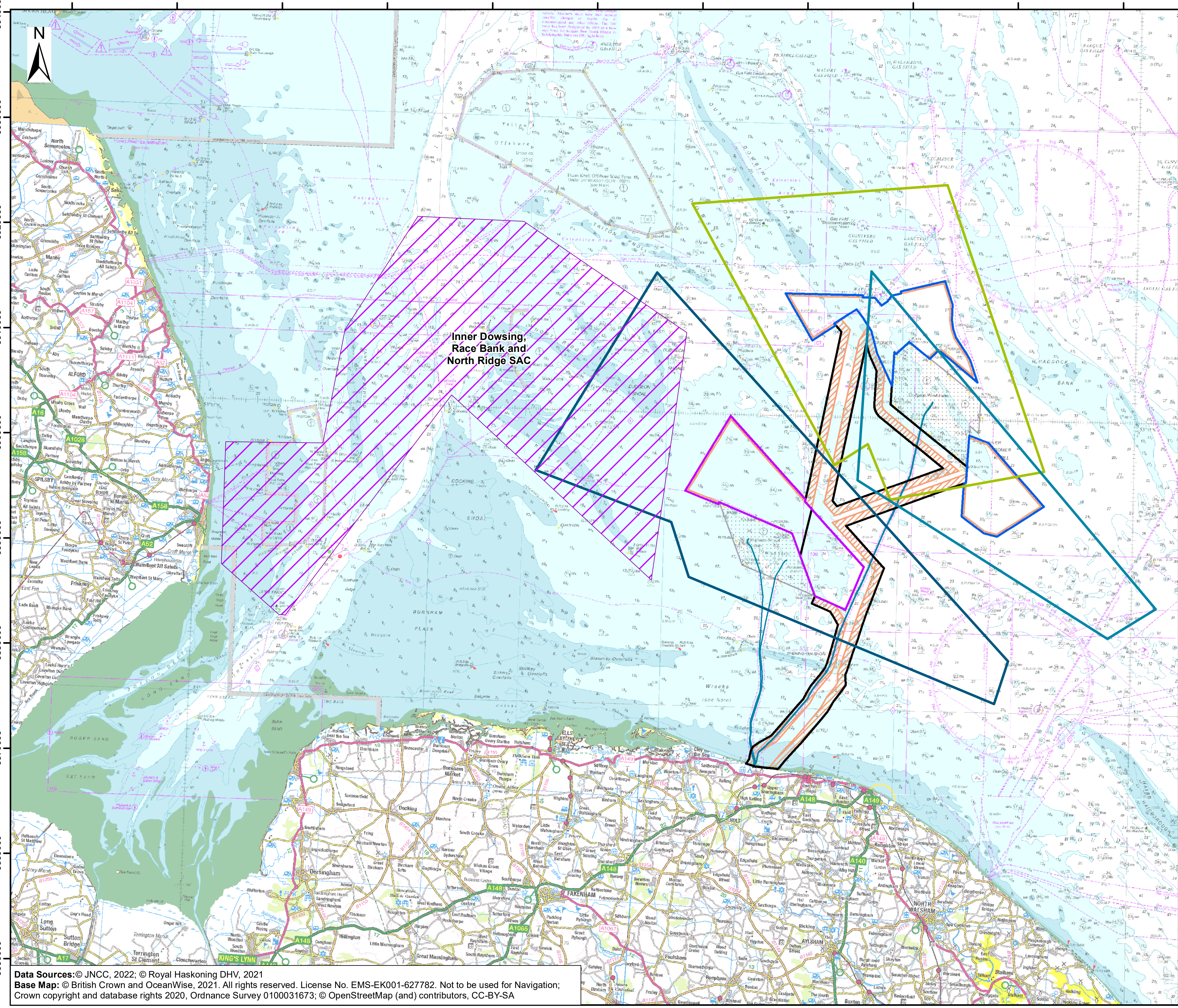
122. Using Natural England's advice on operations for the Inner Dowsing, Race Bank and North Ridge SAC in relation to the relevant pressure of smothering and siltation rate changes (Light)[3] all biotopes associated with the Annex I sandbanks have either a low sensitivity or are not sensitive to this pressure.

123. The potential for increases in SSC is considered greatest during the construction phase and therefore whilst increases in SSC could occur during operation and decommissioning, given the much reduced volumes of sediment that would be disturbed (see **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6)), any effects would be less than those assessed for construction. **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6) assessed the potential increased SSC and deposition from foundation installation during the construction phase. For the total volume released during the construction phase, the worst-case scenario is associated with the maximum number of 18MW GBS foundations (19 at SEP, 24 at DEP) dredged to 5m, with a maximum preparation volume of 322,327m^3 (SEP) and 407,150m^3 (DEP).

124. Mobilised sediment from gravity base foundation installation may be transported by wave and tidal action in suspension in the water column. The disturbance effects at each wind turbine location are likely to last for no more than a few days, within an overall foundation installation programme of approximately 6 months.

125. The median particle sizes of sea bed sediments are predominantly 0.54mm to 7.16mm (coarse sand to fine gravel) across SEP and 0.30mm to 0.81mm (medium to coarse grained sand) across DEP. Most sea bed samples contained less than 10% mud. Typical mean summer suspended sediment concentrations at SEP and DEP are typically less than 10mg/l, whereas mean winter concentrations are 30mg/l. These concentrations may increase significantly during storm events (HR Wallingford *et al*., 2002).

[3] See Annex 5.1 for more information on the relevant pressure.



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Sheringham Shoal and Dudgeon Extension Projects

Title: Figure 7.1 Zone of Potential Influence on the Tidal Regime in the context of the Inner Dowsing, Race Bank and North Ridge SAC

Document:

Habitats Regulations Assessment - Report to Inform Appropriate Assessment

Application Doc. no.: 5.4

Legend:

- Dudgeon Offshore Wind Farm Extension Project Wind Farm Site
- Sheringham Shoal Offshore Wind Farm Extension Project Wind Farm Site
- Offshore Cable Corridors
- Offshore Temporary Work Area
- Existing Offshore Wind Farm
- Existing Offshore Wind Farm Export Cable
- Special Area of Conservation

Predicted Zone of Influence for Tides

- DEP North
- DEP South
- SEP

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 4 8 12 16 20 km
0 4 8 12 Miles

Scale: 1:350,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00012
RHDHV Doc. no.: PB8164-RHD-ZZ-OF-DR-Z-0257

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REV	DATE	STATUS	DRW	CHK	APR

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127. Conceptual evidence-based assessment suggests that, due to the predominance of medium and coarse grained sand across SEP and DEP offshore sites, the sediment disturbed by the drag head of the dredger at the sea bed would remain close to the bed and settle back to the bed rapidly. Most of the sediment released at the water surface from the dredger vessel would fall rapidly (minutes or tens of minutes) to the sea bed as a highly turbid dynamic plume immediately upon its discharge (within a few tens of metres along the axis of tidal flow).

128. Some of the finer sand fraction from this release and the very small proportion of mud that is present are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a measurable but modest concentration plume (tens of mg/l) for around half a tidal cycle (up to six hours). Sediment would eventually settle to the sea bed in proximity to its release (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours). Whilst lower suspended sediment concentrations would extend further from the dredged area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels.

129. Based on the assessment provided in **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6), the impact of increased SSC entering the Inner Dowsing, Race Bank and North Ridge SAC and subsequent deposition is expected to be negligible with all subtidal sand biotopes determined to be low or not sensitive, the conservation objectives of the subtidal sandbanks qualifying feature will not be affected and there will be **no adverse effect on the integrity of the Inner Dowsing, Race Bank and North Ridge SAC**.

7.4.2.1.2 Changes to Physical Processes Resulting in Changes to Sediment Supply

130. Offshore of the North Norfolk coast, sediment transport is tidally driven, with tidal currents moving sediments in a net direction of transport to the south-east. Therefore, net sediment transport is moving away from the Inner Dowsing, Race Bank and North Ridge SAC, and across the SEP and DEP wind farm sites, meaning there will be no interruption of sediment supply to the Annex I sandbanks of the Inner Dowsing, Race Bank and North Ridge SAC, which will be supplied by sediment further up the coast from the north-west. Therefore, there will be no impact from changes to physical processes due to cable protection, and the conservation objectives of the subtidal sandbanks qualifying feature will not be affected and there will be **no adverse effect on the integrity of the Inner Dowsing, Race Bank and North Ridge SAC**.

7.4.2.2 Potential Effects of SEP and DEP In-Combination with Other Plans and Projects

131. As there will be no impacts to the subtidal sandbanks interest feature of the Inner Dowsing, Race Bank and North Ridge SAC due to changes to sediment supply, there is no impact pathway for in-combination effects.

132. However, the impact of increased SSC and sediment deposition within the Inner Dowsing, Race Bank and North Ridge SAC due to SEP and DEP has potential to cause an in-combination effect with other projects in the area.

133. **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) determined the only project with the potential for in-combination impacts with benthic ecology was Hornsea Project Three. This conclusion is also relevant to Annex I habitats features of the Inner Dowsing, Race Bank and North Ridge SAC.

134. Increased SSC will occur at discrete locations for a time-limited duration and are negligible in magnitude. Given that Hornsea Project Three is approximately 80km from SEP and DEP and outside the ZOI it is considered there is no pathway for in-combination impacts in relation to wind turbine foundation installation or infield cable installation.

135. In relation to the export cable installation, based on an assumed Hornsea Project Three construction start in 2023 and offshore export cable corridor construction in years 3 and 4 (2026-2026), and possibly also years 7 and 8 in a two-phase development (2030-2031), temporal overlap of export cable construction between SEP and DEP and Hornsea Project Three could potentially occur. However, given that export cable installation is anticipated to be completed in 50 days for a SEP in isolation scenario, 60 days for a DEP in isolation scenario or 100 days for a SEP and DEP scenario, a temporal overlap in export cable construction activities is considered to be unlikely. Moreover, the SEP and DEP export cable corridor is over 14km from the Inner Dowsing, Race Bank and North Ridge SAC and is therefore outside the ZOI for SSCs and so it is determined there is no impact pathway for in-combination effects in relation to export cable installation.

136. Given that construction impacts in relation to increases in SSC and deposition are greatest during construction and there is no impact pathway for in-combination effects during construction, it is considered there is also no impact pathway for in-combination effects during operation or decommissioning.

7.4.2.3 Summary of Effects on Site Integrity

137. No impact was determined in relation to increased SSC and deposition, and no impact was determined in relation to changes to sediment supply. Therefore, there will be **no adverse effect on site integrity for the Inner Dowsing, Race Bank and North Ridge SAC due to SEP and DEP alone, or in-combination with other plans or projects**. The conservation objectives of maintaining or restoring the extent, distribution or structure and function of qualifying natural habitats will not be hindered, and the supporting processes on which the qualifying natural habitats rely on will not be changed.

138. The current condition of the Annex I sandbanks of the Inner Dowsing, Race Bank and North Ridge SAC is unfavourable, where the assessment is available (33%). SEP and DEP will not result in a change to the condition assessment or the potential for recovery of the interest feature.

8 Offshore Annex II Species (Marine Mammals)

139. This section provides information in order to determine the potential for SEP and DEP to have an adverse effect on the integrity of marine mammal designated sites (**Figure 8-1**):

- Southern North Sea (SNS) SAC for harbour porpoise;
- Moray Firth SAC for bottlenose dolphin;
- Humber Estuary SAC for grey seal; and
- The Wash and North Norfolk Coast SAC for harbour seal.

140. For each marine mammal designated site the following has been provided:

- A summary of the ecology of the marine mammal species relevant for each designated site assessment;
- An assessment of the potential effects during the construction, operation, maintenance and decommissioning phases of SEP and DEP; and
- An assessment of the potential for in-combination effects for SEP and DEP alongside other relevant developments and projects.

141. Additional information relevant to the marine mammal assessment is included in:

- **Appendix 1 HRA Screening Report** and **Appendix 2 HRA Screening Matrices**
- **ES Chapter 4 Project Description** (document reference 6.1.4)
- **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)
- **ES Chapter 8 Benthic Ecology** (document reference 6.1.8)
- **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9)
- **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10)
  - **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)
  - **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2)
  - **ES Appendix 10.3 Marine Mammal Cumulative Impact Assessment (CIA) Screening** (document reference 6.3.10.3)
  - **ES Appendix 10.4 Marine Mammal UXO Assessment** (document reference 6.3.10.4)

Sheringham Shoal and Dudgeon Extension Projects

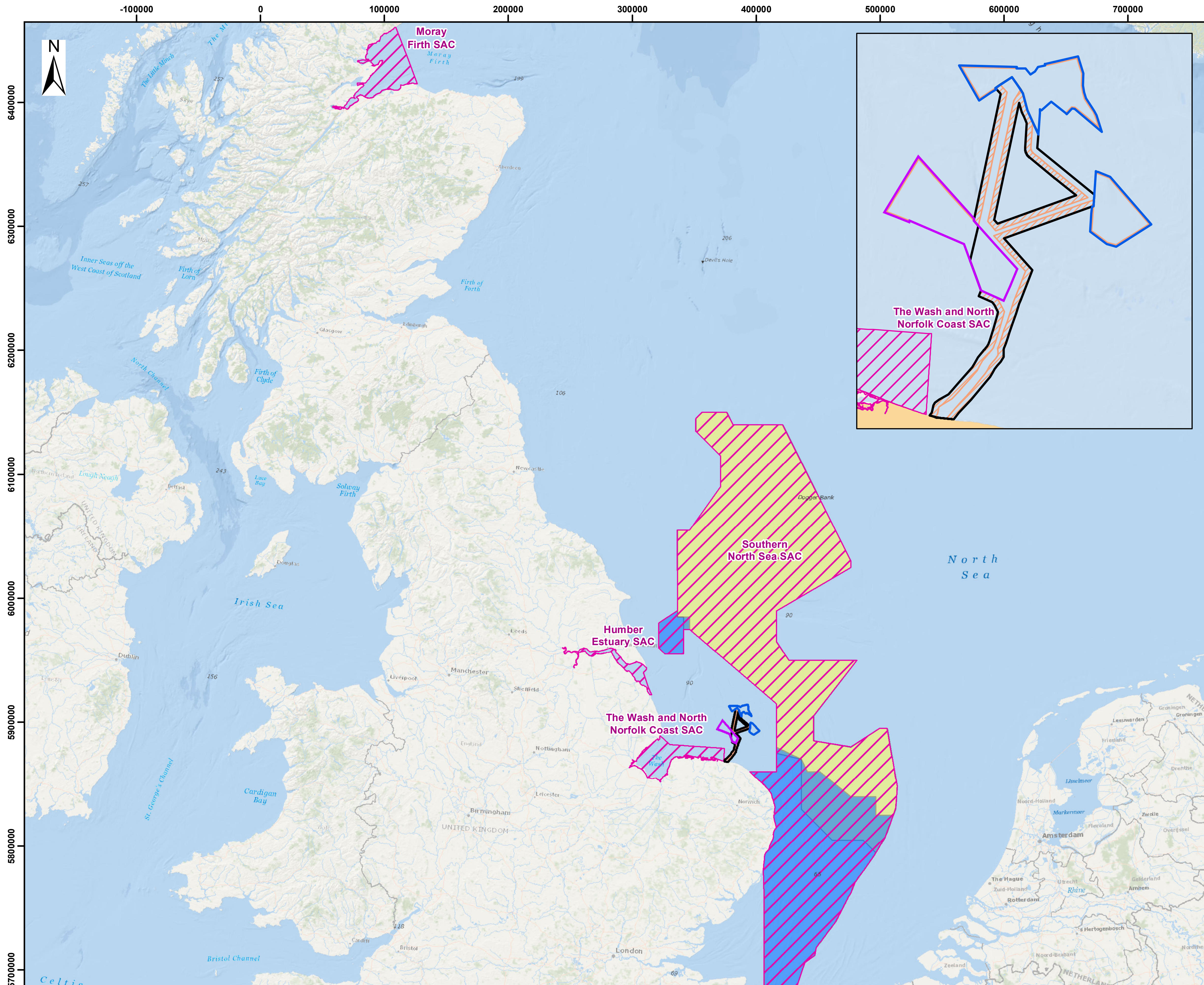
Title:

Figure 8.1 Marine Mammal Special Areas of Conservation (SAC)

Document:

Habitats Regulations Assessment - Report to Inform Appropriate Assessment

Application Doc. no.: 5.4



Legend:

- Dudgeon Offshore Wind Farm Extension Project Wind Farm Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridors
- Offshore Temporary Work Area
- Special Area of Conservation (SAC)
- Southern North Sea SAC Winter Area
- Southern North Sea SAC Summer Area

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 40 80 120 160 200 km
0 20 40 60 80 100 Miles

Scale: 1:3,000,000 Scale at size: A3

Equinor Doc. no.: C282-RH-Z-GA-00012
RHDHV Doc. no.: PB8164-RHD-ZZ-OF-DR-Z-0256

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A	30/06/2022	First Issue	FC	JM	PM

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8.1 Consultation

142. Consultation with regard to marine mammals has been undertaken in line with the general process described in **Section 4.2**. The key elements to date have included screening, the ongoing Evidence Plan Process (EPP) via the Marine Mammal Expert Topic Group (ETG) and the draft ‘Information for HRA Report’, submitted for consultation in April 2021 alongside the Preliminary Environmental Information Report (PEIR).

143. Stakeholders represented on the Marine Mammal ETG are Natural England, the Marine Management Organisation (MMO), the Centre for Environment, Fisheries and Aquaculture Science (Cefas), and The Wildlife Trust (TWT). At their request, Whale and Dolphin Conservation (WDC) have not been directly involved in the ETG, but have been updated on the SEP and DEP in general terms.

144. The feedback received through the EPP has been considered in preparing the marine mammal assessment. This assessment has been updated following the consultation on the draft ‘Information for HRA Report’, in order to produce the final assessment submitted with the DCO application.

145. **Table 8-1** to **Table 8-3** provide a summary of the consultation responses with respect to HRA and how they have been addressed in the marine mammal assessment. **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1) provides further detail on consultation relevant to marine mammals. **Appendix 1 Evidence Plan** (document reference 5.2.1) of the **Consultation Report** (document reference 5.1) provides the full Marine Mammal ETG agreement logs and meeting minutes.

146. As agreed with stakeholders at ETG3 on the 20th of July 2021, a separate Marine Licence 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. An assessment of the potential impacts from UXO clearance at SEP and DEP is provided in **ES Appendix 10.4 Marine Mammal UXO Assessment** (document reference 6.3.10.4) for information purposes only. The potential in-combination effects from UXO clearance at other OWFs during piling at SEP and DEP are assessed.

Table 8-1: Consultation Responses Relevant to Marine Mammal Sections of the ***RIAA***

Consultee	Date/ Document	Comment	Applicant Response
The Wildlife Trusts (TWT)	ETG Meeting 1: 3rd December 2019	There is a harbour porpoise population estimate for the Southern North Sea Special Area of Conservation, and TWT request that this be referenced in the assessment, e.g. as an appendix, in addition to the Management Unit (MU) estimate.	An assessment against the Southern North Sea Special Area of Conservation harbour porpoise population estimate was provided with the draft Information for HRA Report at PEIR. This was provided for information purposes and has not been included with this final RIAA for the DCO application.
TWT	Dudgeon and Sheringham Shoal Extension Projects draft HRA Screening Document comments, letter by email, 20th August 2020	It is not clear if disturbance from vessel movement for harbour porpoise has been taken into account. This is an important consideration, especially when considering in-combination impacts. This approach is now considered best practice and has been undertaken as part of numerous offshore wind farm planning applications.	The potential for effect from underwater noise associated with vessels and the potential for any increased collision risk with vessels has been considered for all marine mammals from designated sites, including for harbour porpoise (**Section 8.4**). The potential for any disturbance at seal haul-out sites has also been assessed (**Sections 8.4.3** and **8.4.4**).
TWT	Draft HRA Screening Document comments, letter by email, 20th August 2020	Commercial fishing must be included in all in-combination assessment.	PINS have accepted the approach that commercial fisheries is not included in in-combination assessments and is considered part of the baseline. This is the approach used on a number of other recent offshore wind farm Projects. As outlined in the BEIS (2020) RoC HRA, "*there are no known plans to suggest that the level of fishing within the SAC will significantly increase over the period the consented wind farms are planned to be constructed, such that, it is predicted that the current level of impacts from fishing on harbour porpoise within the SAC will not increase*" and concluded that "*the potential in-combination impacts between commercial fisheries bycatch and offshore wind farm pile-driving will not have an adverse effect upon the integrity of the Southern North Sea SAC*". Therefore, commercial fishing

Consultee	Date/ Document	Comment	Applicant Response
			has not been assessed further for marine mammal designated sites.
MMO	Draft HRA Screening Document comments, letter by email, 21st August 2020	The three marine mammal species considered are harbour porpoise, grey and harbour seal. The report identifies that there is the potential for Likely Significant Effect (LSE) from underwater noise for harbour porpoise from the Southern North Sea Special Area of Conservation (SAC), grey seal from the Humber Estuary SAC, and harbour seal from The Wash and North Norfolk Coast SAC. Therefore, these three sites have been screened in for further assessment (see also Table 6-3, and Table 6-4). The MMO note from paragraph 243 that a potential disturbance range of 25 kilometres (km) for seals has been used to determine which designated sites are screened in or out. This is based on data from Russell *et al*. (2016a).	Within this RIAA, the potential effects from underwater noise have been assessed for all marine mammal designated sites screened into the draft Information for HRA. Since HRA screening undertaken in April 2021 (**Appendix 1 HRA Screening Report**), bottlenose dolphin from the Moray Firth SAC have now been included in the RIAA which has been reflected in **Appendix 2 HRA Screening Matrices** (document reference 5.4.2). Since HRA screening and draft Information for HRA, the seal densities have been updated based on the latest seals at sea maps (Carter *et al*., (2020)).
MMO	Draft HRA Screening Document comments, letter by email, 21st August 2020	The MMO agree with the screening outcomes in relation to underwater noise impacts. The potential effects of underwater noise (including piling and other construction activities, vessels, operation and maintenance activities, operational turbines and decommissioning activities), Unexploded Ordnance (UXO) clearance (for which a separate marine licence application will be submitted), and barrier effects from underwater noise on marine mammals, have been scoped in for the	The potential for effects from UXO clearance has not been included in the RIAA because, as agreed at the marine mammals ETG in July 2021 (see **Consultation Report Appendix 1 Evidence Plan** (document reference 5.2.1), UXO clearance will be assessed as part of a separate marine licence application. However, a worst-case assessment has been included as **Appendix 10.4 Marine Mammal Unexploded Ordnance (UXO) Assessment** (document reference 6.3.10.4) to the **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) for information.

Consultee	Date/ Document	Comment	Applicant Response
		construction, operation and decommissioning stages.	Underwater noise from piling and other construction activities, vessels, operation and maintenance activities, operational turbines, decommissioning activities and the potential for any barrier effects as a result of underwater noise have been assessed for those marine mammal species and designated sites screened in (**Section 8.4**).
MMO	Draft HRA Screening Document comments, letter by email, 21st August 2020	The MMO believe an appropriate evidence base has been proposed to be used in the assessment, and believe the data sources identified are appropriate, although defer to Natural England for further comments as SNCB.	Noted
MMO	Draft HRA Screening Document comments, letter by email, 21st August 2020	Standard practices for the preparation and gathering of evidence are being proposed. The MMO also believe that the evidence is consistent with that submitted for operations of a similar nature.	Noted
Natural England	Draft HRA Screening Document comments, letter by email, 28th August 2020	Natural England does not agree that disturbance to seals at haul out sites can be screened out from further assessment. Whilst we note that vessels will not be moving within 500m of the coast, there will still be activities associated with landfall and cabling that will take place on the coast which may disturb seals at haul out sites. It is not just vessels that can cause disturbance to hauled-out seals and other activities should be considered in the assessment.	The potential for disturbance at seal haul-out sites has been assessed in the RIAA with respect to the Humber estuary SAC and The Wash and North Norfolk Coast SAC (**Sections 8.4.3** and **8.4.4**).

Consultee	Date/ Document	Comment	Applicant Response
Natural England	Draft HRA Screening Document comments, letter by email, 28th August 2020	Natural England welcomes the commitment to revisit the list of plans or Projects to be considered in-combination as there are several Projects not listed here that Natural England consider should be included in the assessment.	The in-combination assessments have been updated since the draft Information for HRA report (**Section 8.4**).
Natural England	ETG 2 Agreement Log	Ref 2.29: Does the ETG agree with the HRA Screening for marine mammals? Yes, Natural England is in agreement. The MMO defer to Natural England as the Statutory Nature Conservation Body (SNCB) for comments on the HRA. The MMO do not have any major comments or concerns to raise at this time.	At ETG 2 it was explained by the Applicant (and subsequently agreed by Natural England in the ETG2 Agreement Log) that the SACs to be screened into the marine mammals assessment were the SNS SAC for harbour porpoise, Humber Estuary SAC for grey seal and The Wash and North Norfolk Coast SAC for harbour seal. However, as noted above, since ETG2 and the HRA screening undertaken in April 2021 (**Appendix 1 HRA Screening Report**), bottlenose dolphin from the Moray Firth SAC have now been included in the RIAA which has been reflected in **Appendix 2 HRA Screening Matrices**. Also, see **Appendix 1 Evidence Plan** (document reference 5.2.1) of the **Consultation Report** (document reference 5.1) for the full marine mammal ETG minutes and agreement logs.
Natural England and MMO	ETG 2 Agreement Log	Ref: 2.30 Does the ETG agree with the approach for the marine mammal assessments to inform the HRA? Yes, Natural England is in agreement. The MMO defer to Natural England as the Statutory Nature Conservation Body (SNCB) for comments on the HRA. The MMO do not have any major comments or concerns to raise at this time.	
Natural England and MMO	ETG 2 Agreement Log	Ref 2.25: Does the ETG agree with the approach for assessing the potential changes to marine mammal prey resources for DEP & SEP?	Noted

Consultee	Date/ Document	Comment	Applicant Response
		Yes, Natural England is in agreement. In addition, the MMO believe that the general approach proposed for assessing the potential disturbance at seal haul-out sites is reasonable.	
Natural England and MMO	ETG 2 Agreement Log	Ref 2.26: Does the ETG agree with the approach for assessing the potential impacts of changes to water quality on marine mammals and prey for DEP & SEP? Yes, Natural England is in agreement. MMO: The approach to assessing changes to water quality seems reasonable, however, the MMO defer to Natural England for further comment.	Noted
Natural England and MMO	ETG 2 Agreement Log	Ref 2.27: Does the ETG agree with the approach for assessing the potential impacts of decommissioning on marine mammals for DEP & SEP? Yes, Natural England is in agreement. The MMO believe this approach is appropriate.	Noted
Natural England	ETG ¾ Agreement Log	Does the Applicant propose a cut-off date for identifying the latest information for projects in the CIA and in-combination assessments?	In line with the offshore ornithology assessment, the cut off date for inclusion of the latest information from other OWFs into the in-combination assessment was May 2022. If required, updates to the assessment taking account of the latest information, e.g. from projects that have recently gone

Consultee	Date/ Document	Comment	Applicant Response
			through examination, can be undertaken during the Examination period for SEP and DEP.

8.1.1 Section 42 Consultation Responses

Table 8-2: Natural England Section 42 Comments Received 10th June 2021 – Detailed Comments

Point	Section	NE Comment	NE Recommendation	Applicant Response
Natural England comments on Draft Information for the HRA				
6.72	General Point	All mitigation measures need to be secured somewhere within the DCO/DML. A document similar to those produced on EA1N and EA2 and Boreas should be provided outlining where all mitigation is secured. This would provide clarity on any mitigation measures secured within the different plans/conditions.	Secure mitigation measures within DCO/DML.	See the **Schedule of Mitigation and Mitigation Routemap** (document reference 6.5) and the **Draft DCO** (document reference 3.1).
6.73	5.3 Table 5-1	Natural England considers that all the necessary UK SACs for marine mammals have been screened in.	No action needed	Noted
6.74	5.4	Natural England welcomes the inclusion of the Moray Firth SAC in the HRA.	No action needed	Noted
6.75	5.4 Table 5-2	Natural England concurs with the potential effects for marine mammals screened into the assessment of LSE.	No action needed	Noted
6.76	8.2 Table 8-1	Natural England is content with the way that the consultation responses have been addressed.	No action needed	Noted
6.77	8.3.1.2	Natural England concur that the MU population abundance should be used, rather than the figure in the SNS SAC Site Selection Report.	No action needed	Noted

Point	Section	NE Comment	NE Recommendation	Applicant Response
6.78	8.3.1.3	See general comment 4. 4. Natural England understands that overall assessment of conservation status within the UK Marine Atlantic region is “unknown” for harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale. Our understanding is that there is currently too little data to confidently conclude whether there has been any change in the population. We have confirmed that this is also the interpretation of the JNCC.	NE recommends: Update the favourable conservation status of marine mammals.	FCS has been reviewed and updated.
6.79	8.3.1.4 Table 8-4 and Table 8-5	With respect to the first potential effect listed (Physical and permanent auditory injury from piling and the clearance of UXO), if mitigation is being relied upon in order to avoid significant impact to the SNS SAC, then it should be taken through to Stage 2 of the HRA (i.e. if no LSE cannot be concluded without mitigation). Note that this comment also applies to bottlenose dolphin of the Moray Firth SAC (Table 8-5).	Change wording in table to reflect that there is a potential for LSE, as mitigation cannot be applied to screen out LSE.	The potential for effects from UXO clearance has not been included in the RIAA because, as agreed at the marine mammals ETG in July 2021 (see **Consultation Report Appendix 1 Evidence Plan** (document reference 5.2.1)), UXO clearance will be assessed as part of a separate marine licence application. However, a worst-case assessment has been included as **ES Appendix 10.4 Marine Mammal Unexploded Ordnance (UXO) Assessment** (document reference 6.3.10.4) to the **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) for information.
6.81	8.3.2.4	Natural England advises the Applicant that the Conservation Objectives for the Moray Firth were updated	Update the conservation objectives of the SAC.	The Conservation Objectives for the Moray Firth SAC have been

Point	Section	NE Comment	NE Recommendation	Applicant Response
		in March 2021. The revised site documentation can be found here [redacted].		updated (NatureScot, 2021) (**Section 8.2.2.4**).
6.82	8.3.3.2	See general comment 1. Natural England advises that the seal at-sea maps produced by Russell *et al*. (2017) have been updated by Carter *et al*. (2020). Recommendation: Use the updated Carter *et al*. (2020) to characterise the seal at sea baseline.	See general comment 1.	Carter *et al*. (2020) has been used in the ES and RIAA to estimate grey and harbour seal at sea densities (**Sections 8.2.3** and **8.4.4**.
6.83	8.3.3.4	Natural England advises that the conservation objectives for the Humber Estuary SAC grey seal feature are specified, as has been done for Southern North Sea SAC harbour porpoise feature (section 8.3.1.4), the Moray Firth SAC bottlenose dolphin feature (section 8.3.2.4), and The Wash and North Norfolk Coast SAC harbour seal feature. For these SAC features, the Applicant has specified which conservation objectives have been ruled out due to no LSE. We advise that the same should be done for the grey seal feature.	Add the conservation objectives of the Humber Estuary SAC to the text, and screen for LSE.	The Conservation Objectives for the Humber Estuary SAC for grey seal have been included in the RIAA and screened for LSE (**Section 8.4.3**).
6.84	8.3.4.1	Natural England does not agree that there is no potential for effects on foraging harbour seal from The Wash and North Norfolk Coast SAC. Harbour seals typically forage within 40-50km of their haul out sites, and in the case of The Wash population they often travel larger distances of 75-120km, therefore the DEP and SEP sites are within the foraging range from the SAC (Sharples *et al*. 2012). According to Figure 12.2, both the DEP and SEP sites overlap an area of elevated density of harbour seals (5-10 individuals/5km^2).	Update the text so that it states that there is potential for effects on foraging harbour seal from The Wash and North Norfolk Coast SAC. We note that disturbance to foraging seals has been included later in Section 8.5.4. See general comment 2.	Potential for effects on foraging harbour seal from The Wash and North Norfolk Coast SAC have been assessed in the RIAA (**Section 8.4.3.2.7**).

Point	Section	NE Comment	NE Recommendation	Applicant Response
6.85	8.3.4.3	See general comment 2. Natural England is aware of (currently) unpublished data that shows that the harbour seal population in The Wash has undergone a significant decline (20-30%) in the last 2 years (2019 and 2020) and that this should be factored into the assessment. Recommendation: Contact SMRU for more information on the recent decline of the harbour seal population in The Wash and North Norfolk SAC. Factor the reduction into the subsequent assessments e.g. revise the reference population so that it reflects the recent, lower counts.	-	The latest seal counts available at the time of writing (SCOS, 2020) have been used in the assessments.
6.86	8.4.1 Table 8-9	Natural England welcomes the commitment of the Applicant to implement additional mitigation measures including a MMMP for piling activities and UXO clearance, and an SNS SAC SIP. We welcome consultation on these documents.	-	Noted. A **Draft Marine Mammal Mitigation Protocol (MMMP)** (document reference 9.4) and **In Principle Site Integrity Plan for the Southern North Sea SAC** (document reference 9.6) have been submitted with the DCO application.
6.87	8.4.2	Natural England welcomes the commitment of the Applicant to develop an IPMP and welcomes the opportunity to be consulted on this document.	-	Noted. An **Offshore In Principle Monitoring Plan** (**IPMP**) (document reference 9.5) has been submitted with the DCO application.
6.94	8.5.1.1	There are several instances in the document where the Applicant has stated the percentage of the MU population that would be impacted, followed by the conclusion of no adverse effect on the integrity of the SAC. However, the Applicant has not provided justification as to why the	Further justification should be provided as on the SNS SAC	Further information on the approach to determining the potential for a population level adverse effects has been provided in **Section 8.4**.

Point	Section	NE Comment	NE Recommendation	Applicant Response
		percentage stated would not lead to an adverse effect. For example: • Paragraph 405; 0.55% of the NS MU affected • Paragraph 438; 0.55% of the NS MU affected • Paragraph 448; 1.09% of the NS MU affected We therefore request that context be provided on what the percentages above would mean in terms of the population-level effect at the MU level, to ‘join the dots’ between the percentage affected and the conclusion on the SAC.		
6.97	8.5.1.1	We advise that the combined total for disturbance from piling is presented in the spatial assessment, for clarity.	Present the combined total for disturbance from piling in the spatial assessment, for clarity.	Maximum area for potential disturbance from piling is included in the spatial assessment (**Section 8.4**).
6.98	8.5.1.1	It would be beneficial for the Applicant to provide context on the current level of vessel activity in the site and the surrounding area.	Provide context on the current level of vessel activity in the site and the surrounding area.	Information on level of vessel activity in the site and the surrounding area (with reference to the **ES Appendix 13.1 Navigational Risk Assessment** (document reference 6.3.13.1) and **Chapter 13 Shipping and Navigation** (document reference 6.1.14)) has been included within the assessments (**Section 8.4**).
6.99	8.5.1.1	Natural England understands that the Applicant has based the assessment of the spatial extent of barrier effects on the EDRs. As the EDRs are 26 km, and therefore overlap the SNS SAC, it is unclear how the Applicant has concluded that there is no potential for any direct barrier effects on the SNS SAC.	Assess the potential for barrier effects on the SNS SAC or include justification as to why it has not been assessed.	The potential for barrier effects on the SNS SAC have been assessed (**Section 8.4.1.3.4**).

Point	Section	NE Comment	NE Recommendation	Applicant Response
6.100	8.5.1.1 Table8-30	Natural England understands that the assessment of barrier effects has been based on the spatial extent of disturbance from underwater noise, multiplied by the density of the marine mammal species, to determine the number of individuals that would be affected and therefore the percentage of the MU affected (whilst also taking into account the temporal duration of the effect). Natural England notes that this is a novel approach to quantifying barrier effects, as we are more familiar with qualitative approaches. We request that the Applicant provides further information on this approach and how it provides an accurate estimation of the number of animals that could be affected by barrier effects.	Provide further information justifying this approach and how it provides an accurate estimation of the number of animals that could be affected by barrier effects.	Further information has been included for potential barrier effects (**Section 8.4.1.3.4**).
6.101	8.5.1.1	Natural England requests that the Applicant include a reference for the average daily vessels in summer and winter within the sites, or a cross-reference to the relevant chapter that contains this information, for context. Note this also applies to paragraph 556.	Include a reference (or cross-reference) for the average daily vessels in summer and winter within the sites.	Noted. **ES Appendix 13.1 Navigational Risk Assessment** (document reference 6.3.13.1) and **ES Chapter 13 Shipping and Navigation** (document reference 6.1.14) contain the relevant information with respect to average daily vessels. References to this have been added within the assessment text throughout **Section 8.4**.
6.102	8.5.1.1	Natural England requests extra information on the 'good practice' that will be undertaken by vessel operators to reduce any risk of collisions with marine mammals.	Provide extra information on the good practice that will be undertaken by vessel operators to reduce any risk of collisions with marine mammals, and/or cross-	Extra information on the good practice that will be undertaken by vessel operators to reduce any risk of collisions with marine mammals has been included in

Point	Section	NE Comment	NE Recommendation	Applicant Response
			reference any other relevant documents that contain this information in the DCO application.	the **Draft MMMP** (document reference 9.4).
6.103	8.5.1.1	Natural England requests that the Applicant quantifies the area of physical disturbance and temporary habitat loss.	Update the text with the area of physical disturbance and temporary habitat loss. We note that such figures are presented in Chapter 12.	At the closest point, the DEP wind farm site is 13.9km from the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area and export cable corridors are 21.2km from the summer area and 18.4km from the winter area. Therefore, there is no potential for any physical disturbance and loss of sea bed habitat in the SNS SAC
6.104	8.5.1.1	Natural England requests that more detail is provided on the suitability of the foraging habitat in the DEP and SEP sites, and provides further description of the availability of suitable habitat in a wider context of the Southern North Sea.	Update the text with information on the foraging habitat in the sites and the wider area. A cross-reference to the relevant chapter would also be beneficial.	Further information on fish habitat in the offshore sites and the wider area is provided in **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9).
6.105	8.5.1.2	Natural England notes that the existing published literature on the noise levels of operational wind farms, and the cited literature on the effects of operational wind farms on harbour porpoise, are more than 10 years old. The absence of more recent evidence, relevant to the size of turbines being built today, should be acknowledged.	Add in the caveat about the lack of recent data. Natural England is also aware of a new paper by Stober and Thomsen (2021) and suggest this is reviewed.	Further information on underwater noise from operational turbines has been included, based on the latest information available (**Section 8.4.1.3.1**).

Point	Section	NE Comment	NE Recommendation	Applicant Response
6.106	8.5.1.2	The Applicant states that the assessment for construction represents the worst case for collision risk. However, in paragraph 556, it is stated that approximately 1.89 trips per day may be during the operation of either DEP or SEP, which is more than during construction (0.83 vessel movements per day; paragraph 487). We consider that vessels pose a greater risk whilst in transit, than whilst stationary on site. It is therefore possible that the operational phase comprises the worst case for collision risk, and so a full assessment should be provided.	Assess collision risk during the O&M phase separately from construction. Note that this should be applied to all marine mammal documents in the PEIR where this pathway is assessed.	The assessment of collision risk, as presented for the construction phase (**Sections 8.4.1.1.5**, **8.4.2.1.5**, **8.4.3.1.5** and **8.4.4.1.5**), is based on the total project area, within which additional vessels may be present, and is not based on the number of vessels present within that area. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the equivalent assessments during construction, as the areas of potential effect are the same. This has been clarified in **Sections 8.4.1.3.5**, **8.4.2.2.5,** **8.4.3.2.5**, and **8.4.4.2.5**.
6.107	8.5.1.2	Natural England requests that a reference is provided to demonstrate the availability of subtidal sand and gravel habitats, and/or a cross-reference to the relevant chapter.	Provide a reference (or cross-reference) to demonstrate the availability of subtidal sand and gravel habitats.	Further information on fish habitat in the offshore sites and the wider area is provided in **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9).
6.108	8.5.1.4	Natural England requests that the Applicant clarify why only a subset of the impact pathways screened in for the projects alone have been taken forward to the in-combination assessment and others have been screened out. This also applies to paragraphs 829, 999, and 1172.	Provide justification on why certain impacts are screened out of the in-combination assessment.	Further information has been provided on why certain impacts are screened out of the in-combination assessment within **ES Appendix 10.3 Marine Mammals CIA** (see **Section 8.4.1.6** which includes justification

Point	Section	NE Comment	NE Recommendation	Applicant Response
				also relevant to the in-combination assessments at **Sections 8.4.2.4, 8.4.3.4** and **8.4.4.4**).
6.109	8.5.1.4	Natural England advises that the maximum worst-case should be assessed alongside the Applicant's determination of the 'realistic' worst-case in the in-combination assessment. It is not unreasonable that projects may undertake concurrent piling, much like DEP and SEP, therefore this scenario should also be assessed. Note that this is in line with our advice to other wind farms e.g. Hornsea 4.	Undertake an assessment that considers concurrent piling at the other wind farms screened into the in-combination assessment.	The in-combination assessment for the SNS SAC has been based on a single piling event within SEP or DEP, with single piling occurring in the other OWFs, as it is considered unlikely that all OWFs would or could be undertaking simultaneous piling all at the same time. The approach to the in-combination assessment, based on single piling, would allow for some of the OWFs not to be piling at the same time while others could be simultaneously piling. This is considered to be the most realistic worst-case scenario, as it is highly unlikely that all OWFs would or could be simultaneously piling at exactly the same time or even on the same day as piling at SEP and / or DEP. The in-combination assessments have been updated (**Sections 8.4.1.6 8.4.2.4, 8.4.3.4** and **8.4.4.4**). Further scenarios and

Point	Section	NE Comment	NE Recommendation	Applicant Response
				assessments will be undertaken during development of the final SIP post consent.
6.110	8.5.1.4	Natural England welcomes the Applicant's commitment to undertake a SIP.		Noted
6.111	8.5.1.4	Natural England notes that SIPs are typically used to ensure no adverse effect on the integrity of the Southern North Sea SAC, rather than to reduce the total number of individuals that are at risk from disturbance. Furthermore, SIPs are not used for projects that do not have spatial overlap between their effects envelope and the SNS SAC e.g. European projects. Natural England requests that the Applicant provides context on the population-level effect that would result from causing disturbance to 4.87% of the NS MU, to demonstrate that this constitutes no adverse effect on the SNS SAC (whilst acknowledging that this is a worst-case scenario and effects will likely be smaller).	Provide context on what the percentage of the MU affected means in terms of population-level effects.	As noted above (response to Point 6.94 above), there are currently no agreed guidelines for the percentage of the MU and population-level effects. As outlined in the **ES Chapter 10 Marine Mammals** (document reference 6.1.10), temporary effects, such as disturbance from underwater noise, 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,

Point	Section	NE Comment	NE Recommendation	Applicant Response
				consideration is given to uncertainty of the individual consequences of temporary disturbance. Information on the approach to determining the potential for a population level adverse effects has been provided in **Section 8.4**. Population modelling, such as Population Consequences of Disturbance (PCoD), if required, will be considered in developing the SIP.
6.113	8.5.1.4	Natural England advise that seismic surveys cannot be considered a point source of noise, rather they are a mobile source. Therefore, the Applicant should calculate the disturbance footprint using the 12 km EDR as a ‘buffer’ around the predicted survey line(s) that can be completed on a single day and use the values in the assessment.	Update the assessment of the disturbance footprint, using the 12 km EDR as a ‘buffer’ around the predicted survey line(s) that can be completed on a single day, and use the values in the assessment.	Area of potential disturbance during seismic surveys (undertaken by oil and gas developments) has been reviewed and updated within the in-combination assessment in **Section 8.4** in line with the Natural England recommendation.
6.114	8.5.1.4	Natural England welcomes the rationale provided when assessing the potential number of concurrent seismic surveys with the piling and DEP and SEP.		Noted
6.115	8.5.1.4	Natural England understand that the RoC states that there is potential for an increase in vessel activity of up to 0.8% per year	Change 08% to 0.8%, for clarity	Amended
6.116	8.5.2.4	Natural England advises that both the Greater North Sea MU and the Coastal East Scotland MU are used to screen	Update the text to read Greater North Sea MU and	The in-combination assessments in **Section 8.4** have been updated

Point	Section	NE Comment	NE Recommendation	Applicant Response
		in projects, as per the CIA. In paragraph 832, the list of projects should be updated to reflect the addition of the Coastal East Scotland MU (for example, we note that ForthWind Demo Phase 1 is missing). Note that this comment also applies to Paragraph 858.	the Coastal East Scotland MU. Add in ForthWind Demo Phase 1 and any other relevant projects in the CES MU into the assessment.	to take into account all plans and projects in the relevant MUs, including the Coastal East Scotland MU.
6.117	8.5.2.4	We note that the reference used by the Applicant to determine the distance of disturbance to bottlenose dolphin from seismic surveys is not recent (1996). Natural England advises that a more recent reference is used, for example DECC (2011)'s AA of 2D seismic survey determined that the distance for strong avoidance in bottlenose dolphin was 1,800-11,000 m (based on underwater noise modelling from Subacoustech using the dBht method).	Update the disturbance distance from seismic surveys, using the reference provided or another suitably recent one.	The assessment has been updated to account for the suggested strong avoidance ranges for bottlenose dolphin. See **Section 8.4.2.4**.
6.118	8.5.3.1	Natural England welcomes the detailed assessment of vessel numbers and existing vessel routes in proximity to established grey seal haul-outs.	-	Noted
6.119	8.5.3.3	We note that the reference used by the Applicant to determine the distance of disturbance to grey seal from seismic surveys is not recent (2001). Natural England advises that a more recent reference is used, for example BEIS (2020)'s HRA of 3D seismic survey determined that noise capable of causing disturbance is predicted to occur out to 13,300-17,000 m (depending on the modelled outputs).	Update the disturbance distance from seismic surveys, using the reference provided or another suitably recent one.	The assessment has been updated to account for the suggested disturbance ranges for seal species. See **Sections 8.4.3.4**.
6.120	8.5.3.3	Natural England requests that the Applicant provides context on the population-level effect that would result from causing disturbance to 5.6% of the Humber Estuary SAC, to demonstrate that this constitutes no adverse effect	Provide context on what the percentage of the SAC affected means in terms of population-level effects.	Further information has been provided in **Section 8.4.3.4**.

Point	Section	NE Comment	NE Recommendation	Applicant Response
		(whilst acknowledging that this is a worst-case scenario and effects will likely be smaller).		
6.123	8.5.4.1 Table 8-102	We advised that column 2 in the table is resized, as the table is difficult to read in its current form.	Resize column 2 in the table.	Amended
6.125	8.5.4.1	Natural England agrees that the impact of PTS from piling at DEP and SEP alone will not cause adverse effect on The Wash and North Norfolk Coast SAC, so long as a MMMP is in place which includes mitigation measures to reduce the risk of PTS.	-	Noted. The Applicant has submitted a **Draft MMMP** (document reference 9.4) with the DCO application.
6.126	8.5.4.1	As with TTS from UXO clearance, Natural England requests that the Applicant provides a more detailed assessment of the potential impact from TTS due to piling on The Wash and North Norfolk Coast SAC. This also applies to the assessment of DEP and SEP together.	Provide a more detailed assessment of the potential impact of TTS from piling on The Wash and North Norfolk Coast SAC. This should also take into account previous comments on aspects that require updating.	An assessment of the potential impact of Temporary Threshold Shift (TTS) from piling on The Wash and North Norfolk Coast SAC has been included (**Section 8.4.4.1.1**).
6.127	8.5.4.1	The Applicant has presented a series of useful references on the distance at which hauled out seals may be disturbed and the likelihood of recovery. However, is the Applicant aware of any similar evidence to the effects on harbour seals during the breeding season, such as on female seals that have pups?	Include similar evidence on breeding seals, if available.	All currently available information on the disturbance of seals at haul-out sties has been reviewed and relevant information included (**Sections 8.4.4.1.6** and **8.4.4.2.6**).
6.128	8.5.4.1	To support the assessment, Natural England advises that the portion of foraging habitat temporarily "lost" could be presented in the context of the total foraging habitat available to harbour seal from The Wash (which could be	Present the percentage of foraging habitat lost in terms of the context of total foraging habitat available.	Further information added to **Sections 8.4.3.1.9** and **8.4.4.1.9.**

Point	Section	NE Comment	NE Recommendation	Applicant Response
		calculated using published foraging ranges, for example). This would help to provide context for the assessment.		
6.129	8.5.4.4	The Applicant has stated that in order to calculate the mean harbour seal density, they have averaged the density of all offshore windfarms (UK and EU) included within the CIA. Natural England advises that a more appropriate approach would be to average the density around all offshore windfarms in the SE MU and Wadden-zee area only, as this is the extent of the CIA boundary for harbour seal. Natural England raises this point as, for example, the mean density of all the windfarms in Table 8-118 (which are in the harbour seal MU) is 0.07/km^2, which is notably higher than the 0.02/km^2 presented in Table 8-119, and therefore could lead to a higher number of harbour seals predicted to be impacted.	Use the average of harbour seal density around all windfarm projects in the MU, rather than all within the CIA. This could also be applied to other marine mammals.	Seal density estimates have been updated for all OWFs included in the in-combination assessments in **Section 8.4**.
6.130	8.5.4.4	We note that the reference used by the Applicant to determine the distance of disturbance to harbour seal from seismic surveys is not recent (2001). Natural England advises that a more recent reference is used, for example BEIS (2020)'s HRA of 3D seismic survey determined that noise capable of causing disturbance to seals is predicted to occur out to no more than 13,300-17,000 m (depending on the modelled outputs).	Update the disturbance distance from seismic surveys, using the reference provided or another suitably recent one.	The assessment has been updated to account for the suggested disturbance ranges for seal species. See **Section 8.4.4.4.**
6.131	8.5.4.4 Table 8-122	Natural England notes that the total number of harbour seals that may be disturbed by in-combination underwater noise is 142, which represents 3.7% of the SAC (though this percentage is likely higher due to the current reduced population count in the SAC). This is not a negligible percentage of the SAC population, which has already gone through a recent decline. We, therefore, welcome the		Noted

Point	Section	NE Comment	NE Recommendation	Applicant Response
		commitments of the Applicant to undertake mitigation which will reduce the overall impact to the SAC. Furthermore, we will be advising other projects that may act in-combination to do the same.		

Table 8-3: TWT Section 42 Comments Received 10th of June 2021

Ref	Section	TWT Comment	Response
39	Table 8-1	As stated in our comments on Chapter 12, we welcome the approach by Equinor in engaging with TWT on Sheringham and Dudgeon Extensions during the evidence plan process and we hope that this can continue into the post-consent stage. TWT requests to be named on the piling and UXO MMMP, Site Integrity Plan for the Southern North Sea SAC and any marine mammal monitoring documents (including the In Principle Monitoring Plan).	TWT will be named on the piling and UXO MMMP, Site Integrity Plan for the Southern North Sea SAC and any marine mammal monitoring documents (including the **Offshore IPMP** (document reference 9.5)).
40	Table 8-1 p113	In the response to TWTs comment, Equinor stated that they have provided an assessment against the SNS SAC harbour porpoise estimate in Chapter 12. Can Equinor please indicate where this has been included in Chapter 12?	An assessment against the Southern North Sea Special Area of Conservation harbour porpoise population estimate was provided with the draft Information for HRA submitted with PEIR in April 2021. This was provided for information purposes and has not been included with the final RIAA submitted with the DCO application.
41	686	We appreciate that Defra, the MMO and the Underwater Noise Strategic Advisory Group are taking positive steps to develop effective management for in-combination underwater noise impacts on the Southern North Sea SAC and TWT will continue to work closely with all stakeholders on this. However, as a regulatory mechanism for managing the in-combination impacts of multiple SIPs is not yet in place, we cannot agree with the in-combination assessment conclusions of no adverse effect on site integrity of the SNS SAC at this current time.	Noted

8.2 Baseline and Current Conservation Status

8.2.1 Southern North Sea SAC

8.2.1.1 Description of Designation

147. The SNS SAC has been recognised as an area with persistent high densities of harbour porpoise (Joint Nature Conservation Committee (JNCC), 2017a; JNCC and Natural England, 2019) and is the largest designated site for harbour porpoise in UK and European waters at the time of designation.

148. The SNS SAC covers an area of 36,951km^2, with both winter and summer habitats of importance to harbour porpoise (JNCC, 2017a). Approximately 27,028km^2 of the site is important in the summer period (183 days from April to September inclusive) and 12,696km^2 of the site is important in the winter period (182 days from October to March inclusive) (JNCC *et al.,* 2020). The majority of the site is less than 40m in depth, reaching up to 75m in the northern most areas.

149. The closest point to the SEP wind farm area is 25.6km from the SNS SAC summer area and closest point DEP wind farm area is 13.9km to the from the SNS SAC winter area (**Table 8-4**).

Table 8-4: Distances of SEP and DEP to SNS SAC Summer and Winter Areas

Location	Closest point to SNS SAC summer area	Closest point to SNS SAC winter area
SEP wind farm site	31.1km	25.6km
DEP wind farm site	13.9km	19.1km
Export cable corridor	21.2km (DEP)	18.4km (SEP)
Landfall location	42km	21.4km

8.2.1.2 Qualifying Feature

8.2.1.2.1 Harbour porpoise

150. Within the southern North Sea area, harbour porpoise is the most common marine mammal species (Hammond *et al*., 2021). Heinänen and Skov (2015) identified that within the North Sea, water depth and hydrodynamic variables are the most important factors in harbour porpoise densities in species areas, in both winter and summer seasons. The sea bed sediments also play an important role in determining areas of high harbour porpoise density, as well as the number of vessels present in the area.

151. Distribution and abundance maps have been developed by Waggitt *et al.* (2019) for harbour porpoise and show a clear pattern of high density in the southern North Sea, and the coasts of south-east England, for both January and July (Waggitt *et al.*, 2019). Examination of this data, including all 10km grids that overlap with SEP and DEP, including export cable corridor areas, indicates an average annual density estimate of:

- 0.56 individuals per km^2 for SEP, DEP and the export cable corridors.

152. The SEP and DEP offshore sites are in the SCANS-III survey block O (Hammond *et al.,* 2021) where:

- Abundance estimate = 53,485 harbour porpoise (95% Confidence Interval (CI) = 37,413-81,695); and
- Density estimate = 0.888 harbour porpoise/km^2 (Coefficient of Variation (CV) = 0.209).

153. Data from the SEP and DEP site specific surveys have also been used to generate abundance and density estimates for the sites with a 4km buffer (for further details see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1). The average of the winter months, summer months, and annual density has then been calculated based on the maximum calculated for each month. **Table 8-5** shows the densities for harbour porpoise, based on all individuals that have the potential to be harbour porpoise.

Table 8-5: Maximum Harbour Porpoise Summer, Winter and Annual Density Estimate for SEP and DEP Survey Areas plus 4km Buffer

Season	Maximum density estimate (corrected) for whole survey area (animals/km^2)	Maximum density estimate (corrected) for SEP + 4km buffer (animals/km^2)	Maximum density estimate (corrected) for DEP + 4km buffer (animals/km^2)
Average winter	0.65	0.52	0.85
Average summer	1.46	0.63	2.43
Average annual	1.05	0.57	1.64

154. The site specific surveys indicate a seasonal pattern in the abundance of harbour porpoise, with higher numbers present in the summer months within the survey area. There is no evident pattern of harbour porpoise distribution within the survey area, with no indication of a particular area of importance (for further details see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)).

155. The Inter-Agency Marine Mammal Working Group (IAMMWG, 2022) define three MUs for harbour porpoise. The SEP and DEP offshore sites are located in the North Sea MU.

156. The IAMMWG 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 used in the assessments (as supported by Natural England - **Table 8-2**).

157. The SNS SAC Site Selection Report (JNCC, 2017a) identifies that the SNS SAC site supports approximately 18,500 individuals (95% CI = 11,864 - 28,889) for at least part of the year (JNCC, 2017a). However, JNCC and Natural England (2019) states that because this estimate is from a one-month survey in a single year (the SCANS-II survey in July 2005) it cannot be considered as an estimated population for the site. It is therefore not appropriate to use site population estimates in any assessments of effects of plans or projects on the site (i.e. HRA), as they need to take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals (JNCC and Natural England, 2019).

8.2.1.3 Conservation Status

158. Based on the most recent 2013-2018 reporting by the JNCC, the Conservation Status for harbour porpoise within the species range in the North Sea is currently '*unknown*' (JNCC, 2019).

159. More information on the ecology, distribution, abundance, and movements of harbour porpoise including a full summary of the site-specific aerial surveys, can be found in **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1).

8.2.1.4 Conservation Objectives

160. The Conservation Objectives for the SNS SAC are designed to help ensure that the obligations of the Habitats Directive can be met. Article 6(2) of the Habitats Directive requires that there should be no deterioration or significant disturbance of the qualifying species or to the habitats upon which they rely.

161. The Conservation Objectives (JNCC and Natural England, 2019) for the SNS SAC are:

"To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters.

In the context of natural change, this will be achieved by ensuring that:

1. *Harbour porpoise is a viable component of the site;*
2. *There is no significant disturbance of the species; and*
3. *The condition of supporting habitats and processes, and the availability of prey is maintained".*

162. These Conservation Objectives are:

"a set of specified objectives that must be met to ensure that the site contributes in the best possible way to achieving Favourable Conservation Status (FCS) of the

designated site feature(s) at the national and biogeographic level" (JNCC and Natural England, 2019).

8.2.1.4.1 Conservation Objective 1: The Species is a Viable Component of the Site

163. This Conservation Objective is designed to minimise the risk of injury and killing or other factors that could restrict the survivability and reproductive potential of harbour porpoise using the SAC. Specifically, this objective is primarily concerned with operations that would result in unacceptable levels of those impacts on harbour porpoise using the SAC. Unacceptable levels can be defined as those having an impact on the FCS of the population of the species in their natural range.

164. Harbour porpoise are considered to be *a viable component* of the SAC if they are able to live successfully within it. The SNS SAC has been selected primarily based on the long term, relatively higher densities of porpoise in contrast to other areas of the North Sea. The implication is that the SAC provides relatively good foraging habitat and may also be used for breeding and calving. However, because the number of harbour porpoise using the site naturally varies there is no exact value for the number of animals expected within the site (JNCC and Natural England, 2019).

165. The Conservation Objectives (JNCC and Natural England, 2019) state that, with regard to assessing impacts, 'the reference population for assessments against this objective is the MU population in which the SAC is situated'.

166. Harbour porpoise are listed as European Protected Species (EPS) under Annex IV of the Habitats Directive, and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Under the Habitats Regulations, it is an offence if harbour porpoise are deliberately disturbed in such a way as to:

a) Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or

b) To affect significantly the local distribution or abundance of that species.

167. The term deliberate is defined as any action that is shown to be "by a person who knows, in the light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action".

168. In addition, Article 12(4) of the Habitats Directive is concerned with incidental capture and killing. It states that Member States "*shall establish a system to monitor the incidental capture and killing of the species listed on Annex IV (all cetaceans). In light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned*".

8.2.1.4.2 Conservation Objective 2: There is no significant disturbance of the species

169. The disturbance of harbour porpoise typically, but not exclusively, originates from operations that cause underwater noise, including activities such as seismic surveys, pile driving and sonar.

170. Disturbance is considered to be significant if it leads to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time. The current Statutory Nature Conservation Bodies (SNCBs) guidance for the assessment of significant noise disturbance on harbour porpoise in the SNS SAC (JNCC *et al*., 2020) is that:

"*Noise disturbance within an SAC from a plan/project individually or in-combination is considered to be significant if it excludes harbour porpoise from more than:*

1. *20% of the relevant area*[4] *of the site in any given day*[5]*, or*
2. *An average of 10% of the relevant area of the site over a season*[6][7]*.*"

8.2.1.4.3 Conservation Objective 3: The condition of supporting habitats and processes, and the availability of their prey is maintained.

171. Supporting habitats, in this context, means the characteristics of the sea bed and water column. Supporting processes encompass the movements and physical properties of the habitat. The maintenance of these supporting habitats and processes contributes to ensuring prey is maintained within the site and is available to harbour porpoise using the SAC. Harbour porpoise are strongly reliant on the availability of prey species year round due to their high energy demands, and their distribution and condition may strongly reflect the availability and energy density of prey.

172. This Conservation Objective is designed to ensure that harbour porpoise are able to access food resources year round, and that activities occurring in the SNS SAC will not affect this.

[4] The relevant area is defined as that part of the SAC that was designated on the basis of higher persistent densities for that season (summer defined as April to September inclusive, winter as October to March inclusive).
[5] To be considered within the Habitats Regulation Assessment and, if needed, licence conditions should ensure that daily thresholds are not exceeded. Day to day monitoring of compliance is not practicable and therefore retrospective compliance monitoring is required to test whether the licence conditions are being adhered to.
[6] Summer defined as April to September inclusive, winter as October to March inclusive.
[7] For example, a daily footprint of 19% for 95 days would result in an average of 19x95/183 days (summer) =9.86%

8.2.1.4.4 Management Measures

173. Specific management measures are yet to be developed for the SNS SAC, however JNCC and Natural England (2019) advise that "the site should be managed in a way that ensures that its contribution to the maintenance of the harbour porpoise population at FCS is optimised, and that this may require management of human activities occurring in or around the site if they are likely to have an adverse impact on the site's Conservation Objectives either directly or indirectly identified through the assessment process."

174. JNCC and Natural England (2019) also state that "management measures (e.g. the scale and type of mitigation) are the responsibility of the relevant regulatory or management bodies. These bodies will consider SNCB advice and hold discussions with the sector concerned, where appropriate."

175. For the purposes of the assessments, the potential effects considered in relation to the SNS SAC Conservation Objectives are outlined in **Table 8-6**.

Table 8-6: Potential Effects of SEP and DEP in Relation to the Conservation Objectives of the SNS SAC for Harbour Porpoise

Conservation Objective for harbour porpoise	Potential Effect
Harbour porpoise is a viable component of the site	Physical and permanent auditory injury from underwater noise will be mitigated and therefore there is no potential for LSE.
	Significant disturbance and displacement as a result of increased underwater noise levels has the potential to have an adverse effect on harbour porpoise from the SNS SAC and will be considered further.
	Any potential increased collision risk with vessels could cause a potential LSE which will be considered further.
There is no significant disturbance of the species	Significant disturbance and displacement as a result of increased underwater noise levels has the potential to have an adverse effect on harbour porpoise from the SNS SAC and will be considered further.
The condition of supporting habitats and processes, and the availability of prey is maintained	Changes in water quality and prey availability have the potential to affect the harbour porpoise from the SNS SAC and will be considered further.

8.2.2 The Moray Firth SAC

8.2.2.1 Description of Designation

176. The Moray Firth SAC was designated in 2005 and bottlenose dolphin are a qualifying feature. The Moray Firth SAC extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast and covers an area of 1,510km^2 (JNCC, 2015).

177. The closest point to both the SEP and DEP offshore site is more than 600km from the Moray Firth SAC.

8.2.2.2 Qualifying Feature

8.2.2.2.1 Bottlenose Dolphin

178. The population of bottlenose dolphin in the Moray Firth are known to travel south along the Scottish coast. Historically, very few sightings of bottlenose dolphin were recorded further south of the Firth of Forth on the east coast of the UK, however, in recent years an increase in bottlenose dolphins in the north-east of England has been reported (Aynsley, 2017). The studies undertaken by Arso Civil *et al.* (2019 and 2021) confirm that the east coast of Scotland population of bottlenose dolphins has shown a marked change in distribution between 2009 and 2019.

179. The Moray Firth bottlenose dolphin population are present year-round and throughout the Moray Firth, although they appear to have a preference for the nearshore area. Adults and juveniles have been recorded throughout the SAC, however, are most often observed close to the shore (within 3km of the coast), and have also been observed in relatively shallow waters (in less than 20m water depths) (NatureScot, 2021). A review of bottlenose dolphin presence outside of the Moray Firth SAC, along the east coast of Scotland, for sightings from 1997 to 2013, revealed a strong preference for shallow waters and areas close to shore, with the majority of sightings made within a water depth of less than 30m (generally within 2 to 20m), and generally within 2km of the coastline (Quick *et al*., 2014).

180. The SCANS-III surveys found no bottlenose dolphin within the southern North Sea survey block O (in which the SEP and DEP offshore sites are located), with higher densities with survey block R off the east coast of Scotland (Hammond *et al.*, 2021).

181. Examination of the data and distribution maps by Waggitt *et al.* (2019), including all 10km grids that overlap with the SEP, DEP and export cable corridors, indicates an average annual density estimate for bottlenose dolphin of:

- 0.00013 individuals per km^2 for SEP, DEP and export cable corridor .

182. During the site-specific aerial surveys of both SEP and DEP and buffer area, undertaken from May 2018 to April 2020, no bottlenose dolphin were recorded. However, as sightings of bottlenose dolphin have been increasingly reported along the north-east coast of England, as a precautionary approach they have been included in the assessments.

183. There is currently no density estimate for bottlenose dolphin in and around SEP or DEP, therefore, the number of bottlenose dolphins that could be impacted has been based on the SCANS-III density estimates for the adjacent survey block R, as there is no estimate for survey block O in which SEP, DEP and the export cable corridors are located.

184. The assessments for bottlenose dolphin, will be based on data for the adjacent SCANS-III survey block R (Hammond *et al*., 2021):

- Abundance estimate= 1,924 bottlenose dolphin (95% CI = 0 - 5,048); and
- Density estimate = 0.0298 bottlenose dolphin/km^2 (CV = 0.861).

185. The IAMMWG (2022) define seven MUs for bottlenose dolphin. The SEP and DEP offshore sites are located in the Greater North Sea (GNS) MU. The GNS MU for bottlenose dolphin has an abundance estimate of 2,022 (CV = 0.75; 95% CI = 548 – 7,453; IAMMWG, 2022).

186. Assessments for bottlenose dolphins from the Moray Firth will be put into context of the latest estimate for the east coast of Scotland population of 224 individuals (CV = 0.023; 95% CI = 214 - 234; IAMMWG, 2022).

8.2.2.3 Conservation Status

187. Based on the most recent 2013-2018 reporting by the JNCC, the conservation status for bottlenose dolphin within the species range is currently '*unknown*' (JNCC, 2019).

188. More information on the ecology, distribution, abundance, and movements of bottlenose dolphin can be found in **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1).

8.2.2.4 Conservation Objectives

189. The Conservation Objectives (NatureScot, 2021) are "*To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS*; *and*

To ensure that the integrity of Moray Firth SAC is maintained or restored in the context of environmental changes by meeting objectives for each qualifying feature:

- *The population of bottlenose dolphin is a viable component of the site;*
- *The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance; and*
- *The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained. "*

190. For the purposes of the assessments, the potential effects are considered in relation to the Moray Firth SAC Conservation Objectives as outlined in **Table 8-7**.

Table 8-7: Potential Effects of SEP and DEP in Relation to the Conservation Objectives of the Moray Firth SAC for Bottlenose Dolphin

Conservation Objective for bottlenose dolphin	Potential Effect
Bottlenose dolphin is a viable component of the site	Physical and permanent auditory injury from underwater noise will be mitigated and therefore there is no potential for LSE.
	Significant disturbance as a result of increased underwater noise levels has the potential to have an adverse effect on bottlenose dolphin and will be considered further.
	Any potential increased collision risk with vessels will be considered further.

Conservation Objective for bottlenose dolphin	Potential Effect
Distribution of the species within site is maintained by avoiding significant disturbance	Significant disturbance as a result of increased underwater noise levels has the potential to have an adverse effect on bottlenose dolphin and will be considered further.
The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained	No potential LSE. There will be no potential for any change to the distribution and extent of the habitats in the Moray Firth SAC supporting bottlenose dolphin. There will be no potential for any change to the availability of prey for bottlenose dolphin in the Moray Firth SAC. Although potential changes to prey availability in and around SEP and DEP will be considered further.

8.2.3 Humber Estuary SAC

8.2.3.1 Description of Designation

191. The Humber is the second largest coastal plain estuary in the UK, and the largest on the east coast of Britain. Grey seal are present as a qualifying feature of the Humber Estuary SAC (Natural England, 2009).

192. The Humber Estuary SAC is located, at closest point, 59.7km from SEP and DEP. Therefore, there is no potential for direct effect on the SAC as a result of the construction, operation, maintenance or decommissioning of SEP and DEP. However, due to the foraging range of grey seal and the movement of grey seal along the east coast of England (for further details see **Section 10.5.5** of **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)), there is the potential for effects on foraging grey seal from the Humber Estuary SAC in the vicinity of SEP and DEP.

8.2.3.2 Qualifying Feature

8.2.3.2.1 Grey seal

193. There is a considerable amount of movement of grey seal (as indicated by telemetry data; see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)) among different areas and regional subunits of the North Sea, and there is no evidence to suggest that grey seals on the North Sea coasts of Denmark, Germany, the Netherlands or France are independent from those in the UK (Special Committee on Seals (SCOS), 2020).

194. Compared with other times of the year, grey seal in the UK spend longer hauled out during their annual moult (between December and April) and during their breeding season, in eastern England, pupping occurs mainly between early November and mid-December (SCOS, 2020).

195. SEP and DEP are located approximately 15.8km and 26.5km offshore (at the closest point to shore), respectively. The closest point of the SEP wind farm site is 59.7km from the Humber Estuary SAC, the DEP wind farm site is 62.2km, and the closest point of the export cable corridor is 77.1km.

196. The Donna Nook haul-out site is within the Humber Estuary SAC, and represents the current best grey seal population estimate of the SAC. In August 2021 there were 3,897 grey seal counted at Donna Nook (SCOS, 2022[8]).

197. A relatively low number of grey seal were recorded during the site-specific aerial surveys for SEP and DEP, with a total of 31 individuals recorded during the 29 surveys, however, in addition a total of 198 unidentified seal species were recorded, as well as 36 seal / small cetacean species, a proportion of which are expected to be grey seal (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1) for further information). Due to the low number of grey seal sightings, it was not possible to derive robust density and abundance estimates from the site-specific surveys to use in the assessments.

198. Carter *et al*. (2020) produced habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles. The resultant density of seals at-sea maps show the relative density of seals in each 5km by 5km grid cell (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)). The grey seal density estimates used in assessments are based on the Carter *et al*. (2020) data and the current at-sea population of grey seal (of 150,700, as reported by Carter *et al*., 2020). A correction factor was applied to the overall population level to take account of both seals that were not available to count in the during the August count surveys, and those individuals that are estimated to be on land, and therefore not included in the density mapping[9].

199. The mean relative density estimates of grey seal for SEP, DEP, and all export cables areas calculated from Carter *et al.* (2020) are:

- SEP = 0.853 individuals per km^2 (95% CI = 0.528 – 1.184)
- DEP = 0.739 individuals per km^2 (95% CI = 0.458 – 1.022)
- SEP, DEP and export cable corridors = 0.735 individuals per km^2 (95% CI = 0.449 – 1.038)

200. The assessments are based on mean relative density estimates from Carter *et al*. (2020) as a worst-case (i.e. higher number of seals per km^2).

[8] [redacted]
[9] The correction factors applied are as reported within Carter *et al*., 2020, reported by Russell *et al.,* 2016 and Russell *et al.,* 2015

201. The assessments for SEP or DEP in isolation or SEP and DEP are put into the context of the Donna Nook haul-out site count of 3,897 grey seal (SCOS, 2020), as a representative of the Humber Estuary SAC grey seal population. The assessments are also be put into the context of the south-east England MU of 8,667 grey seal (SCOS, 2020).

202. For the in-combination assessment, to take into account the wide area covered by the in-combination project locations and evidence from telemetry studies, movements and potential foraging ranges, the reference population for grey seal incorporates the south-east England MU (8,667 grey seal) and north-east England MU (6,501 grey seal) and the Wadden Sea region (8,948 grey seal) (Schop *et al*., 2022; SCOS, 2020). Therefore, the in-combination reference population is 24,116 grey seal.

8.2.3.3 Conservation Status

203. Based on the most recent 2013-2018 reporting by the JNCC, grey seal have a '*favourable*' conservation status (JNCC, 2019).

8.2.3.4 Conservation Objectives

204. The Conservation Objectives (Natural England, 2018a) are "*To ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:*

- *The extent and distribution of qualifying natural habitats and habitats of qualifying species*
- *The structure and function (including typical species) of qualifying natural habitats*
- *The structure and function of the habitats of qualifying species*
- *The supporting processes on which qualifying natural habitats and habitats of qualifying species rely*
- *The populations of qualifying species, and,*
- *The distribution of qualifying species within the site."*

205. For the assessments, the potential for any effects are considered in relation to the Humber Estuary SAC Conservation Objectives for grey seal as outlined in **Table 8-8**.

Table 8-8: Potential Effects of SEP and DEP in Relation to the Conservation Objectives of the Humber Estuary SAC for Grey Seal

Conservation Objective for grey seal	Potential Effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential LSE. There will be no significant change to the extent and distribution of the habitats of qualifying species in the SAC.

Conservation Objective for grey seal	Potential Effect
The structure and function (including typical species) of qualifying natural habitats.	No potential LSE. There will be no significant change to the structure and function (including typical species) of qualifying natural habitats.
The structure and function of the habitats of qualifying species.	No potential LSE. There will be no significant change to the structure and function) of the habitats of the qualifying species.
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	No potential LSE. There will be no significant change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
The populations of qualifying species.	Increased collision risk with vessels will be considered further.
The distribution of qualifying species within the site.	No potential LSE. There will be no significant change to the distribution of qualifying species within the site. However, significant disturbance and displacement as a result of increased underwater noise levels have the potential to have an effect on the seals foraging at sea and will be considered further.

8.2.4 The Wash and North Norfolk Coast SAC

8.2.4.1 Description of Designation

206. The Wash, located on the east coast of England, is the largest embayment in the UK, and the extensive intertidal flats both within The Wash, and extending along the north Norfolk coast, provide ideal conditions for harbour seal breeding and haul-out sites. Harbour seal are a primary reason for the designation of The Wash and North Norfolk Coast SAC.

207. The Wash and North Norfolk Coast SAC is located, at closest point, 1.3km from SEP and DEP export cable corridor, 8.3km from the closest point at SEP and 24.3km from the closest point at DEP. Therefore, there is no potential for direct effects on the SAC as a result of the construction, operation, maintenance or decommissioning of SEP and DEP. However, due to the foraging range of harbour seal (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)), there is the potential for effects on foraging harbour seal from The Wash and North Norfolk Coast SAC in the vicinity of SEP and DEP.

8.2.4.2 Qualifying Features

8.2.4.2.1 Harbour seal

208. Harbour seal generally 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, 2020). Harbour seal give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS, 2020). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS, 2020).

209. SEP and DEP are located approximately 13.6km offshore (at the closest point to shore). Principal harbour seal haul-out sites in The Wash and North Norfolk Coast SAC are include Blakeney Point and The Wash (SCOS, 2020). **Table 8-9** provides the approximate distance to the closest point of SEP and DEP, and the most recent harbour seal count for each location.

Table 8-9: The Most Recent Harbour Seal Count at Each of the Nearby Haul-Out Sites, and the Distance to SEP and DEP

Haul-out site	Distance to SEP and DEP	Harbour seal count
Blakeney Point NNR	12km from landfall 12km from export cable corridor 38km from DEP 22km from SEP	181 (2021 harbour seal count; SCOS, 2022)
The Wash	58km from landfall 58km from export cable corridor 75km from DEP 57km from SEP	2,667 (2021 harbour seal count; SCOS, 2022)

210. A relatively low number of harbour seal were recorded during the site-specific aerial surveys, with a total of 21 individuals recorded through the 29 survey dates, however, in addition a total of 198 unidentified seal species were recorded, as well as 36 seal / small cetacean species, a proportion of which are expected to be harbour seal (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)). Due to the low number of harbour seal sightings, it was not possible to derive robust density and abundance estimates from the site-specific surveys to use in the assessments.

211. The mean relative harbour seal density estimates have been calculated based on the Carter *et al*. (2020) data and the current at-sea population of harbour seal (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)). The harbour seal density estimates were converted to absolute density estimates using the current at-sea population of harbour seal (of 42,800, as reported by Carter *et al*., 2020). As for grey seal, correction factors were applied to the overall population level to take account of both seals that were not available to count in the during the August count surveys, and those individuals that are estimated to be on land, and therefore not included in the density mapping[10].

212. The mean relative density estimates of harbour seal for SEP, DEP, and all export cables areas calculated from Carter *et al.* (2020) are:

- SEP = 0.274 individuals per km^2 (95% CI = 0.169 – 0.388)
- DEP = 0.080 individuals per km^2 (95% CI = 0.044 – 0.129)
- SEP, DEP and all export cable corridors = 0.189 individuals per km^2 (95% CI = 0.116 – 0.274)

213. The assessments are based on mean relative density estimates from Carter *et al*. (2020). The assessments for SEP or DEP in isolation or SEP and DEP are put into the context of the Blakeney Point NNR and The Wash haul-out sites count of 2,848 harbour seal (**Table 8-9**; SCOS, 2022), as a representative of The Wash and North Norfolk Coast SAC harbour seal population. The assessments will also be put into the context of the south-east England MU of 3,752 harbour seal (SCOS, 2020).

214. For the in-combination assessment, to take into account the wide area covered by the in-combination project locations and evidence from telemetry studies, movements and potential foraging ranges, the reference population for harbour seal incorporates the south-east England MU (3,752 harbour seal; SCOS, 2020) and the Wadden Sea region (count of 26,838 harbour seal; Galatius *et al.,* 2021). Therefore, the in-combination reference population is 30,590 harbour seal.

8.2.4.3 Conservation Status

215. Based on the most recent 2013-2018 reporting by the JNCC (JNCC, 2019), harbour seal have an overall Conservation Status of '*unfavourable-inadequate*'.

8.2.4.4 Conservation Objectives

216. For the assessments for The Wash and North Norfolk Coast SAC, the potential for effects are considered in relation to the SAC Conservation Objectives for harbour seal (Natural England, 2018b; **Table 8-10**).

[10] The correction factors applied are as reported within Carter *et al*., 2020, reported by Lonergan *et al.,* 2013 and Russell *et al.,* 2015

Table 8-10: Potential Effects of SEP and DEP in Relation to the Conservation Objectives of The Wash and North Norfolk Coast SAC for Harbour Seal

Conservation Objective for harbour seal	Potential Effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential LSE. There will be no significant change to the extent and distribution of the habitats of qualifying species in the SAC.
The structure and function (including typical species) of qualifying natural habitats.	No potential LSE. There will be no significant change to the structure and function (including typical species) of qualifying natural habitats.
The structure and function of the habitats of qualifying species.	No potential LSE. There will be no significant change to the structure and function) of the habitats of the qualifying species.
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	No potential LSE. There will be no significant change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
The populations of qualifying species.	Increased collision risk with vessels may cause a potential LSE which will be considered further.
The distribution of qualifying species within the site.	No potential LSE. There will be no significant change to the distribution of qualifying species within the site. However, significant disturbance and displacement as a result of increased underwater noise levels have the potential to have an effect on the seals foraging at sea and will be considered further.

8.3 Assessment Scenarios

8.3.1 Mitigation

8.3.1.1 Mitigation Embedded in the Design

217. This section outlines the embedded mitigation relevant to the marine mammal assessments, which has been incorporated into the design of the Projects (**Table 8-11**). The **Schedule of Mitigation and Mitigation Routemap** (document reference 6.5) details how and where these mitigation measures are secured within the **Draft DCO** (document reference 3.1). Where other mitigation measures are proposed, these are outlined in **Section 8.3.1.2**.

218. A number of techniques and engineering designs / modifications are inherent as part of the Projects where practical, during the pre-application phase, in order to avoid a number of effects or reduce effects as far as reasonably possible. This includes piling parameters, such as maximum hammer energy, duration of soft-start and ramp-up, strike rate and number of strikes. Embedding mitigation into the Project design is a type of primary mitigation, such as minimum number of turbines and foundations, reduction in number of offshore platforms.

Table 8-11: 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). The soft-start and ramp-up allows mobile species to move away from the area before the maximum hammer energy with the greatest noise impact area is reached. This commitment to soft-start and ramp-up is presented in the **Draft MMMP** (document reference 9.4).
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 to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. Further detail is provided in Annex 1 of the **Draft MMMP** (document reference 9.4).
Water Quality	
Best practice to reduce risk of pollution event	Equinor is committed to the use of best practice techniques and due diligence regarding the potential for pollution throughout all construction, operation and maintenance, and decommissioning activities. An **Outline Project Environmental Management Plan (PEMP)** (document reference 9.10) has been submitted alongside the DCO application to set out the details of the measures that will be taken in relation to accidental pollution events. The final PEMP would be agreed with the MMO prior to construction.

8.3.1.2 Other Mitigation Measures

219. In addition to the embedded mitigation measures as outlined above, the Applicant has also committed to the following mitigation measures (**Table 8-12**). The **Schedule of Mitigation and Mitigation Routemap** (document reference 6.5) details how and where these mitigation measures are secured within the **Draft DCO** (document reference 3.1).

Table 8-12: 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 SNCBs and the MMO, detailing the proposed mitigation measures to reduce the risk of any physical or permanent auditory injury (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 mitigation zone and any additional mitigation measures

Parameter	Additional Mitigation Measures
	required in order to minimise potential impacts of PTS. For example, the activation of Acoustic Deterrent Device (ADD) (e.g. for 10 minutes) prior to the soft-start. A **Draft MMMP** (document reference 9.4) has been submitted with the DCO application.
MMMP for UXO Clearance	
MMMP for UXO	A detailed MMMP will be prepared for UXO clearance during the pre-construction phase. The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with the MMO and relevant SNCBs. The MMMP for UXO clearance will include details of all the required mitigation measures to minimise the potential risk of PTS as a result of underwater noise during UXO clearance, for example, this would consider the options, suitability and effectiveness of mitigation measures such as, but not limited to: • Low-order clearance techniques, such as deflagration; • The use of bubble curtains if any high-order detonation is required (taking into consideration the environmental limitations); • All UXO clearance to take place in daylight and, when possible, in favourable conditions with good visibility (sea state 3 or less); • Establishment of a monitoring area with minimum of 1km radius. The observation of the monitoring area will be by dedicated and trained marine mammal observers (MMObs) during daylight hours and suitable visibility; • The activation of ADD; • The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO; and • Other UXO clearance techniques, such as avoidance of UXO; or relocation of UXO. In the event that UXOs are not able to be avoided or removed for onshore disposal, the preferred method for UXO clearance would be a low-order clearance method. However, if high-order detonation is required the following measures are also proposed: • Only one high-order detonation would be detonated at a time during UXO clearance operations at SEP and DEP. There would be no simultaneous UXO high-order detonations, but potentially more than one UXO clearance could occur in a 24 hour period. • There would be no UXO high-order detonations in the SEP offshore site and / or DEP offshore site at the same time as piling in the offshore SEP offshore site or DEP offshore site during the winter period. Although they may occur in the same day or 24 hour period, they would not occur at exactly the same time. • There would be no piling and UXO high-order detonation within the same 24 hour period between SEP and DEP, if both Projects are constructed at the same time.

Parameter	Additional Mitigation Measures
	UXO is not included in the DCO application, as currently not enough detailed information is available. Therefore, UXO clearance will be in a separate Marine Licence (ML) post consent, as agreed with the MMO and Natural England at ETG 3 on the 20th of July 2021.
Site Integrity Plan (SIP)	
SNS SAC SIP	In addition to the MMMPs for piling and UXO clearance, a SIP for the SNS SAC 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 SNS SAC conservation objectives. The SIP is an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the SNS SAC. The SIP will be developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and the MMO. An **In Principle SIP for the SNS SAC** (document reference 9.6) has been submitted with the DCO application.

8.3.2 Worst-Case Scenario

220. The final design of SEP and DEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach referred to as the Rochdale Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine: Rochdale Envelope (v3, 2018). The Rochdale Envelope for a project outlines the realistic worst-case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 5 EIA Methodology** (document reference 6.1.5).

221. The realistic worst-case scenarios for the assessment are summarised in **Table 8-13**. These are based on the project parameters described in **ES Chapter 4 Project Description** (document reference 6.1.4), which provides further details regarding specific activities and their durations.

222. In addition to the design parameters set out in **Table 8-13**, consideration is also given to:

- How SEP and DEP will be built out as described in **Section 8.3.2.1** to **Section 8.3.2.3** below. This accounts for the fact that whilst SEP and DEP are the subject of one DCO application, it is possible that only one Project could be built out (i.e. build SEP or DEP in isolation) or that both of the Projects could be developed. If both are developed, construction may be undertaken either concurrently or sequentially.
- A number of further development options which either depend on pre-investment or anticipatory investment, or that relate to the final design of the wind farms.
- Whether one OSP or two OSPs are required.
- The design option of whether to use all of the DEP North and DEP South array areas, or whether to use the DEP North array area only.

223. 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 4 Project Description** (document reference 6.1.4).

224. The realistic worst-case scenarios relevant for the marine mammal appropriate assessment are summarised in **Table 8-13**. These are based on the Project parameters described in **Section 3**, which provides further details regarding specific activities and their durations.

225. Piled foundations for the wind turbines (monopiles or jackets with pin-piles) and Offshore Substation Platforms (OSP) (jackets with pin-piles) are considered the worst-case for marine mammals as a result of underwater noise levels. However, other options for the foundations are being considered, including screw piles, Gravity Based Structure (GBS) and suction buckets (see **ES Chapter 4 Project Description** (document reference 6.1.4)).

226. For underwater noise from piling, three scenarios have been considered in the assessments:

- Single piling – A scenario where only one pile is installed, either at SEP or at DEP, within a 24 hour period.
- Sequential piling – A scenario where one pile is installed after another pile in the same 24 hour period (e.g. two monopiles in the same 24 hour period or four pin-piles in the same 24 hour period).
- Simultaneous piling - A scenario where two piles are installed at the same time at different locations (i.e. one at SEP at the same time as one at DEP).

227. In relation to the different offshore design scenarios for SEP and DEP (i.e. one OSP or two OSPs), the worst-case has been included in **Table 8-13**, where relevant.

228. The potential effects on marine mammals are:

- Underwater noise (including piling, other construction activities, vessels, operational turbines, operation, maintenance and decommissioning activities);

- Any barrier effects from underwater noise;
- Any increased collision risk with vessels;
- Disturbance at seal haul-out sites;
- Disturbance of foraging seals at sea;
- Changes to water quality;
- Changes to prey availability; and
- In-combination effects.

8.3.2.1 Construction Scenarios

229. In the event that both SEP and DEP are built, the following principles set out the framework for how SEP and DEP may be constructed:

- SEP and DEP may be constructed at the same time, or at different times;
- If built at the same time both SEP and DEP could be constructed in four years;
- If built at different times, either Project could be built first;
- If built at different times, each Project would require a four year period of construction;
- If built at different times, the offset between the start of construction of the first Project, and the start of construction of the second Project may vary from two to four years;
- Taking the above into account, the total maximum period during which construction could take place is eight years for both Projects;
- The earliest construction start date is 2025; and
- The earliest offshore construction could start is 2027, with the start of wind turbine and OSP foundations being installed (piling) at the beginning of 2028.

230. The impact assessment for marine mammals considers the following development scenarios in determining the worst-case scenario for each topic:

- Build SEP or build DEP in isolation – one OSP only; and
- Build SEP and DEP concurrently or sequentially – with either two OSPs, one for SEP and one for DEP, or with one OSP only to serve both SEP and DEP

231. For each of these scenarios it has been considered whether the build out of the DEP North and DEP South array areas, or the build out of the DEP North array area only, represents the worst case for that topic. Any differences between SEP and DEP, or differences that could result from the manner in which the first and the second projects are built (concurrent or sequential (and simultaneous or sequential piling) and the length of any gap) are identified and discussed where relevant in the impact assessment section (**Section 8.4**). For each potential impact, where necessary, only the worst-case construction scenario for the two Projects is presented, i.e. either

concurrent or sequential. The justification for what constitutes the worst-case is provided, where necessary, in **Section 8.4**.

8.3.2.2 Operation Scenarios

232. Operation scenarios are described in detail in **Chapter 4 Project Description**. The marine mammal assessments consider the following three scenarios:

- Only SEP in operation;
- Only DEP in operation; and
- The two Projects operating at the same time, with a gap of two to four years between each Project commencing operation.

233. The operational lifetime of each Project is expected to be 40 years.

8.3.2.3 Decommissioning Scenarios

234. Decommissioning scenarios are described in detail in **ES Chapter 4 Project Description** (document reference 6.1.4). 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 SEP and DEP could be conducted separately, or at the same time and that any potential effects would be the same or less than for construction.

Table 8-13 Realistic Worst-Case Parameters for Marine Mammal Assessment

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
Construction				
Underwater noise during piling	Installation of up to **30 wind turbines** (between 17 and 30 ranging from 15MW to 18+MW) and **one OSP** in the DEP North array area.	Installation of up to **23 wind turbines** (between 13 and 23 ranging from 15MW to 18+MW) and **one OSP** in the SEP wind farm site.	Installation of up to **53 wind turbines** (between 30 and 53 ranging from 15MW to 18+MW) and **two OSPs** (one in the DEP North array area and one in the SEP wind farm site).	Maximum number of wind turbines and OSPs. The worst-case scenario for SEP and DEP assumes 2 OSPs, one in the DEP North array area and one in the SEP wind farm site. The worst-case underwater noise modelling locations are in DEP South East and SEP East as described in **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2).
	Options for piled foundations: • 1 monopile per wind turbine foundation; or • 4 pin-piles per wind turbine foundation; and • Up to 8 pin-piles per OSP. Proportion of foundations that are piled: 100%			Impact piled foundations represent the worst-case scenario for underwater noise. Alternative foundation types are also considered but do not represent the worst-case for underwater noise.
	Number of piled wind turbine foundations:	Number of piled wind turbine foundations:	Number of piled wind turbine foundations:	Worst-case is up to 53 monopiles plus 16 pin-

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	• Up to **30 monopiles**; or • Up to **120 pin-piles**.	• Up to **23 monopiles**; or • Up to **92 pin-piles**.	• Up to **53 monopiles**; or • Up to **212 pin-piles**.	piles; or up to 228 pin-piles based on maximum number of piled foundations for 15MW wind turbines and up to two OSPs. The worst-case scenario for SEP and DEP assumes 2 OSPs, one in the DEP North array area and one in the SEP wind farm site.
	Up to **8 piles for OSP foundations** (1 OSP).	Up to **8 piles for OSP foundations** (1 OSP).	Up to **16 piles for OSP foundations** (2 OSPs).	
	Maximum **hammer energy for monopiles** • Up to **5,000kJ for 15MW** wind turbine • Up to **5,500kJ for 18+MW** wind turbine Maximum **hammer energy for pin-piles**: up to **3,000kJ**			This is the worst-case scenario. The maximum hammer energy will not be required for all piles and would not be required for the entire duration to install a pile.
	Maximum **pile diameter for monopiles**: • Up to **13m for 15MW** wind turbine • Up to **16m for 18+MW** wind turbine Maximum **pile diameter for pin-piles**: • Up to **3m for 15MW** wind turbine • Up to **4m for 18+MW** wind turbine • Up to **4m for OSP**(s)			This is the worst-case, with the greatest potential underwater noise impact ranges for installation of monopiles or pin-piles.
	Duration of wind turbine foundation installation: **3 months**	Duration of wind turbine foundation installation: **3 months**	Duration of wind turbine foundation installation: **6 months for each Project over a period**	Offshore construction works would require up to two years per Project

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
			of up to 39 months (based on sequential construction).	(excluding pre-construction activities such as surveys), assuming SEP and DEP were built at different times. However, the duration of piling for wind turbine foundations would be up to three months for each Project. This is the maximum duration of all offshore activities to install wind turbines, however, active piling will only be a relatively small duration within this overall period.
	Total piling time for wind turbine foundations (15MW or 18+MW): Monopiles: up to **120 hours** for 30 wind turbines (4 hours per wind turbine). or Pin-piles: up to **360 hours** for 30 wind turbines (3 hours per pin-pile x 4 piles per foundation	**Total piling time for wind turbine foundations** (15MW or 18+MW): Monopiles: up to **92 hours** for 23 wind turbines (4 hours per wind turbine). or Pin-piles: up to **276 hours** for 23 wind turbines (3 hours per pin-pile x	**Total piling time for wind turbine foundations** (15MW or 18+MW): Monopiles: up to **212 hours** (9 days) for 53 wind turbines (4 hours per wind turbine). or Pin-piles: up to **636 hours** (26.5 days) for 53 wind turbines (3 hours per pin-	The worst case piling time for pin-piles for all wind turbines including soft start and ramp up (20 minutes) 180 minutes per pin-pile, or 720 minutes (12 hours) per wind turbine.

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	= up to 12 hours per foundation).	4 piles per foundation = up to 12 hours per foundation).	pile x 4 piles per foundation = up to 12 hours per foundation).	
	Total OSP piling time 3 hours per pin-pile x 8 piles per foundation = up to **24 hours** per foundation.	**Total OSP piling time** 3 hours per pin-pile x 8 piles per foundation = up to **24 hours** per foundation.	**Total OSP piling time** 3 hours per pin-pile x 8 piles per foundation = up to 24 hours per foundation. Two OSPs = **48 hours**.	The worst-case scenario for SEP and DEP assumes 2 OSPs, one in the DEP North array area and one in the SEP wind farm site.
	Maximum total active piling time for wind turbines and OSP: **384 hours (16 days)**, based on pin-pile foundations for wind turbines and one OSP. For wind turbine monopiles and OSP pin-piles: 144 hours (6 days).	**Maximum total active piling time** for wind turbines and OSP: **300 hours (12.5 days)**, based on pin-pile foundations for wind turbines and one OSP. For wind turbine monopiles and OSP pin-piles: 116 hours (4.8 days).	**Maximum total active piling time** for wind turbines and OSPs: **684 hours (28.5 days)**, based on pin-pile foundations for wind turbines and two OSPs. For wind turbine monopile and OSP pin-piles: 260 hours (10.8 days).	Worst-case scenario is pin-piles for all wind turbines plus 2 OSPs.
	Activation of Acoustic Deterrent Device (ADD) For example: 10 minutes per pile, or 2,280 minutes (38 hours) for 228 pin-piles.			Indicative only.
	Potential for simultaneous piling at DEP.	Potential for simultaneous piling at SEP.	Potential for simultaneous piling between SEP and DEP depending on build scenario (see **Section 8.3.2.1**).	Simultaneous piling between SEP and DEP represents the worst-case.
	Number of monopiles to be installed sequentially in same 24 hour period = 2	Number of monopiles to be installed sequentially in same 24 hour period = 2	Number of monopiles to be installed sequentially in same 24 hour period = 2	Assessments have been based on a worst-case scenario of up 2 monopiles installed sequentially in the same 24 hour period or up to 4 pin-piles installed

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	Number of pin-piles to be installed sequentially in same 24 hour period = 4	Number of pin-piles to be installed sequentially in same 24 hour period = 4	Number of pin-piles to be installed sequentially in same 24 hour period = 4	sequentially in the same 24 hour period.
Underwater noise during other construction activities (Underwater noise from activities such as sea bed preparations, cable installation and rock placement)	Sea bed clearance methods: Pre-lay grapnel run, boulder grab, plough, sand wave levelling (pre-sweeping), dredging			
	Cable installation methods: Jetting / ploughing / trenching / mechanical cutting			Assumed equal amounts of jetting and mechanical cutting.
	Underwater noise modelling for all construction activities and vessels			
	Wind farm site: Two wind farm wind farm sites (DEP North wind farm site and DEP South wind farm site) = **114.8km^2**	**Wind farm site:** One wind farm wind farm site = **97.0km^2**	**Wind farm sites:** Three wind farm areas = **211.8km^2** (DEP North and DEP South wind farm sites and SEP wind farm site).	Maximum wind site farm area(s).
	Export cable corridor: **96.8km^2** (for DEP in isolation)	**Export cable corridor:** **63.8km^2**	**Export cable corridor:** **160.6km^2**	
	Duration of offshore construction: **2 years** Duration of offshore export cable installation: **60 days**	Duration of offshore construction: **2 years** Duration of offshore export cable installation: **50 days**	Duration of offshore construction: **4 years** if built sequentially with a maximum gap of **3 years (7 years in total)** Duration of offshore export cable installation: **100 days**	Offshore construction works would require up to two years per Project (excluding pre-construction activities such as surveys), assuming SEP and DEP were built at different times. If built at the same time, offshore construction could be completed in two years. Accounting for the development scenarios

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
				described in Section 8.3.2.1, there could be a gap of up to one year between the completion of offshore construction works on the first Project and the start of offshore construction works on the second Project.
Underwater noise and disturbance from vessels, and vessel collision risk	**Vessel movements:** • Maximum number of construction vessels on site at any one time: up to **16** vessels • Construction vessel trips to port: **603** over 2 year construction period	**Vessel movements:** • Maximum number of construction vessels on site at any one time: up to **16** vessels • Construction vessel trips to port: **603** over 2 year construction period	**Vessel movements:** • Maximum number of construction vessels on site at any one time: up to **25** (in total if both SEP and DEP constructed concurrently) • Construction vessel trips to port: **1,196** during 4 year construction period if constructed sequentially	Maximum number of construction vessels. The worst-case for SEP and DEP considers concurrent construction on account of increased construction activity in the study area at the same time. Construction port/s will not be confirmed until nearer the start of construction.
Barrier effect from underwater noise	Maximum impact range from underwater noise assessments (worst-case parameters described above).			The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier impact.

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
Disturbance at seal haul-out sites	Distance of SEP and DEP, landfall location and vessel routes to seal haul-out sites for grey seal and harbour seal.			Construction port/s will not be confirmed until nearer the start of construction.
Changes to prey availability (temporary habitat loss / disturbance; increased suspended sediments and sediment re-deposition; re-mobilisation of contaminated sediments; and underwater noise)	Impacts to prey species and habitat as described in **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9) and **ES Chapter 8 Benthic Ecology** (document reference 6.1.8).			
	Total sea bed disturbance within the DEP offshore site Worst-case scenario total temporary disturbance footprint for DEP in isolation = **5.12km²**	**Total sea bed disturbance within the SEP offshore site** Worst-case scenario total temporary disturbance footprint for SEP in isolation = **2.12km²**	**Total Disturbance within the SEP and DEP offshore sites** Worst-case scenario total temporary disturbance footprint for SEP and DEP = **7.87km²**	The worst-case scenario for maximum area of temporary habitat loss / disturbance of sea bed from offshore cable installation, sea bed preparation, jack-up vessels and HDD exit points). Worst-case area is based on a 1 OSP scenario where both the DEP North and South array areas are developed.
	Worst-case scenario for total temporary increases in suspended sediment concentration (SSC) for DEP in isolation = **1,041,750m³**	Worst-case scenario for total temporary increases in SSC for SEP in isolation= **444,625m³**	Worst-case scenario for total temporary increases in SSC for SEP and DEP = **1,544,802m³**	The worst-case for increased suspended sediments and sediment re-deposition from sea bed preparation and cable trenching. Worst-case is based on a 1 OSP scenario where both the DEP North and South array areas are developed.
	Remobilisation of contaminated sediments: As described for increased suspended sediments and sediment re-deposition.			

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	Underwater noise parameters as outlined for construction noise-related impacts above and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) (piling, other construction activities and vessels).			As above for underwater noise.
Changes to water quality (increased suspended sediments and sediment re-deposition; and re-mobilisation of contaminated sediments)	Impacts to water quality are as described in **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). See worst-case for temporary increases in SSC and re-mobilisation of contaminated sediments as described for Impact 10.			
Operation and Maintenance				
Underwater noise from operational turbines	Turbine parameters (e.g. size and number) as outlined above and underwater noise parameters described in **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2).			Underwater noise modelling for operational turbines.
Underwater noise from maintenance activities	Estimated timeframe for any cable repair, replacement or reburial works: • One export cable repair every 10 years (400m) • Up to 100m per export cable subject to reburial works every 10 years • One interlink cable repair every 10 years (800m);	Estimated timeframe for any cable repair, replacement or reburial works: • One export cable repair every 10 years (400m) • Up to 100m per export cable subject to reburial works every 10 years • One infield cable repair every 10 years (2,500m in total)	Estimated timeframe for any cable repair, replacement or reburial works: • One export cable repair every 10 years (800m) • Up to 100m per export cable (200m in total) subject to reburial works every 10 years • One interlink cable repair every 10 years (800m);	SEP and DEP is the worst case scenario since the duration has potential to be longer given the requirement to repair or rebury longer cable lengths compared to the in isolation scenario.

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	• Reburial of 1% of interlink cabling every 10 years (660m) • One infield cable repair every 10 years (2,500m in total) • Reburial of 1% of infield cabling every 10 years (1,350m)	• Reburial of 1% infield cabling every 10 years (900m)	• Reburial of 1% of interlink cabling every 10 years (1,540m) • Two infield cable repairs every 10 years (5,000m in total) • Reburial of 1% infield cabling every 10 years (2,250m)	
Underwater noise from vessels, and vessel collision risk	**Vessel movements:** • Maximum number of vessels on site at any one time: **6** • Operation and maintenance vessel trips to port per year: approximately **604** (although majority (600) will be (small operation and maintenance vessel (Crew Transfer Vessel (CTV)).	**Vessel movements:** • Maximum number of vessels on site at any one time: **6** • Operation and maintenance vessel trips to port per year: approximately **604** (although majority (600) will be (small operation and maintenance vessel (CTV)).	**Vessel movements:** • Maximum number of vessels on site at any one time: **7** (in total if both SEP and DEP constructed concurrently) • Operation and maintenance vessel trips to port per year: approximately **1,206** (although majority (1,200) will be (small operation and maintenance vessel (CTV)).	Where possible, SEP and DEP will use the existing operation and maintenance programme for SOW and DOW respectively.
Barrier effect from underwater noise	Maximum impact range 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.
	Distance of SEP and DEP to haul-out sites for grey seal and harbour seal.			

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
Disturbance at seal haul-out sites	Operation and maintenance base location: Great Yarmouth			Operation and maintenance activities could happen at any time of year.
Changes to prey availability (temporary habitat loss / disturbance; permanent habitat loss; introduction of wind turbine foundations, scour protection and hard substrate; increased suspended sediments and sediment re-deposition; re-mobilisation of contaminants from sea bed sediment; underwater noise; and Electromagnetic Fields (EMF)).	Impacts to prey species and habitat as described in **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9) and **ES Chapter 8 Benthic Ecology** (document reference 6.1.8).			
	Approximate total temporary disturbance footprint for DEP in isolation for operational lifetime (40 years) = **0.55km²**	Approximate total temporary disturbance footprint for SEP in isolation for operational lifetime (40 years) = **0.53km²**	Approximate total temporary disturbance footprint for SEP and DEP for operational lifetime (40 years) = **1.148km²**	The worst-case scenario for maximum area of temporary habitat loss / disturbance of sea bed from jack-up vessel deployments, cable repair, replacement and reburial footprint.
	See Operation Impact 2 in **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) **Total permanent habitat loss: 0.67km²**	See Operation Impact 2 in **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) **Total permanent habitat loss: 0.50km²**	See Operation Impact 2 in **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) **Total permanent habitat loss: 1.159km²**	The worst-case scenario for maximum area of permanent habitat loss / introduction of wind turbine foundations, OSP foundations, scour protection and hard substrate (including subsea cable surface protection and pipeline crossing).
	Temporary increases in SSC and any deterioration in water quality through the resuspension of contaminated sediment due to maintenance activities could result from periodic jack-up vessel deployment, and cable repair, replacement and reburial activities – same as temporary habitat loss / disturbance.			The worst-case scenario based on maximum area of temporary habitat loss / disturbance of sea bed (as above).

Potential Effect	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	Underwater noise parameters as outlined for operation noise-related impacts above and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) (operational turbines, maintenance activities, vessels).			As above for underwater noise.
	Offshore cables: Up to **263km** of offshore cables comprising: • One High Voltage Alternating Current (HVAC) export cable up to **62km** in length • **135km** of infield cables (DEP North wind farm site: 90km; DEP South: 45km) • Up to 3 parallel interlink cables between DEP South wind farm site and OSP in DEP North: up to **66km** in length (combined) • Burial depth: 0.5 to 1m (excluding burial in sand waves up to 20m); and up to 1.0m for the export cables.	**Offshore cables:** Up to **130km** of cables comprising: • One HVAC export cable up to **40km** in length • **90km** of infield cables • No interlink cables Burial depth: same as DEP in isolation.	**Offshore cables:** Worst-case for 1 OSP scenario where both the DEP North and DEP South wind farm sites are developed) Up to **448km**: • 2 HVAC export cables from SEP up to **80km** in length • Up to **225km** of infield cables (DEP North wind farm site: 90km; DEP South wind farm site 45km; SEP 90km) • Up to 7 interlink cables from DEP North wind farm site (up to 5) and DEP South wind farm site (up to 3) to OSP in SEP, up to **143km** total length • Burial depth: same as SEP or DEP in isolation.	
Changes to water quality	Impacts to water quality (as described in **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)). 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.			

<table>
<tr><th>Potential Effect</th><th>DEP in Isolation</th><th>SEP in Isolation</th><th>SEP and DEP</th><th>Notes and Rationale</th></tr>
<tr><td colspan="5">Decommissioning</td></tr>
<tr><td>Underwater noise from foundation removal of wind turbines and substations</td><td colspan="3" rowspan="7">No final decision has yet been made regarding the final decommissioning policy for the offshore Project infrastructure. It is also recognised that legislation and industry best practice change over time. However, the following infrastructure is likely be removed, reused or recycled where practicable:
• Turbines including monopile, steel jacket and GBS foundations;
• OSPs including topsides and steel jacket foundations;
• Offshore cables may be removed or left in situ depending on available information at the time of decommissioning; and
• Cable protection in the Cromer Shoal Chalk Beds Marine Conservation Zone (MCZ).
The following infrastructure is likely to be decommissioned in situ depending on available information at the time of decommissioning:
• Scour protection;
• Offshore cables may be removed or left in situ; and
• Crossings and cable protection outside the Cromer Shoal Chalk Beds MCZ.
The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator.
For the purposes of the worst-case scenario, it is anticipated that the impacts will be no greater than those identified for the construction phase, as no piling will be required.</td><td rowspan="7">Assumed to be no worse than during construction.

Decommissioning arrangements will be detailed in a Decommissioning Programme, which will be drawn up and agreed with BEIS prior to construction.</td></tr>
<tr><td>Underwater noise from other decommissioning activities</td></tr>
<tr><td>Underwater noise from vessels, and vessel collision risk</td></tr>
<tr><td>Barrier effect from underwater noise</td></tr>
<tr><td>Disturbance at seal haul-out sites</td></tr>
<tr><td>Changes to prey availability</td></tr>
<tr><td>Changes to water quality</td></tr>
</table>

8.4 Assessment of Potential Effects

235. The potential effects have been assessed for each of the four designated sites for marine mammals for construction, operation, maintenance and decommissioning at SEP or DEP in isolation and for SEP and DEP.

236. Assessments of the potential for adverse effects, at the population level, have been based on the JNCC *et al.* (2010) draft guidance for effects on EPS, and the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) agreement.

237. The JNCC *et al.* (2010) draft guidance provides some indication on how many animals may be removed from a population without causing detrimental effects to the population at FCS. The JNCC *et al.* (2010) draft guidance also provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement.

238. JNCC *et al.* (2010) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the ‘default’ rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth could be halted. In assigning 5% to a temporary effect, consideration is given to uncertainty of the individual consequences of temporary disturbance.

239. Permanent effects with a greater than 1% of the reference population being affected within a single year are considered to result in a significant effect. This is based on ASCOBANS and Defra advice (Defra, 2003; ASCOBANS, 2015) relating to impacts from fisheries by-catch (i.e. a permanent effect) on harbour porpoise. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to ASCOBANS, with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra, 2003; ASCOBANS, 2015).

240. As a precautionary approach, and as there is no current guidance on what determines a significant temporary or permanent effect, the above information on the potential for population level effects has been used to inform the approach to defining potential for adverse effect for harbour porpoise, bottlenose dolphin, grey seal and harbour seal populations. The approach to define the potential for adverse effect on the integrity of the site, based on the potential effect to the overall populations, is therefore as follows;

- For temporary effects, there would be potential for an adverse effect on the integrity of the site, if there is an effect to 5% or more of the population; and
- For permanent effects, there would be potential for an adverse effect on the integrity of the site, if there is an effect to 1% of more of the population.

8.4.1 Southern North Sea SAC

241. The potential effects during the construction, operation, maintenance and decommissioning of SEP and / or DEP (in relation to harbour porpoise from the SNS SAC were agreed during consultation with the marine mammal ETG as part of the EPP and confirmed by Natural England at Section 42 consultation (see **Table 8-2** and **Appendix 1 Evidence Plan** (document reference 5.2.1) of the **Consultation Report** (document reference 5.1)). The potential effects of SEP and / or DEP that are assessed to determine any potential for an adverse effect on the integrity of the SNS SAC in relation to the Conservation Objectives for harbour porpoise are:

- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during piling;
- Disturbance impacts resulting from underwater noise during other construction activities, including sea bed preparations, rock placement and cable installation;
- Potential effects resulting from construction vessels:
  - Underwater noise and disturbance from construction vessels; and
  - Vessel interaction (collision risk);
- Barrier effects as a result of underwater noise;
- Changes to prey availability; and
- Changes to water quality; and
- In-combination effects.

242. Assessment of the potential effects on the SNS SAC for harbour porpoise, is based on the current SNCB advice (JNCC *et al*., 2020) that noise disturbance within an SAC from a plan/project, individually or in-combination, is considered to be significant if it excludes harbour porpoises from more than:

- 20% of the relevant area of the site in any given day, or
- an average of 10% of the relevant area of the site over a season.

243. The potential effect should be considered in the context of the seasonal components of the SAC area (see **Section 8.2.1**), rather than the SAC area as a whole.

244. The assessments are based on the current recommended Effective Deterrence Ranges (EDRs) for assessing the disturbance of harbour porpoise in the SAC from different noise generating activities (JNCC *et al*., 2020).

8.4.1.1 Potential Effects During Construction

8.4.1.1.1 Potential Effects of Underwater Noise during Piling

245. A range of foundation options are being considered for SEP and DEP, including monopile, jacket (pin-piles), screw piles, gravity base structure and suction bucket. Of these, monopiles and jackets (pin-piles) may require piling. As a worst-case scenario for underwater noise, it has been assumed that all foundations could be piled.

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

8.4.1.1.1.1 Assessment for SEP or DEP In Isolation

8.4.1.1.1.1.1 Permanent Auditory Injury (PTS)

247. Underwater noise modelling was carried out by Subacoustech to estimate the noise levels likely to arise during piling and determine the maximum potential areas of effect (see **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) for further details).

248. The assessments are based on the worst-case location at each site (i.e. location with greatest noise propagation) for:

- Monopile with maximum diameter of 16m, maximum hammer energy of up to 5,500kJ and maximum starting energy of 1,000kJ; and
- Pin-pile with diameter of 4m, maximum hammer energy of up to 3,000kJ and maximum starting hammer energy of 400kJ.

249. To determine the potential for PTS from cumulative sound exposure level (SEL_{cum}), the soft-start, ramp-up, hammer energy, total duration and strike rate are taken into account. The soft-start takes place over the first 30 minutes of piling at the starting hammer energy, after which the hammer energy will increase (ramp-up) to the maximum hammer energy required to safely install the pile.

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

251. The soft-start, ramp-up and piling duration used to assess SEL_{cum} for monopiles and pin-piles are summarised in **Table 8-14**.

Table 8-14: Hammer Energy, Ramp-Up and Piling Duration

Parameter	Starting hammer energy	Ramp-up				Maximum hammer energy
Monopile – worst-case						
Monopile hammer energy	1,000kJ	1,500kJ	2,500kJ	3,500kJ	4,500kJ	5,500kJ
Number of strikes	1,350	2,400	1,600	1,200	1,350	1,350
Strikes per minute	45	60	40	30	30	30
Duration (minutes)	30	40	40	40	45	45
Total duration	4 hours (9,250 total strikes)					
Pin-pile						
Pin-pile hammer energy	400	920	1,440	1,960	2,480	3,000
Number of strikes	1,200	1,200	1,200	1,200	900	900
Strikes per minute	40	40	40	40	30	30
Duration (minutes)	30	30	30	30	30	30
Total duration	3 hours (6,600 total strikes)					

252. The assessments are based on the latest Southall *et al*. (2019) thresholds and criteria for marine mammals. The thresholds indicate the onset of PTS, the point at which there is an increase in risk of permanent hearing damage in an underwater receptor (although not all individuals within the maximum PTS range will have permanent hearing damage, this is assumed as a worst-case scenario).

253. The maximum impact ranges (and areas) are used to inform the assessments.

254. The results of the underwater noise modelling for PTS in harbour porpoise are presented in **Table 8-15** and **Table 8-16**.

Table 8-15: Predicted Impact Ranges (and Areas) for Harbour Porpoise at SEP or DEP in Isolation for PTS From a Single Strike and From Cumulative Exposure (Maximum Impact Range and Area Indicated in ***Bold****)*

Species	Impact	Criteria and threshold (Southall *et al*., 2019)	Location	Monopile (16m diameter) Maximum impact range (km) and area (km^2)		Pin-pile (4m diameter) Maximum impact range (km) and area (km^2)		Pin-pile (4m diameter for OSPs) Maximum impact range (km) and area (km^2)	
				Starting hammer energy (1,000kJ)	Maximum hammer energy (5,500kJ)	Starting hammer energy (400kJ)	Maximum hammer energy (3,000kJ)	Starting hammer energy (400kJ)	Maximum hammer energy (3,000kJ)
Harbour porpoise (VHF)	PTS from single strike (without mitigation)	SPL_{peak} Unweighted (202 dB re 1µPa) Impulsive	SEP	**0.27km ($0.22km^2$)**	**0.51km ($0.82km^2$)**	**0.13km ($0.05km^2$)**	**0.44km ($0.59km^2$)**	0.12km ($0.04km^2$)	0.42km ($0.54km^2$)
			DEP	**0.29km ($0.27km^2$)**	**0.57km ($1km^2$)**	**0.14km ($0.06km^2$)**	**0.49km ($0.72km^2$)**	0.13km ($0.05km^2$)	0.47km ($0.67km^2$)
		SEL_{ss} Weighted (155 dB re $1µPa^2s$) Impulsive	SEP	0.01km ($0.03km^2$)	0.18km ($0.1km^2$)	0.06km ($0.01km^2$)	0.22km ($0.14km^2$)	0.05km (<$0.01km^2$)	0.16km ($0.08km^2$)
			DEP	0.01km ($0.03km^2$)	0.19km ($0.11km^2$)	0.06km ($0.01km^2$)	0.23km ($0.16km^2$)	0.05km (<$0.01km^2$)	0.16km ($0.08km^2$)
	PTS from cumulative SEL (including soft-start and ramp-up)	SEL_{cum} Weighted (155 dB re $1µPa^2s$) Impulsive	SEP	N/A	3.4-**4.1km ($43km^2$)**	N/A	1.2-1.8km ($8.3km^2$)	N/A	1.2-**1.8km ($8.5km^2$)**
			DEP	N/A	3.6-**4.9km ($61km^2$)**	N/A	1.6-2.2km ($13km^2$)	N/A	1.7-**2.3km ($13km^2$)**

Table 8-16: Predicted Impact Ranges (and Areas) for PTS From Cumulative Exposure During Sequential Piling at SEP or DEP in Isolation

Species	**Impact**	**Criteria and threshold (Southall *et al*., 2019)**	**Location**	**Two monopiles (16m diameter; 5,500kJ)**	**Four pin-pile (4m diameter; 3,000kJ)**
				Impact range (km) and area (km^2)	**Impact range (km) and area (km^2)**
Harbour porpoise (VHF)	PTS from cumulative SEL during sequential piling in same 24 hour period	SEL_{cum} Weighted (155 dB re 1µPa^2s) Impulsive	SEP	3.4-4.1km ($43km^2$)	1.5-1.8km ($8.3km^2$)
			DEP	3.9-4.9km ($60km^2$)	1.8-2.3km ($13km^2$)

255. At the closest point the DEP wind farm site is 13.9km from the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area and export cable corridors are 21.2km from the summer area and 18.4km from the winter area (**Table 8-4**). Therefore, there would be no direct overlap for the maximum impact range for PTS (without mitigation) with the SNS SAC (**Table 8-15** and **Table 8-16**).

256. The maximum potential number of harbour porpoise that could be at possible risk of PTS from SEL_{cum} during piling, without any mitigation, could be up to 148 individuals (0.04% of the North Sea MU) based on the highest density rate of 2.43/km^2 during the summer at DEP (**Table 8-17**). For SEP, maximum potential number of harbour porpoise that could be at possible risk of PTS from SEL_{cum} during piling, without any mitigation, could be up to 27 individuals (0.008% of the North Sea MU) based on the highest density rate of 0.63/km^2 during the summer period (**Table 8-17**).

*Table 8-17: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be at Risk of PTS for Monopile or Pin-Pile Installation Without Mitigation, Based on Worst-Case for SEP or DEP in Isolation (Worst-Case in **Bold** with Shaded Cell)*

Species	Criteria and threshold (Southall *et al.*, 2019)	Location	Season	Monopile	Pin-pile
First Strike of Soft-Start for Monopile (1,000kJ) or Pin-pile (400kJ)					
Harbour porpoise (VHF)	SPL_{peak} Unweighted (202 dB re 1 µPa) Impulsive	SEP	Summer	0.14 (0.00004% of NS MU) (SEP density of 0.63/km^2)	0.03 (0.000009% of NS MU) (SEP density of 0.63/km^2)
			Winter	0.11 (0.00003% of NS MU) (SEP density of 0.52/km^2)	0.03 (0.000008% of NS MU) (SEP density of 0.52/km^2)
		DEP	Summer	0.66 (0.0002% of NS MU) (DEP density of 2.43/km^2)	0.15 (0.000042% of NS MU) (DEP density of 2.43/km^2)
			Winter	0.23 (0.00007% of NS MU) (DEP density of 0.85/km^2)	0.05 (0.000015% of NS MU) (DEP density of 0.85/km^2)
Single Strike of Maximum Hammer Energy for Monopile (5,500kJ) or Pin-pile (3,000kJ)					
Harbour porpoise (VHF)	SPL_{peak} Unweighted (202 dB re 1 µPa) Impulsive	SEP	Summer	0.52 (0.00015% of NS MU) (SEP density of 0.63/km^2)	0.37 (0.00011% of NS MU) (SEP density of 0.63/km^2)
			Winter	0.43 (0.00012% of NS MU) (SEP density of 0.52/km^2)	0.31 (0.00009% of NS MU) (SEP density of 0.52/km^2)
		DEP	Summer	2.43 (0.0007% of NS MU)	1.75 (0.0005% of NS MU)

Species	Criteria and threshold (Southall *et al.*, 2019)	Location	Season	Monopile	Pin-pile
				(DEP density of 2.43/km²)	(DEP density of 2.43/km²)
			Winter	0.85 (0.00025% of NS MU) (DEP density of 0.85/km²)	0.61 (0.0002% of NS MU) (DEP density of 0.85/km²)
PTS from Cumulative Exposure (SEL_{cum}) during Installation of Single Monopile (5,500kJ) or Pin-pile (3,000kJ)					
Harbour porpoise (VHF) SEL_{cum} Weighted (155 dB re 1 µPa²s) Impulsive		SEP	Summer	**27 (0.008% of NS MU) (SEP density of 0.63/km²)**	5 (0.002% of NS MU) (SEP density of 0.63/km²)
			Winter	22 (0.006% of NS MU) (SEP density of 0.52/km²)	4 (0.001% of NS MU) (SEP density of 0.52/km²)
		DEP	Summer	**148 (0.04% of NS MU) (DEP density of 2.43/km²)**	32 (0.009% of NS MU) (DEP density of 2.43/km²)
			Winter	52 (0.015% of NS MU) (DEP density of 0.85/km²)	11 (0.003% of NS MU) (DEP density of 0.85/km²)
PTS from Cumulative Exposure (SEL_{cum}) during Sequential piling of Two Monopiles (5,500kJ) or Four Pin-piles (3,000kJ)					
Harbour porpoise (VHF) SEL_{cum} Weighted (155 dB re 1 µPa²s) Impulsive		SEP	Summer	27 (0.008% of NS MU) (SEP density of 0.63/km²)	5 (0.002% of NS MU) (SEP density of 0.63/km²)
			Winter	22 (0.006% of NS MU) (SEP density of 0.52/km²)	4 (0.001% of NS MU) (SEP density of 0.52/km²)
		DEP	Summer	146 (0.04% of NS MU) (DEP density of 2.43/km²)	32 (0.009% of NS MU) (DEP density of 2.43/km²)
			Winter	51 (0.01% of NS MU) (DEP density of 0.85/km²)	11 (0.003% of NS MU) (DEP density of 0.85/km²)

257. As outlined in **Section 8.3.1**, a MMMP for piling in accordance with the **Draft MMMP** (document reference 9.4) will be produced post-consent in consultation with the MMO and relevant SNCBs and will be based on the latest scientific understanding and guidance, as well as detailed Project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of PTS from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

258. Mitigation to reduce the risk of instantaneous PTS from the first strike of the soft-start would include activation of ADDs prior to the soft-start commencing. For a maximum impact range of 0.29km (**Table 8-15**), based on a swimming speed of 1.5m/s, the ADDs would be activated for 10 minutes to ensure harbour porpoise had moved beyond the maximum predicted impact range (distance of 0.9km for 10 minute ADD activation).

259. Mitigation to reduce the risk of instantaneous PTS from a single strike of monopile or pin-pile with maximum hammer energy would include establishing a mitigation zone for the maximum potential impact range of at least 0.57km (**Table 8-15**), activation of ADDs prior to the soft-start commencing for 10 minutes, soft-start for at least 20 minutes followed by ramp-up. The 10 minute ADD activation (0.9km) and 20 minute soft-start (1.8km), would allow harbour porpoise to move at least 2.7km, based on a swimming speed of 1.5m/s.

260. Mitigation to reduce the risk of PTS from cumulative exposure during installation of monopile would include mitigation for the maximum potential impact range (up to 4.9km for harbour porpoise; **Table 8-15**), such as increasing the activation of ADDs prior to the soft-start to 55 minutes which would ensure harbour porpoise were 4.95km from the location based on a swimming speed of 1.5m/s.

261. Development of the MMMP (in accordance with the **Draft MMMP** (document reference 9.4) prior to construction will also consider other mitigation methods based on the latest information and requirements.

262. The effective implementation of the MMMP for piling will reduce the risk of PTS to harbour porpoise during piling at SEP or DEP, therefore, there would be **no adverse effect on the integrity of the SNC SAC in relation to the conservation objectives for harbour porpoise, due to PTS from piling during construction, for SEP or DEP in isolation**.

8.4.1.1.1.1.2 Disturbance

263. The SNCBs currently recommend that a potential disturbance range or EDR of 26km (approximate area of 2,124km^2) around monopile locations (without mitigation) is used to assess harbour porpoise disturbance in the SNS SAC (JNCC *et al*., 2020).

264. As outlined above, at the closest point the DEP wind farm site is 13.9km for the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area (**Table 8-4**). Therefore, for a 26km EDR based on the closest point as a worst-case, there is the potential for some direct overlap with the SNS SAC.

265. The SNCBs currently recommend that an EDR of 15km for pin-piles (with or without mitigation) and 15km for monopiles with mitigation is used to assess harbour porpoise disturbance in the SNS SAC (JNCC *et al*., 2020). However, as a worst-case, the assessments are based on 26km EDR for monopiles with no mitigation.

8.4.1.1.1.1.2.1 Spatial assessment

266. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC summer or winter area on any given day during piling at SEP or DEP, based on the worst-case scenario (**Table 8-18**). Therefore, under these circumstances, there would be **no adverse effect on the integrity of the SNC SAC in relation to the conservation objectives for harbour porpoise, due to disturbance from piling during construction, for SEP or DEP in isolation**.

Table 8-18: Maximum Potential Overlap with SNS SAC Summer and Winter Areas Based on 26km EDR at Closest Point for SEP or DEP

Location	Maximum area of overlap with SNS SAC summer area (% of SNS SAC summer area)	Maximum area of overlap with SNS SAC winter area (% of SNS SAC winter area)	Potential adverse effect on site integrity
SEP	No overlap	0.15km^2 (0.0012%)	**No** Temporary effect. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area on any given day during piling at SEP or DEP, based on the worst-case scenario.
DEP	356km^2 (1.32%)	32.7km^2 (0.26%)	

8.4.1.1.1.1.2.2 Seasonal average

267. The active piling duration could be up to 12.5 days for SEP and up to 16 days for DEP (**Table 8-13**). As a precautionary approach, assessments are also based on up to 25 days for SEP, assuming one day per foundation installation for 23 turbines at SEP plus 2 days recovery, and up to 32 days for DEP, assuming one day per foundation installation for 30 turbines plus 2 days recovery.

268. ADD activation, based on the worst-case of 55 minutes, would disturb harbour porpoise over 4.95km. Therefore, there would be no overlap with the SNS SAC summer or winter area for ADD activation at SEP or DEP, based on the closest distance.

269. The seasonal averages have been calculated by taking into account the maximum potential overlap with SNS SAC seasonal areas (**Table 8-18**) on any one day by the estimated maximum number of days within the season on which piling could occur (**Table 8-19**). The summer season is assumed to be 183 days (April-September) and the winter season is assumed to be 182 days (October-March).

270. The seasonal averages have been based on the precautionary approach that all piling and related disturbance could occur in a single season.

271. The assessment indicates, less than 10% of the seasonal component of the SNS SAC over the duration of that season could be affected during piling at SEP and DEP, based on the worst-case scenario (**Table 8-19**). Therefore, under these circumstances, there would be **no adverse effect on the integrity of the Southern North Sea SAC in relation to the conservation objectives for harbour porpoise, due to disturbance from piling during construction, for SEP or DEP in isolation**.

Table 8-19: Estimated Seasonal Average for SNS SAC Summer and Winter Areas Based on 26km EDR at Closest Point for SEP or DEP

Location	Number of disturbance days per season	Maximum seasonal average for SNS SAC summer area	Maximum seasonal average for SNS SAC winter area	Potential adverse effect on site integrity
SEP (23 foundation installation plus 2 days recovery)	25 days	No overlap	0.00016%	**No** Temporary effect. Displacement of harbour porpoise would not exceed 10% of the seasonal component of the SNS SAC over the duration of that season during piling at SEP or DEP, based on the worst-case scenario
DEP (30 foundation installation plus 2 days recovery)	32 days	0.23%	0.04%	

8.4.1.1.1.1.2.3 Assessment in relation to North Sea MU

272. **Table 8-20** presents the assessments for the maximum number of harbour porpoise that could be disturbed in the seasonal areas of the SNS SAC based on the maximum potential overlap and seasonal density estimate for each season.

273. As a worst-case scenario, the number of harbour porpoise that could be disturbed from the area around SEP or DEP has been estimated based on a 26km EDR (2,124km^2) and the SCANS-III density estimate of 0.888/km^2 for the wider area.

274. The assessment indicates that 0.54% or less of the North Sea MU reference population could be temporarily displaced during piling at SEP or DEP, based on the worst-case scenario (**Table 8-20**). The temporary disturbance of 0.54% or less of the North Sea MU population would not result in any significant population effects or result in any changes to the FCS of harbour porpoise.

275. 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. Based on this and as a precautionary approach, temporary impacts that could affect 5% or less of the population are not considered to have the potential to have long term significant impacts on the population. In assigning 5% to a temporary impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

276. Therefore, under these circumstances, there would be **no adverse effect on the integrity of the Southern North Sea SAC in relation to the conservation objectives for harbour porpoise, due to disturbance from piling during construction, for SEP or DEP in isolation**.

Table 8-20: Maximum Number of Harbour Porpoise Potentially Disturbed Based on 26km EDR for Piling for SEP or DEP in Isolation

Species	Location	Season and area in seasonal SNS SAC area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour porpoise	SEP	Summer (no overlap)	0	**No** Temporary effect. 0.54% or less of the reference population could be temporarily displaced during piling at SEP or DEP, based on the worst-case scenario.
		Winter ($0.15km^2$)	0.08 (0.000023% of NS MU) (SEP density of $0.52/km^2$)	
	DEP	Summer ($356km^2$)	865 (0.25% of NS MU) (DEP density of $2.43/km^2$)	
		Winter ($32.7km^2$)	28 (0.008% of NS MU) (DEP density of $0.85/km^2$)	
	SEP or DEP	$2,124km^2$	1,886 (0.54% of NS MU) (SCANS-III density of $0.888/km^2$)	

8.4.1.1.1.2 Assessment for SEP and DEP

8.4.1.1.1.2.1 Permanent Auditory Injury (PTS)

277. The maximum area of PTS from cumulative exposure during sequential piling at SEP and DEP in the same 24 hour period is 170km² (**Table 8-21**). The number of harbour porpoise that could be at risk of PTS, without mitigation, could be up to 248 in the summer period (0.07% of the NS MU), or up to 111 in the winter period (0.032% of the NS MU) (**Table 8-23**), based on SEP and DEP summer and winter density estimates for the entire survey area (**Table 8-5**).

278. The potential impact area of 170km² for sequential piling at SEP and DEP would not directly overlap with the SNS SAC winter or summer areas.

279. The maximum area of PTS from cumulative exposure during simultaneous piling at SEP and DEP is up to 260km² (**Table 8-22**). The number of harbour porpoise that could be at risk of PTS, without mitigation, could be up to 380 in the summer period (0.11% of the NS MU), or up to 169 in the winter period (0.05% of the NS MU) (**Table 8-23**), based on SEP and DEP summer and winter density estimates for the entire survey area (**Table 8-5**).

280. The potential impact area of 260km² for simultaneous piling at SEP and DEP would not directly overlap with the SNS SAC winter or summer areas.

Table 8-21: Predicted Impact Ranges (and Areas) for PTS From Cumulative Exposure During Sequential Piling at SEP and DEP

Species	Impact	Criteria and threshold (Southall *et al.*, 2019)	Location	Monopiles (5,500kJ)	Pin-piles (3,000kJ)
				Impact area (km²)	Impact area (km²)
Harbour porpoise (VHF)	PTS from cumulative SEL during sequential piling in same 24 hour period	SEL_{cum} Weighted (155 dB re 1µPa²s) Impulsive	SEP & DEP	170km²	Less than monopiles

Table 8-22: Predicted Impact Areas for PTS From Cumulative Exposure During Simultaneous Piling at SEP and DEP

Species	Impact	Criteria and threshold (Southall *et al.*, 2019)	Location	Monopile (16m diameter; 5,500kJ) at each site	Pin-pile (4m diameter; 3,000kJ) at each site	Pin-pile at SEP and monopile at DEP	Monopile at SEP and pin-pile at DEP
				Impact area (km²)	Impact area (km²)	Impact area (km²)	Impact area (km²)
Harbour porpoise	PTS from cumulative	SEL_{cum} Weighted	SEP & DEP	260km²	150km²	210km²	200km²

Species	Impact	Criteria and threshold (Southall *et al.*, 2019)	Location	Monopile (16m diameter; 5,500kJ) at each site	Pin-pile (4m diameter; 3,000kJ) at each site	Pin-pile at SEP and monopile at DEP	Monopile at SEP and pin-pile at DEP
				Impact area (km^2)	Impact area (km^2)	Impact area (km^2)	Impact area (km^2)
(VHF)	SEL during simultaneous piling	(155 dB re $1\mu Pa^2s$) Impulsive					

Table 8-23: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be at Risk of PTS for Monopile or Pin-Pile Installation Without Mitigation, Based on Worst-Case for SEP and DEP

Species	Criteria and threshold (Southall *et al.*, 2019)	Location	Season	Monopile (5,500kJ)	Pin-pile (3,000kJ)
PTS from Cumulative Exposure (SEL_{cum}) during Sequential piling of Monopiles (170km²) or Pin-piles at SEP & DEP					
Harbour porpoise (VHF) Weighted (155 dB re $1\mu Pa^2s$) Impulsive		SEP & DEP	Summer	248 (0.07% of NS MU) (SEP&DEP density of 1.46/km²)	Less than monopiles
			Winter	111 (0.03% of NS MU) (SEP&DEP density of 0.65/km²)	Less than monopiles
PTS from Cumulative Exposure (SEL_{cum}) during Simultaneous piling of Monopiles (260km²) or Pin-piles (150km²) at SEP & DEP					
Harbour porpoise (VHF) Weighted (155 dB re $1\mu Pa^2s$) Impulsive		SEP & DEP	Summer	380 (0.11% of NS MU) (SEP&DEP density of 1.46/km²)	219 (0.06% of NS MU) (SEP&DEP density of 1.46/km²)
			Winter	169 (0.05% of NS MU) (SEP&DEP density of 0.65/km²)	98 (0.03% of NS MU) (SEP&DEP density of 0.65/km²)

281. The effective implementation of the MMMP will reduce the risk of PTS to harbour porpoise during piling at SEP and DEP, therefore, there would be **no adverse effect on the integrity of the Southern North Sea SAC in relation to the conservation objectives for harbour porpoise, due to PTS from piling during construction, for SEP and DEP**.

8.4.1.1.1.2.2 Disturbance

8.4.1.1.1.2.2.1 Spatial Assessment

282. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC summer or winter area on any given day during piling at SEP and DEP, based on the worst-case scenario (**Table 8-24**). Therefore, under these circumstances, there is no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from piling during construction, for SEP and DEP**.

Table 8-24: Maximum Potential Overlap with SNS SAC Summer and Winter Areas Based on 26km EDR at Closest Point for SEP and DEP

Location	Maximum area of overlap with SNS SAC summer area (% of SNS SAC summer area)	Maximum area of overlap with SNS SAC winter area (% of SNS SAC winter area)	Potential adverse effect on site integrity
SEP and DEP	356km^2 (1.32%)	30.45km^2 (0.24%)	**No** Temporary effect. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area on any given day during piling at SEP and DEP, based on the worst-case scenario.

8.4.1.1.1.2.2.2 Seasonal average

283. The assessment indicates less than 10% of the seasonal component of the SNS SAC over the duration of that season could be affected during piling at SEP and DEP, based on the worst-case scenario (**Table 8-25**). Therefore, under these circumstances, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from piling during construction, for SEP and DEP**.

Table 8-25: Estimated Seasonal Average for SNS SAC Summer and Winter Areas Based on 26km EDR at Closest Point for SEP and DEP

Location	Number of disturbance days per season	Maximum seasonal average for SNS SAC summer area	Maximum seasonal average for SNS SAC winter area	Potential adverse effect on site integrity
SEP and DEP (53 foundation installations plus 4 days recovery)	57 days	0.41%	0.08%	**No** Temporary effect. Displacement of harbour porpoise would not exceed

Location	Number of disturbance days per season	Maximum seasonal average for SNS SAC summer area	Maximum seasonal average for SNS SAC winter area	Potential adverse effect on site integrity
				10% of the seasonal component of the SNS SAC over the duration of that season during piling at SEP and DEP, based on the worst-case scenario.

8.4.1.1.1.2.2.3 Assessment in relation to North Sea MU

284. During piling at SEP and DEP, the number of harbour porpoise that could be temporarily disturbed in the summer area of the SNS SAC is up to 865 (0.25% of NS MU) and the number in the winter area of the SNA SAC is up to 26 (0.0075% of NS MU) (**Table 8-26**).

285. As a worst-case scenario, the number of harbour porpoise that could be disturbed from the around SEP and DEP has been estimated based on a 26km EDR at each site (an area of 3,719.6km^2 for both sites together, taking into account overlap areas and overlap with land) and the SCANS-III density estimate of 0.888/km^2 for the wider area.

286. The assessment indicates that up to 0.95% of the North Sea MU reference population could be temporarily displaced during piling at SEP and DEP, based on the worst-case scenario (**Table 8-26**). The temporary disturbance of up to 0.95% of the North Sea MU population would not result in any significant population effects or any changes to the FCS of harbour porpoise. Therefore, under these circumstances, there is **no adverse effect on the integrity of the SNC SAC in relation to the conservation objectives for harbour porpoise due to disturbance from piling during construction, for SEP and DEP**.

Table 8-26: Maximum Number of Harbour Porpoise Potentially Disturbed Based on 26km EDR for Piling at SEP and DEP

Species	Location	Season and area in seasonal SNS SAC area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour porpoise	Total for SEP and DEP	Summer (356km^2)	865 (0.25% of NS MU) (SEP&DEP density of 1.46/km^2)	**No** Temporary effect. Up to 0.95% of the reference population could be temporarily
		Winter (30.45km^2)	26 (0.0075% of NS MU) (SEP&DEP	

Species	Location	Season and area in seasonal SNS SAC area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
			density of 0.65/km^2)	displaced during piling at SEP and DEP, based on the worst-case scenario.
	Wider area around SEP and DEP	3,719.6km^2	3,303 (0.95% of NS MU) (SCANS-III density of 0.888/km^2)	

8.4.1.1.2 Potential Effects of Underwater Noise during Other Construction Activities

8.4.1.1.2.1 Assessment for SEP or DEP in Isolation

287. Potential sources of underwater noise during construction activities, other than piling, include sea bed preparation, dredging, rock placement, drilling (if piling is refused at any location), trenching and cable installation.

288. Underwater noise modelling was undertaken to assess the impact ranges of construction activities, other than piling, on harbour porpoise, and this has been used to determine the potential area of effect (for further information see **ES Chapter 10 Marine Mammals** (document reference 6.1.10) and **ES Appendix 10.2 Underwater Noise Modelling** (document reference 6.3.10.2) for further details).

289. For SEL_{cum} calculations, the duration of noise is also considered, with all sources operating for a worst-case of 24 hours in any given 24-hour period for non-impulsive noise.

290. To account for the weightings required for modelling using the Southall *et al*. (2019) criteria, reductions in source level have been applied to the various noise sources (see **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) for further information).

291. The cumulative impact ranges are to the nearest 100m, however, they are likely to be less than 100m especially for PTS impact ranges.

292. The results of the underwater noise modelling (**Table 8-27**) indicate that harbour porpoise 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 based on the Southall *et al*. (2019) non-impulsive thresholds and criteria for SEL_{cum}. With the exception of the predicted impact ranges for TTS of 1km for rock placement and 0.2km for dredging.

293. PTS is unlikely to occur in harbour porpoise, as the modelling indicates that harbour porpoise would have to remain less than 100m for 24 hours in any given 24-hour period for any potential risk of PTS (**Table 8-27**). Therefore, PTS as a result of construction activity, other than piling, is highly unlikely and has not been further assessed.

294. There is the potential that more than one of these activities could be underway at either site or the export cable corridor area at the same time. As a worst-case and unlikely scenario, an assessment for all five activities has been undertaken (**Table 8-28**).

295. The maximum duration for the offshore construction period is up to two years for each Project. However, construction activities would not be underway constantly throughout this period. The duration of offshore export cable installation and trenching activities is expected to take approximately 60 days and 50 days for SEP and DEP, respectively.

296. The potential 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 periods for SEP and DEP and would be limited to only part of the overall construction period and area at any one time.

297. If the behavioural response is displacement from the area, it is predicted that harbour porpoise 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 impact on harbour porpoise.

298. As previously outlined, at the closest point, the DEP wind farm site is 13.9km from the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area and export cable corridors are 21.2km from the summer area and 18.4km from the winter area (**Table 8-4**). Therefore, there is no potential for any direct overlap with the SNS SAC for underwater noise from other construction activities.

299. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury (PTS or TTS) during construction (activities other than piling), for SEP or DEP in isolation**.

300. No additional mitigation is required or proposed for underwater noise for construction activities, other than piling.

Table 8-27 Predicted Impact Ranges (and Areas) for PTS and TTS From Cumulative Exposure of Other Construction Activities, Based on Southall et al. (2019) Thresholds and Criteria

Species	Impact	Criteria and threshold (Southall *et al.*, 2019)	Cable laying	Trenching	Rock placement	Drilling	Dredging	Total area for all activities
Harbour porpoise (VHF)	PTS	SEL_{cum} Weighted (173 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	0.15km²
	TTS	SEL_{cum} Weighted (153 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)	**1km (3.14km²)**	<0.1km (<0.03km²)	**0.2km (0.13km²)**	**3.36km²**

Table 8-28 Maximum Number of Harbour Porpoise (and % of Reference Population) That Could Be Affected 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 SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL (3.36km^2), based on 24 hour exposure, for: - Cable laying - Trenching - Drilling - Rock placement - Dredging	Harbour porpoise (VHF)	SEP or DEP	5 (0.0014% of NS MU) (SEP, DEP & cable export area summer density of 1.46/km^2)	**No** Temporary effect. Up to 0.0014% of the reference population could be affected during other construction activities at SEP or DEP, based on the worst-case scenario for TTS SEL_{cum}.

8.4.1.1.2.2 Assessment for SEP and DEP

301. As a worst-case, the maximum number of harbour porpoise that could be impacted if SEP and DEP are both developed has been assessed (**Table 8-29**).

Table 8-29: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be Affected 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 SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL (6.72km^2), based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging	Harbour porpoise (VHF)	SEP & DEP	10 (0.003% of NS MU) (SEP, DEP & cable export area summer density of 1.46/km^2)	**No** Temporary effect. Up to 0.003% of the reference population could be affected during other construction activities at SEP and DEP, based on the worst-case scenario for TTS SEL_{cum}.

302. The maximum duration of offshore construction, including piling and export cable installation, is up to two years for each Project, therefore four years for SEP and DEP. However, construction activities would not be underway constantly throughout this period. The duration of offshore export cable installation and trenching activities is expected to take approximately 100 days for SEP and DEP.

303. There is no potential for any direct overlap with the SNS SAC for underwater noise from other construction activities at SEP and DEP. There would be **no adverse effect on the integrity of the SNC SAC in relation to the conservation objectives for harbour porpoise due to auditory injury (PTS or TTS) during construction (activities other than piling), for SEP and DEP**.

304. No additional mitigation is required or proposed for underwater noise from construction activities, other than piling.

8.4.1.1.3 Potential Effects of Underwater Noise and Disturbance from Construction Vessels

8.4.1.1.3.1 Assessment for SEP or DEP in Isolation

305. As previously outlined, at the closest point, the DEP wind farm site is 13.9km from the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area and export cable corridors are 21.2km from the summer area and 18.4km from the winter area (**Table 8-4**). Therefore, there is no potential for any direct overlap with the SNS SAC for underwater noise and the presence of vessels.

306. 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 SEP and DEP wind farm sites and offshore cable corridors.

307. The results of the underwater noise modelling (**Table 8-30**) indicate that harbour porpoise would have to be less than 100m (precautionary maximum range) from the vessel for 24 hours, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al*. (2019) thresholds and criteria. Therefore, PTS as a result of underwater noise from construction vessels is highly unlikely and has not been assessed further.

Table 8-30: Predicted Impact Ranges (and Areas) for PTS and TTS from Cumulative Exposure of Construction Vessels, Based on Southall et al. (2019) Thresholds and Criteria

Species	Impact	Criteria and threshold (Southall *et al*., 2019)	Large vessel	Medium vessel
Harbour porpoise (VHF)	PTS	SEL_{cum} Weighted (173 dB re 1 µPa^{2}s) Non-impulsive	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)
	TTS	SEL_{cum} Weighted (153 dB re 1 µPa^{2}s) Non-impulsive	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)

308. The number of harbour porpoise that could be impacted from TTS as a result of underwater noise during construction from vessels has been assessed based on the maximum impact area for large and medium sized vessels, for up to 16 vessels at each offshore site (an area of 0.48km^2 at each offshore site; **Table 8-31**).

309. Disturbance from vessel noise could occur where increased noise from construction vessels associated is greater than the background ambient noise.

310. 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).

311. Studies in the Moray Firth indicate that at a mean distance 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).

312. During the periods when piling is underway, vessel noise is unlikely to add an additional impact to those assessed for piling, as the vessels and vessel noise would be within the maximum impact areas assessed.

313. 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.

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

315. Taking into account the maximum number of vessels that could be onsite during construction, the site area and the displacement of other vessels from the area, the number of vessels would not exceed the Heinänen and Skov (2015) threshold level of 80 vessels per day in a $5km^2$ area for harbour porpoise.

316. For example, 16 vessels in either the SEP or DEP wind farm sites ($97.0km^2$ and $114.8km^2$ respectively) would equate to less than 0.2 vessels per km^2 (approximately one vessel per $5km^2$). In addition, due to safety and logistical considerations during piling, it is likely that the number of vessels in a small area, for example, around a pile location during pile installation would be limited to a very low number of essential vessels only.

317. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project. Therefore, it is assumed that construction vessels could be at either the SEP or DEP offshore site for up to two years.

318. If the behavioural response is displacement from the area, it is predicted that harbour porpoise will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance of harbour porpoise.

319. There would be **no adverse effect on the integrity of the SNC SAC in relation to the conservation objectives for harbour porpoise due to auditory injury (PTS or TTS) during construction (disturbance from construction vessels) for SEP or DEP in isolation**.

320. No additional mitigation is required or proposed for underwater noise from construction vessels.

Table 8-31: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be Affected as a Result of Underwater Noise Associated with all Construction Vessels at SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for all vessels	Potential adverse effect on site integrity
TTS from cumulative SEL (0.48km^2), based on 24 hour exposure for 16 large or medium vessels	Harbour porpoise (VHF)	SEP or DEP	0.7 (0.0002% of NS MU) (SEP, DEP & cable export area summer density of 1.46/km^2)	**No** Temporary effect. Up to 0.0002% of the reference population could be temporarily affected due to construction vessels at SEP or DEP, based on TTS SEL_{cum}.

8.4.1.1.3.2 Assessment for SEP and DEP

321. As a worst-case, the maximum number of harbour porpoise has been assessed to indicate the maximum number that could be impacted by vessels from SEP and DEP, if they are developed concurrently (**Table 8-32**). The assessment is based on up to 25 vessels on both sites at the same time (an area of 0.75km^2).

Table 8-32 Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be Affected as a Result of Underwater Noise Associated with Construction Vessels Based on Underwater Noise Modelling for all Vessels at SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for TTS for all vessels	Potential adverse effect on site integrity
TTS from cumulative SEL (0.75km^2), based on 24 hour exposure, for 25 large or medium vessels	Harbour porpoise (VHF)	SEP & DEP	1.1 (0.00032% of NS MU) (SEP, DEP & cable export area summer density of 1.46/km^2)	**No** Temporary effect. Up to 0.00032% of the reference population could be temporarily affected due to all

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for TTS for all vessels	Potential adverse effect on site integrity
				construction vessels at SEP and DEP, based on TTS SEL_{cum}.

322. As outlined above, there is no potential for any direct overlap with the SNS SAC for underwater noise and the presence of vessels. If the behavioural response is displacement from the area, it is predicted that harbour porpoise will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance of harbour porpoise.

323. There would be **no adverse effect on the integrity of the SNC SAC in relation to the conservation objectives for harbour porpoise due to auditory injury (PTS or TTS) during construction (disturbance from construction vessels), for SEP and DEP**.

324. No additional mitigation is required or proposed for underwater noise from construction vessels.

8.4.1.1.4 Potential Barrier Effects from Underwater Noise

8.4.1.1.4.1Assessment for SEP or DEP In Isolation

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

326. The greatest potential barrier effect for harbour porpoise could be from underwater noise during piling. However, 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.

327. The maximum duration of any barrier effects would be for the maximum piling duration at SEP and DEP, based on worst-case scenarios.

328. There is unlikely to be the potential for any barrier effects from underwater noise for other construction activities and vessels, as it is predicted that harbour porpoise 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 harbour porpoise.

329. Harbour porpoise are wide ranging. Therefore, if there are any potential temporary barrier effects from underwater noise during construction, harbour porpoise would be able to compensate by travelling to other foraging areas within their range. 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 harbour porpoise and would not be continuous throughout the offshore construction period.

330. The worst-case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area and longest duration) scenarios.

331. The spatial worst-case is the maximum area over which potential disturbance could occur at any one time. This would be the potential disturbance of harbour porpoise based on a 26km EDR for a single monopile installation at SEP or DEP. SEP and DEP are located 15.8km and 26.5km from the coast, respectively, therefore with the exception of very nearshore activities, any other construction activities, including vessels, in the export cable corridor would be within the 26km EDR.

332. The SEP wind farm site has an area of 97.0km^2, with an offshore export cable corridor area of approximately 26.7km^2. Therefore, the 2,124km^2 area for the 26km EDR at SEP would cover the SEP wind farm site plus the export cable corridor area. DEP has an area of 114.8km^2, with an estimated export cable corridor area of approximately 96.8km^2. Therefore, the 2,124km^2 area for the 26km EDR at DEP would cover DEP wind farm site and the export cable corridor.

333. As a result, there would be no additional disturbance of harbour porpoise from construction noise sources at SEP or DEP in addition to the 26km EDR. This would include ADD activation which would also be within the 26km EDR.

334. As outlined above, at the closest point, the DEP wind farm site is 13.9km from the SNS SAC summer area (26km EDR has a maximum overlap of 356km^2 (1.32%)) and is 18.9km from the SNS SAC winter area (26km EDR has a maximum overlap of 32.7km^2 (0.26%)). The SEP wind farm site is 25.6km from the SNS SAC winter area (26km EDR has a maximum overlap of 0.15km^2 (0.0012%)) and is 31.1km from the SNS SAC summer area (no overlap). The export cable corridors are 21.2km from the summer area and 18.4km from the winter area. Therefore, there is no potential for any direct barrier effects from underwater noise in the SNS SAC.

335. There would be no significant barrier effects to harbour porpoise during construction for SEP or DEP in isolation and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to barrier effects from underwater noise during construction, for SEP or DEP in isolation.**

336. A SIP for the SNS SAC will be developed to set out the approach to deliver any project mitigation or management measures in relation to the significant disturbance of harbour porpoise (**Section 8.3.1.2**). Any measures to reduce the potential significant disturbance of harbour porpoise would also reduce the potential for any barrier effects as a result of underwater noise.

8.4.1.1.4.2 Assessment for SEP and DEP

337. As assessed for SEP or DEP in isolation, there would be no significant barrier effects to harbour porpoise during construction of SEP and DEP and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential barrier effects from underwater noise during construction for SEP and DEP.**

8.4.1.1.5 Potential Effects of Any Increased Collision Risk with Construction Vessels

8.4.1.1.5.1 Assessment for SEP or DEP In Isolation

338. During the offshore construction phase of SEP and DEP there will be an increase in vessel traffic within and on transit to the offshore sites. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

339. The approximate number of vessels on site at any one time during construction is estimated to be 16 vessels at SEP or DEP, with an average of approximately 25 trips per month, resulting in a daily average of approximately 0.83 vessel movements, based on 603 vessel trips over a two year construction period.

340. The baseline conditions indicate an already relatively high level of shipping activity in and around the offshore sites. Shipping and navigation data indicate 14 existing main routes within the study area, with two routes overlapping the SEP wind farm site, four routes intersecting the DEP wind farm site and 10 intersecting the offshore export cable corridor. The number of vessels on these main vessel routes could be up to 75 vessels per day.

341. As described within the **ES Appendix 13.1 Navigational Risk Assessment** (document reference 6.3.13.1) there is an existing relatively high level of vessel traffic within the navigational study area (SEP and DEP plus 10km buffer), including area close to the coastline. In summer, an average of 82 vessels were recorded per day within the study area, and in winter an average of 81 vessels were recorded.

342. In total, for the construction of either SEP or DEP, the daily construction vessels trips, represents a very small increase of 1% compared to average daily vessels (n=82, in summer) currently within the SEP and DEP vessel and navigation study area, or an increase of 0.95% compared to the average daily vessels present in winter (n=81).

343. Harbour porpoise are small and highly mobile and given their responses to vessel noise (e.g. Thomsen *et al*., 2006; Evans *et al*., 1993; Polacheck and Thorpe, 1990), are expected to largely avoid vessel collisions. The Heinänen and Skov (2015) report indicates a negative relationship between the number of ships and the distribution of harbour porpoise in the North Sea, suggesting that the species could exhibit avoidance behaviour which reduces the risk of strikes.

344. 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).

345. 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). There is currently limited information on the collision risk of marine mammals in the SNS area.

346. Although the risk of collision is likely to be low, as a precautionary worse-case scenario, the number of harbour porpoise that could be at increased collision risk with vessels during construction has been assessed based on 5% of the number of individuals that could be present in the SEP wind farm site, DEP wind farm site and export cable corridor areas potentially being at increased collision risk (**Table 8-33**). This has been based on the percentage of harbour porpoise post mortem examinations in the ASCOBANS area with evidence of interaction with vessels.

347. Permanent effects (i.e. assuming all vessel interactions are fatal) with a greater than 1% of the reference population being affected within a single year are considered to have the potential to result in population effects. 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 less than 1% of the population (Defra, 2003; ASCOBANS, 2015).

348. As a worst-case, up to 0.008% of the North Sea MU reference population could be at increased collision risk with vessels (**Table 8-33**). Therefore, this is not predicted to result in any significant population effects or any changes to the conservation status of harbour porpoise.

349. This is a highly precautionary approach, as it is unlikely that harbour porpoise present in the SEP wind farm site, DEP wind farm site and export cable corridor areas would be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number vessel movements in the area and that vessels within the wind farm sites and export cable corridor areas would be stationary or very slow moving. In addition, based on the assumption that harbour porpoise would be disturbed as a result of the vessel noise and presence, there should be no potential for increased collision risk with construction vessels.

350. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to 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 (see the **Draft MMMP** (document reference 9.4)).

351. Taking into account the limited potential for increased collision risk with vessels during construction, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to increased collision risk with construction vessels for SEP or DEP in isolation.**

Table 8-33: Estimated Number of Harbour Porpoise (and % of Reference Population) That Could be at Increased Collision Risk with Construction Vessels, based on 5% of Individuals Present in SEP and / or DEP and Export Cable Corridors

Species	Location (impact area)	5% Vessel Collision Risk	
		Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour porpoise	SEP wind farm site and export cable corridor (160.8km^2)	5.1 (0.0015% of NS MU) (SEP summer density of 0.63/km^2)	**No** Up to 0.0074% of the reference population could be at increased collision risk with vessels at SEP or DEP.
	DEP wind farm site and export cable corridor (211.6km^2)	25.7 (0.0074% of NS MU) (DEP summer density of 2.43/km^2)	
	SEP & DEP wind farm sites and export cable corridor (372.4km^2)	27.9 (0.008% of NS MU) (SEP, DEP & cable route summer density of 1.46/km^2)	**No** Up to 0.008% of the reference population could be at increased collision risk with vessels at SEP and DEP.

8.4.1.1.5.2 Assessment for SEP and DEP

352. As a precautionary worst-case, the number of marine mammals that could be at increased risk of collision with construction vessels, if SEP and DEP are both constructed has been based on the estimated maximum number for SEP or DEP in isolation multiplied by two (**Table 8-33**).

353. As for SEP or DEP in isolation, there would be limited potential for increased collision risk with vessels during construction and therefore **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to increased collision risk with construction vessels for SEP and DEP.**

8.4.1.1.6 Potential Effects of any Changes to Water Quality

8.4.1.1.6.1 Assessment for SEP or DEP In Isolation

354. Disturbance of sea bed sediments has the potential to release any sediment-bound contaminants, such as heavy metals and hydrocarbons that may be present within them into the water column. The accidental release of contaminants (e.g. through spillage) also has the potential to affect water quality. During construction there is also the potential for increased suspended sediments.

355. Throughout the construction phase, best practice techniques and due diligence regarding the potential for pollution will be followed throughout all construction activities. Any risk of accidental release of contaminants (e.g. through spillage) will be mitigated in line with the PEMP and any changes to water quality as a result of any accidental release of contaminants (e.g. through spillage or vessel collision) would be negligible. Therefore, the potential for pollutants to be released into the environment is not considered further in this assessment.

356. As outlined in the **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7), during construction there is the potential for the deterioration of water quality through:

- Increase in suspended sediment through sea bed preparation;
- Increase in suspended sediment associated with drill arisings for foundation installation of piled foundations;
- Increase in suspended sediment during export cable installation;
- Increase in suspended sediment during offshore cable installation (infield and interlink cables); and
- Due to the release of contaminated sediment during construction activities.

357. Harbour porpoise often inhabit turbid environments and utilise sonar to sense the environment around them and there is little evidence that turbidity affects harbour porpoise directly (Todd *et al*., 2014). Increased turbidity is unlikely to have a substantial direct effect on harbour porpoise that often inhabit naturally turbid or dark environments.

358. Any direct impacts to harbour porpoise as a result of any contaminated sediment during construction activities are unlikely as any exposure is more likely to be potential indirect impacts via prey species.

359. It is highly unlikely that any changes in water quality could occur over the entirety of the offshore sites during construction. It is more likely that effects would be restricted to an area around the working sites as the potential increase in suspended sediments through construction activities will be localised and temporary.

360. The potential changes in water quality have been assessed as negligible in **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Sediment contamination levels in the surveyed area are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment.

361. Due to the limited range and short duration of the potential effects, the effect on harbour porpoise would be negligible.

362. No additional mitigation is required or proposed, other than the embedded mitigation outlined in **Table 8-11**.

363. The array sites and cable corridor for SEP and DEP are outside the SAC and therefore there will be no direct effect on the spatial or seasonal components of the SNS SAC from any changes in water quality.

364. Potential changes in water quality would have a negligible effect on harbour porpoise and therefore there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in water quality during construction for SEP or DEP in isolation.**

8.4.1.1.6.2 Assessment for SEP and DEP

365. The effects from SEP and DEP would be the same as those assessed for SEP or DEP in isolation, with negligible effects on harbour porpoise. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in water quality during construction for SEP and DEP.**

8.4.1.1.7 Potential Effects of Any Changes in Prey Availability

8.4.1.1.7.1 Assessment for SEP or DEP In Isolation

366. The potential effects on prey species during construction can result from physical disturbance and loss of sea bed habitat; increased suspended sediment concentrations (SSC) and sediment re-deposition; and underwater noise. **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. 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 SEP and DEP would result in detectable changes to harbour porpoise populations.

367. The diet of the harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources (for more information see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)). Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet their daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*., 1997).

8.4.1.1.7.1.1 Physical Disturbance and Temporary Habitat Loss

368. During construction, activities such as foundation installation (for wind turbines and OSPs), sea bed preparation (including sandwave levelling, boulder removal and UXO clearance), the trenching and burial of cables, cable protection, vessel moorings and jack-up vessel legs all have the potential to cause physical disturbance or temporary loss of sea bed habitat.

369. The disturbance would be temporary during the approximate two years (24 months) of construction activity at each site with the majority of disturbance occurring during installation of foundations and cables. Some elements of disturbance, such as that caused by jack-up vessel legs, will be highly localised and only occur over a short period.

370. The magnitude of effect of physical disturbance to sea bed habitat during construction has been assessed as low for SEP and DEP in **ES Chapter 8 Benthic Ecology** (document reference 6.1.8). In **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9) the magnitude of physical disturbance during construction activities for either SEP or DEP is considered to be negligible for all species. This is based on the availability of similar suitable habitat both in the offshore sites and in the wider context of the southern North Sea together with the intermittent and reversible nature of the effect, meaning physical disturbance during construction activities for the either SEP or DEP is considered to be negligible.

371. As previously outlined, at the closest point the DEP wind farm site is 13.9km from the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area and export cable corridors are 21.2km from the summer area and 18.4km from the winter area. Therefore, there is no potential for any physical disturbance and loss of sea bed habitat in the SNS SAC.

372. Any potential changes to prey availability as a result of physical disturbance and temporary habitat loss would have **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability during construction (from physical disturbance and temporary habitat loss) for SEP or DEP in isolation.**

8.4.1.1.7.1.2 Increased Suspended Sediments and Sediment Deposition

373. 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 SSC and low changes in sea bed level when the sediments are deposited.

374. As previously outlined, at the closest point the DEP wind farm site is 13.9km for the SNS SAC summer area, the SEP wind farm site is 25.6km from the SNS SAC winter area and export cable corridors are 21.2km from the summer area and 18.4km from the winter area. Therefore, there is no potential for any increased SSC in the SNS SAC.

375. Any potential changes to prey availability as a result of increased SSC and sediment deposition is assessed as negligible and would have **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability during construction (from increased suspended sediments and sediment deposition) for SEP or DEP in isolation.**

8.4.1.1.7.1.3 Re-Mobilisation of Contaminated Sediment

376. The data and analysis in **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7) indicates that levels of contaminants within the SEP and DEP offshore sites are very low and do not contain elevated levels to cause concern.

377. Therefore, any potential changes to prey availability as a result of re-mobilisation of contaminated sediments is assessed as negligible and would have **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability during construction (due to re-mobilisation of contaminated sediment) for SEP or DEP in isolation.**

8.4.1.1.7.1.4 Underwater Noise

378. **Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of the potential underwater noise impacts on fish and shellfish species and predicts that impacts would be of low magnitude and a temporary nature. See that chapter for a detailed assessment of underwater noise impacts on fish species. Potential sources of underwater noise and vibration during construction include piling, increased vessel traffic, sea bed 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. Note, UXO clearance is not part of the DCO application and will be assessed within a separate Marine Licence application post-consent.

379. The underwater noise modelling (**ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2)) indicates that fish species in which the swim bladder is involved in hearing are the most sensitive to the impact of underwater noise.

380. The maximum predicted cumulative impact range for TTS of 19km for fish species based on a stationary model (**ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2)), is the same as TTS SEL_{cum} range for harbour porpoise. However, it is important to note that the SEL_{cum} modelling for fish is based on a stationary model. This is considered to be a highly precautionary approach, as it is unlikely that an individual would remain within the vicinity of the high noise levels.

381. Therefore, modelling assuming a fleeing animal in response to noise, especially fish with a swim bladder involved in hearing, is more realistic and therefore has been used to assess the potential impact on marine mammals.

382. The maximum predicted cumulative impact range for TTS of 12km for fish species based on the fleeing response model, is less than the TTS SEL_{cum} range of 19km for harbour porpoise (**ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2)). This is the largest potential impact range for prey (fish) species, and has therefore been used to inform the below worst-case and precautionary assessment. This assessment assumes that all harbour porpoise within the largest impact area for fish (as noted above) would be at risk of a reduction in prey availability, due to the prey (fish) species themselves being potentially affected within that area.

383. As a precautionary approach, the number of harbour porpoise that could be impacted as a result of any changes in prey availability has been assessed based on the worst-case for TTS SEL_{cum} for fish species with a swim bladder involved in hearing, using the more realistic fleeing response model (up to 210km^2 at SEP and 330km^2 at DEP; **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2); **Table 8-34**). However, it is highly unlikely that there would be significant changes to prey over the entire area. It is more likely that effects would be restricted to an area around the working sites.

384. There is unlikely to be any additional displacement of harbour porpoise as a result of any changes in prey availability during piling as harbour porpoise would also be disturbed from the area.

Table 8-34: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be Affected as a Result of Changes in Prey Availability During Construction at SEP or DEP

Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Changes in prey availability	SEP (210km^2)	132.3 (0.04% of NS MU) (SEP summer density of 0.63/km^2)	**No** Temporary effect. Up to 0.23% of the reference population could be temporarily
	DEP (330km^2)	802 (0.23% of NS MU) (DEP summer density of 2.43/km^2)	

Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
			displaced due to any changes in prey availability during construction at SEP or DEP.

385. This means that, under the precautionary assumptions of this assessment, up to 802 harbour porpoise (or 0.23% of the NS MU) could be at risk of a reduced (or removed) potential to forage within that area. More realistically, however, the reduction of prey (fish) species availability would not be for all fish within that area, and harbour porpoise would be able to forage within that area still, or, would be able to travel outside of that area to forage, with no reduction or impact to the overall population anticipated.

386. Mitigation 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.

387. Taking into account that the closest point of the DEP wind farm site is 13.9km from the SNS SAC summer area and 19.1km from the winter area, and the SEP wind farm site is 25.6km from the SNS SAC winter area and that export cable corridors are 21.2km from the summer area and 18.4km from the winter area. The maximum predicted cumulative impact range for TTS of 12km for fish species based on the fleeing response model, would not overlap directly with the SNS SAC.

388. The temporary displacement of up to 0.23% of the North Sea MU population (**Table 8-34**) would not result in any significant population effects or result in any changes to the FCS of harbour porpoise.

389. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes to prey availability (from underwater noise effects) for SEP or DEP in isolation.**

8.4.1.1.7.2 Assessment for SEP and DEP

390. As a worst-case, the maximum number of harbour porpoise from each Project has been assessed to indicate the impact as a result of potential changes in prey availability from underwater noise during piling if SEP and DEP are developed concurrently (**Table 8-35**).

Table 8-35: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be Impacted as a Result of Changes in Prey Availability During Construction at SEP and DEP

Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Changes in prey availability	SEP & DEP	934.2 (0.27% of NS MU)	**No** Temporary effect.

Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
			Up to 0.27% of the reference population could be temporarily displaced due to any changes in prey availability during construction at SEP and DEP.

391. The temporary displacement of up to 0.27% of the North Sea MU population (**Table 8-35**) would not result in any significant population effects or any changes to the FCS of harbour porpoise.

392. Taking into account the distances of SEP and DEP from the SNS SAC and the number of harbour porpoise potentially affected by changes in prey availability assessed as a result of underwater noise during piling at SEP and DEP, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise for SEP and DEP.**

8.4.1.2 Potential Overall Effects during Construction

8.4.1.2.1 Potential Overall Effects during Pilling

393. The assessment of potential underwater noise and barrier effects during piling represents the worst-case scenario for underwater noise. Any additive effects from other construction activities and vessels within the offshore sites would be within the maximum potential impact range of piling activities.

394. There would therefore be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise from potential overall effects during piling for SEP and DEP.

8.4.1.2.2 Potential Overall Effects during other Construction Activities

395. There would be no further overall effects in relation to the conservation objectives for harbour porpoise during construction other than those assessed above for SEP and DEP, as the potential disturbance from underwater noise during other construction activities has been based on the maximum potential impact area, which would include any potential disturbance from vessels associated with these activities, any changes in prey availability, vessel collision risk and water quality.

8.4.1.3 Potential Effects during Operation and Maintenance

8.4.1.3.1 Potential Effects of Underwater Noise from Operational Turbines

396. The operational turbines will operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The SEP and DEP design life is 40 years. Therefore, there is concern that underwater noise from operational turbines could contribute a consistent, long duration of sound to the marine environment.

397. However, the underwater noise levels emitted during the operation of wind 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 turbine (Tougaard *et al*., 2009a; Sigray and Andersson, 2011).

398. Measurements made at three different wind turbines in Denmark and Sweden at ranges between 14m and 40m from the turbine foundations found that the sound generated due to turbine operation was only detectable over underwater ambient noise at frequencies below 500Hz (Tougaard *et al*., 2009a).

399. Tougaard *et al*. (2020) reviewed the available measurements of underwater noise from different wind turbines during operation and found that source levels were at least 10–20 dB lower than ship noise in the same frequency range. A simple multi-turbine model indicated that cumulative noise levels could be elevated up to a few kilometres from a wind farm under very low ambient noise conditions. However, the noise levels were well below ambient levels unless very close to the individual turbines in locations with high ambient noise from shipping or high wind speeds (Tougaard *et al*., 2020).

400. There is the potential for larger operational wind turbines to have greater noise levels compared to the smaller wind turbines currently in operation (Stöber and Thomsen, 2021). This increase in size of operational wind turbines at SEP and DEP has been taken into account in the underwater noise modelling (see **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2)).

401. As outlined in **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2), noise measurements made at operational wind farms have demonstrated that the operational noise produced was at such a low level that it was difficult to measure relative to background noise at distances of a few hundred metres.

402. Currently available data indicate that there is no lasting disturbance or exclusion of harbour porpoise around wind farm sites during operation (Diederichs *et al*., 2008; Scheidat *et al*., 2011; Tougaard *et al*., 2005, 2009a, 2009b). Data collected suggests that any behavioural responses in harbour porpoise may only occur up to a few hundred metres away (Touggard *et al*., 2009b).

403. 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.

404. Harbour porpoise have been shown to forage within operational wind farm sites (e.g. Lindeboom *et al*., 2011), indicating no restriction to movements in operational OWF sites.

405. The results of the underwater noise modelling (**Table 8-36**) indicate that harbour porpoise would have to be less than 100m (precautionary maximum range) for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS based on the Southall *et al*. (2019) non-impulsive thresholds and criteria for SEL_{cum}. Therefore, PTS as a result of operational wind turbine noise, is highly unlikely and has not been assessed further.

Table 8-36: Predicted Impact Ranges (and Areas) for PTS and TTS from Cumulative Exposure of Operational Turbines

Species	Impact	Criteria and threshold (Southall *et al*., 2019)	Operational wind turbine (18+ MW)
Harbour porpoise (VHF)	PTS	SEL_{cum} Weighted (173 dB re 1 µPa^{2}s) Non-impulsive	<0.1km (<0.03km^2)
	TTS	SEL_{cum} Weighted (153 dB re 1 µPa^{2}s) Non-impulsive	<0.1km (<0.03km^2)

406. As a precautionary approach, the number of harbour porpoise that could be affected has been assessed for the number of wind turbines at SEP and DEP, based on worst-case for TTS SEL_{cum} (**Table 8-37**).

407. The indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.05km (maximum of 3.3km) therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine.

Table 8-37: Maximum Number of Harbour Porpoise (and % of Reference Population) That Could be Affected from Cumulative Exposure for All Operational Turbines at SEP and DEP

Species	Location	Operational Turbines	
		Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour porpoise	SEP (up to 23 wind turbines; 0.69km^2)	0.43 (0.00013% of NS MU) (SEP summer density of 0.63/km^2)	**No** Up to 0.00076% of the reference population could be affected due to underwater noise from operational turbines at SEP and DEP, based on TTS SEL_{cum}.
	DEP (up to 30 wind turbines; 0.90km^2)	2.19 (0.00063% of NS MU) (DEP summer density of 2.43/km^2)	
	SEP & DEP (up to 53 wind turbines; 1.59km^2)	2.62 (0.00076% of NS MU)	

408. Long-term effects such as the potential disturbance as a result of underwater noise from operational wind turbines during the lifetime of the Projects is considered to have possible population effects if between 1% and 5% of the reference population are anticipated to be exposed to the effect. This is based on permanent effects with a greater than 1% of the reference population being affected within a single year having the potential to result in population effects and that temporary impacts that affect 5% or less of the population are not considered to have the potential to have long term significant impacts on the population.

409. Up to 0.00076% of the North Sea MU reference population could be affected due to underwater noise from operational turbines at SEP and DEP, based on worst-case for TTS SEL_{cum}. Therefore, any potential effects would not result in any significant population effects or any changes to the FCS of harbour porpoise.

410. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to underwater noise effects from operational turbines for SEP and / or DEP.**

411. No additional mitigation is required or proposed.

8.4.1.3.2 Potential Effects of Underwater Noise during Operation and Maintenance Activities

412. The requirements for any potential maintenance work, such as additional rock placement or cable re-burial, are currently unknown, however the work required, and associated impacts would be less than those during construction.

413. The impacts from additional cable laying and protection are temporary in nature and will be limited to relatively short periods during the operational 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.

414. The underwater noise from maintenance activities are considered to be the same or less than those assessed for underwater noise from other construction activities (including rock placement, trenching and cable laying).

415. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to underwater noise and disturbance effects from operation and maintenance activities for SEP and / or DEP.**

416. No additional mitigation is required or proposed.

8.4.1.3.3 Potential Effects of Underwater Noise and Disturbance from Operation and Maintenance Vessels

417. The requirements for any potential maintenance work are currently unknown, however the work required, and impacts associated with underwater noise and disturbance from vessels during operation and maintenance would be less than those during construction.

418. 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 seven, which is considerably less than the 16 vessels that could be on site at SEP or DEP during construction. However, as a precautionary approach the assessment for construction has been used for the operational and maintenance assessment, as a worst-case scenario.

419. For the operation of either SEP or DEP, there could be up to 604 vessel trips per year (see **Chapter 4 Project Description** (document reference 6.1.4)) (approximately 1.65 trips per day), representing an increase of up to 2% compared to average daily vessels (n=82, in summer) currently within the SEP and DEP vessel and navigation study area, or an increase of up to 2% compared to the average daily vessels present in winter (n=81).

420. The potential impacts for underwater noise and disturbance from operation and maintenance vessels at SEP and DEP would be less than the assessment for construction vessels. However, the assessment for construction vessels has been used for the assessment for operation and maintenance vessels as a precautionary and worst-case scenario.

421. The underwater noise from maintenance vessels are considered to be the same or less than those assessed for underwater noise from construction vessels.

422. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to underwater noise and disturbance effects from operation and maintenance vessels for SEP and / or DEP.**

423. No additional mitigation is required or proposed.

8.4.1.3.4 Potential Barrier Effects from Underwater Noise during Operation and Maintenance

424. No barrier effects as a result of underwater noise during operation and maintenance are anticipated.

425. The indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.05km (maximum of 3.3km) 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 sites.

426. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to barrier effects from increased underwater noise during operation and maintenance of SEP and / or DEP**.

427. No additional mitigation is required or proposed.

8.4.1.3.5 Potential Effects of Any Increased Collision Risk with Operation and Maintenance Vessels

428. 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 seven at SEP or DEP, which is less than the 16 vessels that could be on site during the construction periods. However, as a precautionary approach, the assessment for operational and maintenance collision risk has been based on the collision risk impact assessment for the construction phase, as a worst-case. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

429. The assessment of collision risk, as presented for the construction phase (**Section 8.4.1.1.5**), is based on the total project area, within which additional vessels may be present, and is not based on the number of vessels present within that area. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

430. The potential impacts for underwater noise and disturbance from operation and maintenance vessels at SEP and DEP would be the same as the assessment for construction vessels. However, the assessment for construction vessels has been used for the assessment for operation and maintenance vessels as a precautionary and worst-case scenario.

431. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to increased collision risk from operation and maintenance vessels for SEP and / or DEP.**

8.4.1.3.6 Potential Effects of any Changes to Water Quality during Operation and Maintenance

432. Throughout the operation and maintenance phase, due diligence and best practice techniques regarding the potential for pollution will be followed throughout the required activities. The PEMP will include the embedded mitigation measures regarding best practice techniques to avoid the accidental release of contaminants (**Table 8-11**). Any risk of accidental release of contaminants (e.g. through spillage) will be mitigated in line with the PEMP and any changes to water quality as a result of any accidental release of contaminants (e.g. through spillage or vessel collision) would be negligible.

433. During operation and maintenance disturbance of sea bed sediments will be localised to specific foundations or sections of cable and considerably less than that during construction phase.

434. Potential changes in water quality during operation and maintenance include:

- Increase in suspended sediment due to scouring effects;

- Increase in suspended sediment due to cable repairs / reburial and maintenance vessel footprints; and
- The resuspension of contaminated sediment due to scouring effects and maintenance activities.

435. Changes in water quality are considered to have negligible effect on marine mammals. As assessed in **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7), any potential changes in water quality at SEP and / or DEP during operation and maintenance would be negligible.

436. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of any changes to water quality during operation and maintenance for SEP and / or DEP**.

437. No additional mitigation is required or proposed, other than the embedded mitigation outlined in **Table 8-11**.

8.4.1.3.7 Potential Effects of Any Changes in Prey Availability during Operation and Maintenance

438. The potential impacts on fish species during operation and maintenance can result from:

- Temporary habitat loss / disturbance
- Permanent habitat loss;
- Introduction of wind turbine foundations, scour protection and hard substrate;
- Increased suspended sediments and sediment re-deposition;
- Re-mobilisation of contaminated sediments;
- Underwater noise; and
- Electromagnetic fields (EMF).

439. Any impacts on prey species have the potential to affect marine mammals.

8.4.1.3.7.1 Temporary Habitat Loss / Disturbance

440. Certain activities during operation will result in the temporary disturbance of the sea bed and effect prey species. This includes any requirement for use of jack-up vessels or anchoring, as well as cable reburial and/or repairs.

441. Effects on prey will be on a considerably smaller scale and at a much lower frequency than those assessed in relation to construction. As such, the potential magnitude of effect has been assessed negligible to low, depending on the prey species.

442. Therefore, any potential changes to prey availability as a result of physical disturbance and temporary habitat loss would be negligible for harbour porpoise. Taking this into account alongside the separation distances from the SNS SAC and that there is no potential for any direct impact on the habitat loss / disturbance of the SNS SAC. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from temporary habitat loss / disturbance) during the operation and maintenance phase for SEP and / or DEP**.

8.4.1.3.7.2 Permanent Habitat Loss

443. Habitat loss will occur during the lifetime of SEP and DEP as a result of structures, scour and external cable protection installed on the sea bed. 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.

444. At SEP, the estimated total permanent habitat loss would be up to 0.50km^2 and up to 0.66km^2 at DEP. In **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9) 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 SEP and DEP offshore sites and the wider region, as demonstrated by survey data from SOW and DOW, as well as Hornsea Project Three OWF (RPS, 2018), and the localised spatial extent of impacts, the magnitude of effect of permanent habitat loss is considered to be low.

445. Due to the presence of comparable subtidal sand and gravel habitats in and around the SEP and DEP offshore sites, any loss of habitat is considered to have a negligible effect on any changes in prey availability for harbour porpoise. Taking this into account along with the separation distance from the SNS SAC and no potential for any direct effect on the SNS SAC, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from permanent habitat loss resulting from the introduction of hard substrates) during the operation and maintenance phase for SEP and / or DEP.**

8.4.1.3.7.3 Introduction of Wind Turbine Foundations, Scour Protection and Hard Substrate

446. The introduction of various man-made structures such as foundations and scour protection in soft sediment areas increases and changes habitat availability and type, 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).

447. 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).

448. Studies show that the effect of a FAD results in an increase in the biomass of fish species around foundations compared to areas where there was no FAD present. Fish are attracted and aggregate from the surrounding areas as they are attracted to the new habitat by increased feeding opportunities.

449. Taking this into account along with the separation distances from the SNS SAC and no potential for any direct impact on the SNS SAC, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from the introduction of wind turbines, scour protection and hard substrates) during the operation and maintenance phase for SEP and / or DEP**.

8.4.1.3.7.4 Increased Suspended Sediment Concentrations and Sediment Deposition

450. Increases in SSC within the water column and subsequent deposition onto the sea bed 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.

451. Any increases in SSC 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. It is assumed that there could be up to 10 jack-up movements per year for each of SEP and DEP (i.e. 20 in total). Cable repairs or replacements will only be carried out infrequently, for example, one export and interlink cable repair every 10 years and two infield cable repairs every 10 years. Similarly, for reburial, there may be up to 0.2km per export cable affected every 10 years, and 1% of each of the total interlink and infield cabling every 10 years.

452. Increased SSCs and levels of sediment re-deposition will be localised and short term. Therefore, the effect of SSC and re-deposition during the operational phase would be negligible for prey species and harbour porpoise.

453. Taking this into account along with the separation distances from the SNS SAC and no potential for any direct impact on the SNS SAC, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from increased SSC and sediment deposition) during the operation and maintenance phase for SEP and / or DEP**.

8.4.1.3.7.5 Underwater Noise during Operation and Maintenance

454. Sources of underwater noise during operation and maintenance include, operational wind turbines, maintenance activities, such as cable repairs, replacement and protection, and vessels.

455. Underwater noise modelling (**ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2)), 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).

456. 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.

457. The impact range for fish species are less than the predicted impact range for harbour porpoise for operational turbines, maintenance activities such as cable laying, trenching and rock placement and vessels. Therefore, there would be no additional effects on harbour porpoise as a result of any impacts on fish species from underwater noise during operation and maintenance.

458. There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of any changes in prey availability from underwater noise during the operation and maintenance phase of SEP and / or DEP**.

8.4.1.3.7.6 Electromagnetic Fields (EMF)

459. OWFs transmit the energy produced along a network of cables. As energy is transmitted, the cables emit low-energy EMF. The electrical and magnetic fields generated increase proportionally to the amount of electricity transmitted.

460. SEP and DEP will involve installing offshore export cable circuits using HVAC technology. Fish and shellfish species are less likely to exhibit responses to HVAC cables when compared to High Voltage Direct Current (HVDC) transmission cables due to the higher strength EMFs emitted by HVDC (Normandeau *et al*., 2011).

461. As outlined in **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), the predicted magnetic fields for SEP and DEP based on Tripp (2021) are greatest on the sea bed and reduce rapidly with vertical and horizontal distance from the circuits. The magnetic fields from all scenarios reduced to very low levels within a few metres from the circuits and it is important to note that these levels do not take account of shielding factors of the cable sheath which would further reduce the fields.

462. The areas potentially affected by EMF generated by the worst-case scenario for offshore cables are expected to be small and restricted to the immediate vicinity of the cables (i.e. within metres). EMFs are expected to attenuate rapidly in both horizontal and vertical plains with distance from the source.

463. The effect of EMFs on prey species and any changes in prey availability would be low and there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise from EMF effects on prey species during the operation and maintenance phase of SEP and / or DEP.**

8.4.1.4 Potential Overall Effects during Operation and Maintenance

464. There would be no further overall effects during operation and maintenance, as the assessment for any potential disturbance as a result of underwater noise represents the worst-case.

465. Any potential effects during operation and maintenance from underwater noise during maintenance activities, changes in prey availability, vessel collision risk or water quality would be localised, temporary and less than those assessed for construction.

466. No additional mitigation is required or proposed for any potential effects during operation and maintenance.

467. As the SEP and DEP offshore sites are outside the SNS SAC, there will be no direct effect on the spatial or seasonal components of the SNS SAC during operation and maintenance.

468. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to the overall effects as mentioned above for SEP and / or DEP.**

8.4.1.5 Potential Effects During Decommissioning

469. Potential effects on harbour porpoise 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 the regulator prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

470. Decommissioning would most likely involve the removal of the accessible installed components comprising: all of the wind turbine components; part of the foundations (those above sea bed level); and the sections of the infield cables close to the offshore structures, as well as sections of the export cables. The process for removal of foundations is generally the reverse of the installation process. There would be no piling, and foundations may be cut to an appropriate level.

471. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, it is expected that the activity levels will be comparable to construction (with the exception of pile driving noise which would not occur).

472. Therefore, the potential effects on harbour porpoise during decommissioning would be the same or less than those assessed for construction due to the processes of decommissioning potentially being the reverse of the installation, without the need for piling.

8.4.1.6 Potential In-Combination Effects

473. The following in-combination assessment is based on both SEP and DEP being constructed, as the worst-case scenario. If only SEP or DEP were to be developed, all potential in-combination effects would be less than those assessed.

474. The in-combination assessment considers plans, projects and activities where the predicted effects have the potential to combine with the potential effects during construction of SEP and DEP alone. The construction phase has been assessed as the worst-case for potential in-combination effects.

475. The activities, plans and projects screened into the in-combination assessment for harbour porpoise are those that are located in the North Sea MU. Full information on the screening is provided in **ES Appendix 10.3 Marine Mammals CIA Screening** (document reference 6.3.10.3).

476. The potential in-combination effects for harbour porpoise within the SNS SAC has been identified as disturbance from underwater noise during piling and other construction activities, including vessels at SEP and DEP. Any in-combination effects for offshore wind farms during operation and maintenance or decommissioning have been screened out of further assessment. See **Sections 10.3.4.1.3**, **10.3.4.1.4** and **10.3.4.1.5** of **Appendix 10.3 Marine Mammals CIA Screening** (document reference 6.3.10.3) for further information.

477. All other potential effects, including PTS from underwater noise, TTS from underwater noise, changes to prey availability, increased collision risk with vessels and all operational effects have been screened out, with no potential in-combination effects in relation to the SNS SAC and harbour porpoise (see **ES Appendix 10.3 Marine Mammals CIA Screening** (document reference 6.3.10.3)). Note that the potential for TTS / fleeing response has been used as a proxy for disturbance where disturbance specific thresholds are not available.

478. The commitment to the mitigation measures agreed through the MMMP (in accordance with the **Draft MMMP** (document reference 9.4)) for piling would reduce the risk of physical injury or permanent auditory injury (PTS) in harbour porpoise. In light of this, and taking account of the type, scale and extent of potential impacts arising from SEP and / or DEP, the project alone assessment concluded no AEoI for SNS SAC harbour porpoise from physical injury or PTS from piling during the construction phase (see **Sections 8.4.1.1.1.1.1** and **8.4.1.1.1.2.1**).

479. Other licenced projects or activities that may result in underwater noise that could cause physical injury or PTS will have similar controls in place (noting that all projects have either a SIP condition applied with their DCO or are required to account for this, following the Review of Consents[11]). Taking this into account, there is considered to be no pathway for SEP and DEP or any of the other projects screened into the in-combination assessment (see **ES Appendix 10.3 Marine Mammals CIA Screening** (document reference 6.3.10.3) to contribute to in-combination effects for physical injury or permanent auditory injury (PTS) from piling activities. Other activities such as dredging, drilling, rock placement, vessel activity, operational wind farms, oil and gas installations or wave and tidal sites will emit broadband noise in lower frequencies and auditory injury (PTS) from these activities is very unlikely. Therefore, the potential risk of any auditory injury (PTS) is not included in the in-combination assessments. Thus, the following assessment only considers potential disturbance effects on harbour porpoise.

480. The potential sources of in-combination effects of underwater noise which could disturb harbour porpoise are:

- piling at OWFs, including SEP and DEP
- other construction activities at OWFs (vessels, cable installation works, dredging, sea bed preparation and rock placement)
- geophysical surveys for other OWFs
- aggregate extraction and dredging
- subsea cable and pipelines
- oil and gas seismic surveys
- UXO clearance (other than for SEP and DEP)

481. The approach to the assessment for the in-combination effects of disturbance from underwater noise for harbour porpoise has been based on the current advice from the SNCBs (JNCC *et al*., 2020) on the assessment of impacts on the SNS SAC.

482. It should be noted that a large amount of uncertainty is inherent within in-combination assessments. To take this uncertainty into account, where possible, a precautionary approach has been applied at multiple stages of the assessment process.

483. The approach to dealing with uncertainty has led to a highly precautionary assessment of the potential for in-combination effect, especially for pile driving, as the assessment is based on the worst-case scenarios for all projects included. It should therefore be noted that building precaution on top of precaution can lead to unrealistic worst-case scenarios within the assessment.

[11] https://www.gov.uk/government/publications/review-of-consented-offshore-wind-farms-in-the-southern-north-sea-harbour-porpoise-special-area-of-conservation

484. Therefore, the following in-combination assessment is based on the most realistic worst-case scenario of all other projects to reduce any uncertainty, and avoid presentation of highly unrealistic worst-case scenarios, while still providing a conservative assessment. Careful consideration has been given to determine the most realistic worst-case scenario for the assessment of in-combination effects.

8.4.1.6.1 Potential for In-Combination Disturbance Effects due to Underwater Noise from Piling at Other OWFs

485. The assessment of in-combination effects considers the potential disturbance of harbour porpoise during piling for SEP and DEP, with the piling at other OWF projects, where there is the potential for simultaneous piling.

486. The potential piling period for SEP and DEP has been based on the widest likely range of offshore construction and piling dates, dependent on the construction scenario, as a very precautionary approach. It should be noted that while the projects included within the assessment have the potential to overlap with SEP and DEP, there is a lot of uncertainty on when OWFs could be piling. This assessment is therefore considered worst-case.

487. The worst-case scenario for harbour porpoise would be if the following OWFs in the North Sea MU for harbour porpoise were constructed concurrently with simultaneous piling in 2028:

- SEP and / or DEP
- Berwick Bank
- Dogger Bank South
- East Anglia ONE North
- East Anglia TWO
- Five Estuaries
- Hornsea Project Four
- North Falls
- Outer Dowsing
- Rampion Extension

488. Under the SNCB guidance for assessing the potential for effect from disturbance as a result of piling (JNCC *et al*., 2020), it is important to consider projects that have the potential for disturbance effects to overlap with the SNS SAC. Therefore, projects that are either within the SNS SAC, or within 26km of the SNS SAC included in the assessment are:

- Dogger Bank South is within the summer area.
- East Anglia ONE North is within the winter area, and partly within the summer area.

- East Anglia TWO is within the winter area, and partly within 26km of the summer area.
- Five Estuaries is within the winter area.
- Hornsea Project Four is within the summer area.
- North Falls is within the winter area.
- Outer Dowsing is within the summer area.

489. As previously outlined, SEP and DEP are not located within the SNS SAC. However, DEP is within 26km of both the SNS SAC summer (distance at closest point is 13.9km) and winter area (distance at closest point is 19.1km), and SEP is within 26km of the SNS SAC winter area (distance at closest point is 25.6km).

490. The other OWFs (Berwick Bank and Rampion Extension), are not located in or within 26km of the SNS SAC.

491. The in-combination assessment has been based on a single piling event within SEP or DEP, with single piling occurring in the other OWFs, as it is considered unlikely that all OWFs would or could be undertaking simultaneous piling all at the same time.

492. The approach to the in-combination assessment, based on single piling, would allow for some of the OWFs not to be piling at the same time while others could be simultaneously piling. This is considered to be the most realistic worst-case scenario, as it is highly unlikely that all OWFs would or could be simultaneously piling at exactly the same time or even on the same day as piling at SEP and / or DEP.

493. The approach to the in-combination assessment for disturbance from underwater noise follows the current advice from the SNCBs on the assessment of impacts on the SNS SAC (JNCC *et al*., 2020). The potential disturbance area from piling activities for all OWF projects has been based on the EDR of 26km from each piling location and the area which would overlap with the seasonal areas of the SNS SAC.

494. The assessments for all OWFs are based on the worst-case for piling of monopiles with no noise abatement or reduction (26km EDR).

495. It should be noted that the potential areas of disturbance assume that there is no overlap in the areas of disturbance between different projects and are therefore highly conservative.

8.4.1.6.1.1 Spatial assessment for the Southern North Sea SAC

496. For each OWF with the potential for disturbance within either the summer or winter area of the SNS SAC, the area of potential effect for single piling that overlaps with the winter and summer areas has been estimated, based on the worst-case scenarios for the maximum, minimum and average overlap.

497. This highly conservative potential worst-case scenario for offshore wind farms that could be piling at the same time as SEP and DEP, that also have the potential for disturbance within the SNS SAC for each seasonal area are:

- For the summer area
  - DEP
  - Dogger Bank South (DBS)
  - East Anglia Hub (East Anglia ONE North (EA1N) as the worst-case potential overlap with the summer area)
  - Hornsea Project Four (HP4)
  - Outer Dowsing (OD)
- For the winter area
  - SEP
  - DEP
  - East Anglia Hub (East Anglia TWO (EA2) as the worst-case potential overlap with the winter area)
  - Five Estuaries (FE)
  - North Falls (NF)

498. The estimated maximum, minimum and average overlap with the SNS SAC summer and winter areas is outlined in **Table 8-38**.

Table 8-38: Estimated Maximum, Minimum, and Average Overlaps with the SNS SAC Summer and Winter Areas from Single Piling (26km EDR) at Other OWFs on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Minimum overlap with seasonal area	Average overlap with seasonal area
Summer area:			
DEP	355.70km^2	0km^2	177.85km^2
DBS	2,123.71km^2	1,976.48km^2	2,050.09km^2
EA1N	1,167.90km^2	305.43km^2	736.66km^2
HP4	2,123.71km^2	1,551.80km^2	1,837.75km^2
OD	1,718.95km^2	143.83km^2	931.39km^2
Total for summer area	7,489.96km^2 (27.71% of the summer area)	3,977.55km^2 (14.72% of the summer area)	5,733.75km^2 (21.21% of the summer area)
Winter area:			
SEP	0.15km^2	0km^2	0.07km^2
DEP	32.7km^2	0km^2	15.16km^2
EA2	2,123.71km^2	2,039.63km^2	2,081.67km^2

In-combination assessment scenario	Maximum overlap with seasonal area	Minimum overlap with seasonal area	Average overlap with seasonal area
FE	2,123.71km^2	1,844.75km^2	1,984.23km^2
NF	2,106.76km^2	1,688.37km^2	1,897.57km^2
Total for winter area	6,387.0km^2 (50.3% of the winter area)	5,572.76km^2 (43.89% of the winter area)	5,978.70km^2 (47.09% of the winter area)

499. The assessment indicates that more than 20% of the summer area could be affected, based on the maximum and average potential overlaps for all OWFs, and more than 20% of the winter area could be affected, based on the maximum, minimum and average potential overlaps for all OWFs (**Table 8-38**).

500. It should also be noted that the contribution of both SEP and DEP to the maximum potential disturbance areas that overlap the summer and winter areas of the SAC are small, with a total of 355.7km^2 potential maximum disturbance area due to piling at DEP in the summer area (4.75% of the total in-combination disturbance area), and a total potential disturbance area of 0.15km^2 and 32.7km^2 at SEP and DEP, respectively in the winter area (0.0023% and 0.48% of the total in-combination disturbance area, respectively).

501. However, in line with the conclusions of the Review of Consents (RoC) HRA (BEIS, 2020) a Site Integrity Plan (SIP) will be developed for SEP and DEP, which will set out the approach to deliver any Project-level mitigation or management measures, to ensure that the spatial threshold is not exceeded and there is no significant disturbance and no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.

502. It is also important to note that the in-combination assessments are based on the worst-case for all possible OWFs. As projects develop and programmes are established there will be changes to the potential piling periods for each OWF project. There will also be limitations on the fabrication of wind turbines and the vessels available to install the wind turbine foundations. Therefore, it is unlikely that all OWFs would or could be all piling at the same time.

503. All other OWFs will also have to produce a SIP to ensure that the spatial threshold is not exceeded and there is no significant disturbance and no adverse effect on the integrity of the SNS SAC. This could include the use of noise abatement and reduction measures (which would reduce the EDR to 15km), and / or seasonal restrictions and agreements on when OWF piling could be undertaken. For example, restrictions to reduce the potential for simultaneous piling (i.e. on the same day) at EA1N, DBS and HP4 during the summer period would reduce the maximum in-combination overlap with the summer area. Similarly, restrictions to reduce the potential for simultaneous piling (i.e. on the same day) at EA2, FE and NF during the winter period would reduce the maximum in-combination overlap with the winter area.

504. With the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of in-combination disturbance effects from underwater noise during piling at SEP and DEP and other OWFs**

8.4.1.6.1.2 Seasonal average assessment for the Southern North Sea SAC

505. Seasonal averages have been calculated by multiplying the average effect on any given day in each season by the proportion of days within the season on which piling could occur (i.e. taking into account the average of effect / area of overlap with the SNS SAC and number of days piling per season).

506. This has been put into the context of the maximum number of piling days for SEP and DEP (**Table 8-13**):

- up to 26 days for SEP, assuming one day per foundation installation plus 2 days recovery, for 23 turbines and one OSP at SEP
- for up to 33 days for DEP, assuming one day per foundation installation plus 2 days recovery, for 30 turbines and one OSP at DEP

507. As a worst-case, no allowance has been made for downtime as a result of technical issues and no assumptions have been made for reloading of piling vessels with foundations.

Table 8-39 Estimated Seasonal Averages for the SNS SAC Summer and Winter Areas from Single Piling at Other OWFs Which Could be Piling on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Average overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: Single piling at DBC, EA1N, HP4 and OD, at the same time as piling at DEP	21.21%	33 days for piling at DEP	3.82%
Winter area: Single piling at the EA2, FE and NF, at the same time as SEP	46.97%	26 days for piling at SEP	6.71%
Winter area: Single piling at the EA2, FE and NF, at the same time as DEP	47.09%	33 days for piling at DEP	8.54%
Winter area: Single piling at the EA2, FE and NF, at the same time as SEP and DEP	47.1%	26 days for piling at SEP and DEP	6.73%

508. The assessment indicates based on the worst-case scenarios, the 10% seasonal average threshold would not be exceeded for the summer or winter areas, based on the number of piling days for SEP and DEP on which in-combination effects could occur (**Table 8-39**).

509. As outlined above, the contribution of SEP and DEP to the average overlap with the seasonal areas is relatively small, compared to the other OWFs included in the in-combination assessment.

510. With the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of in-combination disturbance effects from underwater noise during piling at SEP and DEP and other OWFs.**

8.4.1.6.1.3Assessment for the North Sea MU reference population

511. For each OWF project located within the North Sea MU, the number of harbour porpoise within the potential area of effect for single piling, has been estimated using the latest SCANS-III density estimates (Hammond *et al.,* 2021) for the relevant survey block that each OWF project is located within.

512. For this potential worst-case scenario (2,123.7km^2 at each wind farm), the estimated maximum area of potential disturbance is 23,360.7km^2, without any overlap in the potential areas of disturbance between OWFs. The maximum number of harbour porpoise that could potentially be temporarily disturbed is 16,310 individuals, which represents approximately 4.71% of the North Sea MU reference population (**Table 8-40**). However, this is very precautionary, as outlined above, it is unlikely that all OWF projects could be piling at exactly the same time as piling at SEP and DEP.

513. Piling at both SEP and DEP has been included in the in-combination assessment as a worst-case scenario.

Table 8-40: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise During Single Piling at the OWF Projects Which could be Piling on the Same Day as SEP and DEP

Name of Project	SCANS-III Block	Harbour porpoise density per km^2	Impact area for 26km EDR (km^2)	Maximum number of individuals potentially disturbed during single piling
SEP	O	0.888	2,123.7	1,886
DEP	O	0.888	2,123.7	1,886
Berwick Bank	R	0.599	2,123.7	1,272
Dogger Bank South	O	0.888	2,123.7	1,886
East Anglia ONE North	L	0.607	2,123.7	1,289

Name of Project	SCANS-III Block	Harbour porpoise density per km^2	Impact area for 26km EDR (km^2)	Maximum number of individuals potentially disturbed during single piling
East Anglia TWO	L	0.607	2,123.7	1,289
Five Estuaries	L	0.607	2,123.7	1,289
Hornsea Project Four	O	0.888	2,123.7	1,886
North Falls	L	0.607	2,123.7	1,289
Outer Dowsing	O	0.888	2,123.7	1,886
Rampion Extension	C	0.213	2,123.7	452
Total number of harbour porpoise (Total without SEP or DEP)			**23,360.7**	**16,310 (14,424)**
Percentage of NS MU (346,601 harbour porpoise) (% without SEP or DEP)				**4.71% (4.16%)**

514. The approach to the in-combination assessment, based on the potential for single piling at the OWFs in the North Sea MU, would allow for some of these OWFs not to be piling at the same time while others could be simultaneously piling. This is considered to be the most realistic worst-case scenario, as it is highly unlikely that all OWFs would or could be simultaneously piling at exactly the same time or even on the same day as piling at SEP and DEP.

515. The potential effects would be less than those predicted in this assessment as there is likely to be a great deal of variation in timing, duration, and hammer energies used throughout the various OWF construction periods. In addition, not all individuals would be displaced over the entire potential disturbance ranges used within the assessments. For example, the study of harbour porpoise at Horns Rev (Brandt *et al.* 2011), indicated that at closer distances (2.5 to 4.8km) there was 100% avoidance, however, this proportion decreased significantly moving away from the pile driving activity and at distances of 10km to 18km avoidance was 32% to 49% and at 21km the abundance was reduced by just 2%.

516. With the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of in-combination disturbance effects from underwater noise during piling at SEP and DEP and other OWFs.**

8.4.1.6.2 Potential for In-Combination Disturbance Effects due to Underwater Noise Sources, Other than Piling

517. During the construction period for SEP and DEP, there are other potential noise sources in addition to piling that could also disturb harbour porpoise. These other noise sources include:

- OWF construction activities (other than piling, including vessels, cable installation works, dredging, sea bed preparation and rock placement)
- Geophysical surveys for OWFs
- Aggregate extraction and dredging
- Subsea cable and pipelines
- Oil and gas seismic surveys
- UXO clearance

518. The CIA screening (**ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)) and BEIS (2020) determined that it was highly unlikely that the following activities could contribute significantly to any in-combination effects of underwater noise, therefore they have not been assessed further or included in this in-combination assessment:

- OWF operational activities
- Tidal and wave developments (construction, operation and maintenance)
- Offshore mining
- Oil and gas projects, other than potential seismic surveys
- Licensed disposal sites
- Navigation and shipping operations
- Carbon capture projects

8.4.1.6.2.1 Potential for Disturbance from Construction Activities at Other OWFs

519. During piling at SEP and DEP, there is the potential to overlap with potential effects from the non-piling construction activities at other OWFs. Noise sources which could cause potential disturbance effects during OWF construction activities, other than pile driving, can include vessels, sea bed preparation, ploughing / jetting / pre-trenching or cutting for installation of cables and rock placement for protection of the cable.

520. There would be no additional in-combination effects of underwater noise from other construction activities for OWFs which also have overlapping piling with SEP and DEP, as the ranges for piling would be significantly greater than those from other construction noise sources. The OWFs that therefore have the potential for in-combination effect with SEP and DEP, that are based within the North Sea MU are:

- Norfolk Boreas

- Norfolk Vanguard
- Dolphyn Project
- Salamander

521. In addition, it is important to consider OWFs that have the potential for disturbance effects to overlap with the SNS SAC. Therefore, OWFs that are within the SNS SAC and included in the in-combination assessment are:
   - Norfolk Boreas
     - SNS SAC summer area
   - Norfolk Vanguard
     - SNS SAC summer area

522. The potential temporary disturbance during OWF construction activities, other than piling, has been based on worst-case areas used in assessments for SEP and DEP for all construction activities other than piling (with a disturbance area of 3.36km^2 for harbour porpoise) and all construction vessels (0.48km^2) at each of the screened in OWF sites, totalling a potential disturbance area of 3.84km^2 for each OWF screened in. This is a very precautionary approach, as it is highly unlikely that all non-piling construction activities and all vessels would be on site at any one time. Any disturbance is likely to be limited to the area in and around where the activity is actually taking place.

8.4.1.6.2.1.1 Spatial assessment for the Southern North Sea SAC

523. There is the potential, as outlined above, for three other OWFs to be undergoing construction at the same time as SEP and DEP, in the summer area of the SNS SAC. Therefore, there is the potential for disturbance to up to 11.52km^2 (0.043% of the summer area).

524. Taking into account piling at DEP (maximum overlap area of 355.7km^2), the maximum area of potential disturbance in the SNS SAC summer area is 367.22km^2 (1.36% of the summer area). Displacement of harbour porpoise would not exceed 20% of the summer seasonal component of the SNS SAC during the construction of other OWFs on the same day as piling at SEP and DEP. Therefore, under these circumstances, there would be no significant disturbance and **no adverse effect on the integrity of SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance from underwater noise due to construction activities (other than piling) for SEP and DEP in-combination with other plans and projects.**

8.4.1.6.2.1.2 Seasonal Average Assessment for the Southern North Sea SAC

525. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which other OWF construction activities could occur at the same time as piling at SEP and DEP.

526. The assessment indicates that the seasonal average would be less than 10% of the summer area of the SNS SAC (Table 8-41). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise from construction activities (other than piling) for SEP and DEP in-combination with other plans and projects.**

Table 8-41: Estimated Seasonal Averages with the SNS SAC Summer Area from Construction of Other OWFs on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: Other OWF construction at the same time as piling at DEP	363.38km^2 (1.36% of the summer area)	33 days for piling at DEP	0.25% of the summer season

8.4.1.6.2.1.3 Assessment for the North Sea MU reference population

527. For each project, the number of harbour porpoise has been estimated using the latest SCANS-III density estimates (Hammond *et al.*, 2021) for the relevant survey block that the OWF is located within. The number of harbour porpoise that could potentially be disturbed has been put into the context of the reference population for the North Sea MU (Table 8-42).

Table 8-42: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise from Other OWF Construction Activities, Including Vessels at the Same Time as Piling at SEP and DEP

Name of Project	Area (km^2)	SCANS-III Block	Harbour porpoise density	Number of individuals at risk of disturbance
SEP	2,123.7	O	0.888	1,886
DEP	2,123.7	O	0.888	1,886
Norfolk Boreas	3.84	O	0.888	3.41
Norfolk Vanguard	3.84	O	0.888	3.41
Dolphyn Project	3.84	T	0.402	1.54
Salamander	3.84	R	0.599	2.30
Total number of harbour porpoise at risk of disturbance				**3,782**
% of reference population				**1.1%**

528. For the potential temporary effects during construction, including vessels, there is likely to be a great deal of variation in timing and durations, as well as different construction methods, used throughout the various OWF construction periods. Therefore, this assessment is considered to be a precautionary worst-case.

529. As assessed in **Table 8-42**, the number of harbour porpoise that could potentially be temporarily disturbed during the construction of other OWFs at the same time as piling at SEP and DEP could be up to 1.1% of the NS MU reference population. Therefore, under these circumstances there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise from construction activities (other than piling) for SEP and DEP in-combination with other plans and projects.**

8.4.1.6.2.2 Potential for Disturbance from Geophysical Surveys

530. The current guidance for assessing the significance of noise disturbance for harbour porpoise SACs (JNCC *et al*., 2020) recommends the use of an EDR of 5km (78.54km^2) for geophysical surveys.

531. In the BEIS (2020) RoC HRA, it was estimated that in the unlikely event that a Sub-Bottom Profiler (SBP) is used continuously over a period of 24 hours with a vessel speed of 7.4 km/h (4 knots) a total area of approximately 256km^2 per day could be affected (approximately 0.9% of the SAC summer area) (BEIS, 2020). However, as outlined in the RoC HRA (BEIS, 2020) this is a highly precautionary scenario as it is very unlikely that a SBP would be undertaken along a single transect line of 178km in a single day.

532. It is currently not possible to estimate the location or number of potential geophysical surveys that could be undertaken at the same time as piling at SEP and DEP. It is therefore assumed, as a worst-case scenario, that there could potentially be up to two geophysical surveys during the summer at any one time, and one geophysical survey during the winter at any one time, during piling at SEP and DEP.

533. Geophysical surveys for SEP and DEP will be assessed separately prior to the surveys being undertaken, based on the type of survey required, equipment used, area covered, time of year and duration, including in-combination assessments during geophysical surveys at SEP and DEP. Therefore, geophysical surveys for SEP and DEP are not included in this assessment.

8.4.1.6.2.2.1 Spatial assessment for the Southern North Sea SAC

534. If two geophysical surveys were undertaken within the SNS SAC summer area (with an area of 256km^2 each), at the same time as piling at DEP (maximum overlap area of 355.7km^2), the potential area of disturbance could be 867.7km^2, which would be approximately 3.2% of the summer area.

535. If one geophysical survey was undertaken within the winter area (with an area of 256km^2), at the same time as piling at SEP and DEP (maximum overlap area of 32.7km^2 and 0.15km^2 respectively), the potential area of disturbance could be 286.48km^2 which would be approximately 2.3% of the winter area.

536. The displacement of harbour porpoise therefore would not exceed 20% of either the summer or winter seasonal component of the SNS SAC during geophysical surveys on the same day as piling at SEP and DEP. Therefore, under these circumstances, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with geophysical surveys.**

8.4.1.6.2.2.2 Seasonal Average Assessment for the Southern North Sea SAC

537. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which geophysical surveys could occur at the same time as piling at SEP and DEP (**Table 8-43**).

Table 8-43: Estimated Seasonal Averages with the SNS SAC Summer and Winter Areas from Geophysical Surveys on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: Two geophysical surveys at the same time as piling at DEP	867.7km^2 (3.21% of the summer area)	33 days for piling at DEP	0.58% of the summer season
Winter area: One geophysical survey at the same time as piling at SEP and DEP	288.7km^2 (2.27% of the winter area)	33 days for piling at DEP	0.41% of the winter season

538. The assessment indicates that on average less than 10% of the summer and winter areas of the SNS SAC could be affected, due to geophysical surveys being undertaken on the same day as piling at SEP and DEP (**Table 8-43**). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with geophysical surveys**.

8.4.1.6.2.2.3 Assessment for the North Sea MU reference population

539. The SCANS-III harbour porpoise density estimate for the North Sea MU is 0.52/km^2 (Hammond *et al.,* 2021). Without knowing the actual location for any seismic surveys, this density estimate has been used to estimate the potential number of individuals that could potentially be disturbed.

540. **Table 8-44** presents the in-combination assessment for two geophysical surveys occurring on the same day as piling at SEP and DEP within the harbour porpoise North Sea MU.

Table 8-44: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise During Geophysical Surveys on the Same Day as Piling at SEP and DEP

Activity	Area of disturbance	Density estimate	Potential number of harbour porpoise at risk of disturbance
Piling at SEP	2,123.7km^2	0.888/km^2	1,886
Piling at DEP	2,123.7km^2	0.888/km^2	1,886
Disturbance from two geophysical surveys in the North Sea area	512km^2	0.52/km^2	266
Total number of harbour porpoise at risk of disturbance			**4,038**
% of reference population			**1.2%**

541. As assessed in **Table 8-44**, the number of harbour porpoise that could potentially be temporarily disturbed during two geophysical surveys at the same time as piling at SEP and DEP could be up to 4,038 harbour porpoise (1.2% of the NS MU reference population). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with geophysical surveys**.

8.4.1.6.2.3 Potential for Disturbance from Aggregate Extraction and Dredging

542. The current guidance for assessing the significance of noise disturbance for harbour porpoise SACs (JNCC *et al*., 2020) does not currently include an EDR for aggregate extraction and dredging.

543. As outlined in the BEIS (2020) RoC HRA for the SNS SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600m of the activities (Diederichs *et al*., 2010).

544. As a very precautionary approach, a total of 11 aggregate extraction and dredging projects are included in the in-combination assessment for the disturbance of harbour porpoise.

545. Based on a precautionary level of behavioural displacement of harbour porpoise out to 600m, there is potential for an area of 1.13km^2 to be affected (BEIS, 2020). As a worst-case scenario, assuming all 11 sites are active at the same time, the area of potential disturbance of harbour porpoise is up to 12.43km^2.

8.4.1.6.2.3.1 Spatial assessment for the Southern North Sea SAC

546. If aggregate extraction and dredging activities were undertaken within the SNS SAC summer area (with an area of up to 12.43km^2), at the same time as piling at DEP (maximum overlap area of 355.7km^2), the potential area of disturbance could be 368.13km^2 which would be approximately 1.4% of the summer area.

547. If aggregate extraction and dredging activities were undertaken within the winter area (with an area of up to 12.43km^2), at the same time as piling at SEP and DEP (maximum overlap area of 32.7km^2 and 0.15km^2 respectively), the potential area of disturbance could be 45.13km^2 which would be approximately 0.36% of the winter area.

548. The displacement of harbour porpoise therefore would not exceed 20% of either the summer or winter seasonal component of the SNS SAC during aggregate extraction and dredging activities on the same day as piling at SEP and DEP. Therefore, under these circumstances, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with aggregate extraction and dredging activities.**

8.4.1.6.2.3.2 Seasonal Average Assessment for the Southern North Sea SAC

549. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which aggregate extraction and dredging activities could occur at the same time as piling at SEP and DEP (**Table 8-49**).

Table 8-45: Estimated Seasonal Averages with the SNS SAC Summer and Winter Areas from Aggregate Extraction and Dredging Activities on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: Aggregate extraction and dredging activities at the same time as piling at DEP	368.13km^2 (1.36% of the summer area)	33 days for piling at DEP	0.25% of the summer season
Winter area: Aggregate extraction and dredging activities at the same time as piling at SEP and DEP	45.13km^2 (0.36% of the winter area)	33 days for piling at DEP	0.06% of the winter season

550. The assessment indicates that on average less than 10% of the summer and winter areas of the SNS SAC could be affected, due to aggregate extraction and dredging activities being undertaken on the same day as piling at SEP and DEP (**Table 8-45**). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with aggregate extraction and dredging activities**.

8.4.1.6.2.3.3 Assessment for the North Sea MU reference population

551. The SCANS-III harbour porpoise density estimate for the North Sea MU of 0.52/km^2 (Hammond *et al.*, 2021) has been used to estimate the potential number of harbour porpoise that could potentially be disturbed during aggregate extraction and dredging activities.

552. **Table 8-46** presents the in-combination assessment for aggregate extraction and dredging activities occurring on the same day as piling at SEP and DEP within the harbour porpoise North Sea MU.

Table 8-46: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise During Aggregate Extraction and Dredging Activities on the Same Day as Piling at SEP and DEP

Activity	Area of disturbance	Density estimate	Potential number of harbour porpoise at risk of disturbance
Piling at SEP	2,123.7km^2	0.888/km^2	1,886
Piling at DEP	2,123.7km^2	0.888/km^2	1,886
Disturbance from aggregate extraction and dredging activities in the North Sea area	12.43km^2	0.52/km^2	6
Total number of harbour porpoise at risk of disturbance			**3,778**
% of reference population			**1.1%**

553. As assessed in **Table 8-46**, the number of harbour porpoise that could potentially be temporarily disturbed during aggregate extraction and dredging activities at the same time as piling at SEP and DEP could be up to 3,778 harbour porpoise (1.1% of the NS MU reference population). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with aggregate extraction and dredging activities**.

8.4.1.6.2.4 Potential for Disturbance from Subsea Cables and Pipelines

554. The current guidance for assessing the significance of noise disturbance for harbour porpoise SACs (JNCC *et al*., 2020) does not currently include an EDR for subsea cables and pipelines.

555. For harbour porpoise, the potential impact has been based on an impact range of 1km, with the potential impact area of 3.14km^2 for both SEP and DEP and 18.84km^2 for the six projects.

556. As a precautionary approach, six subsea cable and pipeline projects are included in the in-combination assessment for the potential disturbance of harbour porpoise.

8.4.1.6.2.4.1 Spatial assessment for the Southern North Sea SAC

557. If six subsea cable and pipeline projects were undertaken within the SNS SAC summer area (with an area of up to 18.84km^2), at the same time as piling at DEP (maximum overlap area of 355.7km^2), the potential area of disturbance could be 374.54km^2 which would be approximately 1.4% of the summer area.

558. If six subsea cable and pipeline projects were undertaken within the winter area (with an area of up to 18.84km^2), at the same time as piling at SEP and DEP (maximum overlap area of 32.7km^2 and 0.15km^2 respectively), the potential area of disturbance could be 51.54km^2 which would be approximately 0.41% of the winter area.

559. The displacement of harbour porpoise therefore would not exceed 20% of either the summer or winter seasonal component of the SNS SAC during subsea cable and pipeline projects on the same day as piling at SEP and DEP. Therefore, under these circumstances, no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with subsea cables and pipelines**.

8.4.1.6.2.4.2 Seasonal Average Assessment for the Southern North Sea SAC

560. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which aggregate extraction and dredging activities could occur at the same time as piling at SEP and DEP (**Table 8-47**).

Table 8-47: Estimated Seasonal Averages with the SNS SAC Summer and Winter Areas from Subsea Cable and Pipeline Projects on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: Subsea cable and pipeline projects at the same time as piling at DEP	374.54km^2 (1.39% of the summer area)	33 days for piling at DEP	0.25% of the summer season
Winter area: Subsea cable and pipeline projects at the same time as piling at SEP and DEP	51.54km^2 (0.41% of the winter area)	33 days for piling at DEP	0.07% of the winter season

561. The assessment indicates that on average less than 10% of the summer and winter areas of the SNS SAC could be affected, due to subsea cable and pipeline projects being undertaken on the same day as piling at SEP and DEP (**Table 8-47**). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with subsea cables and pipelines**.

8.4.1.6.2.4.3 Assessment for the North Sea MU Reference Population

562. The SCANS-III harbour porpoise density estimate for the North Sea MU of 0.52/km^2 (Hammond *et al.*, 2021) has been used to estimate the potential number of harbour porpoise that could potentially be disturbed during subsea cable and pipeline projects.

563. **Table 8-48** presents the in-combination assessment for subsea cable and pipeline projects occurring on the same day as piling at SEP and DEP within the harbour porpoise North Sea MU.

Table 8-48: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during Subsea Cable and Pipeline Projects on the Same Day as Piling at SEP and DEP

Activity	Area of disturbance	Density estimate	Potential number of harbour porpoise at risk of disturbance
Piling at SEP	2,123.7km^2	0.888/km^2	1,886
Piling at DEP	2,123.7km^2	0.888/km^2	1,886

Activity	Area of disturbance	Density estimate	Potential number of harbour porpoise at risk of disturbance
Disturbance from subsea cable and pipeline projects in the North Sea area	18.84km^2	0.52/km^2	10
Total number of harbour porpoise at risk of disturbance		**3,781**	
% of reference population		**1.1%**	

564. As assessed in **Table 8-48**, the number of harbour porpoise that could potentially be temporarily disturbed during subsea cable and pipeline projects at the same time as piling at SEP and DEP could be up to 3,781 harbour porpoise (1.1% of the NS MU reference population). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with subsea cables and pipelines**.

8.4.1.6.2.5 Potential for Disturbance from Seismic Surveys

565. The assessment is based on the potential for disturbance due to seismic surveys undertaken for oil and gas developments, in-combination with piling at SEP and DEP. The potential disturbance from seismic surveys has been estimated based on the current SNCB guidance for the assessment of effects of disturbance to harbour porpoise in the SNS SAC (JNCC *et al*., 2020), and uses a potential impact area of 452.4km^2 per survey, based on a 12km EDR.

566. It is currently not possible to estimate the number of potential seismic surveys, survey area or number of survey days that could be undertaken at the same time as piling at SEP and DEP.

567. The BEIS (2020) RoC HRA reports that, between 2008 and 2017, there were 61 seismic surveys in the SNS SAC during the summer and winter periods, resulting in an average of 6.1 surveys per year. The average number of days per year was 60.4 days (up to 17% of 365 days per year). Taking this into account it is unlikely that more than two seismic surveys will be conducted in the southern North Sea at exactly the same time. It is therefore assumed, as a worst-case scenario, that there could potentially be up to two seismic surveys in the SNS SAC summer area at any one time, and taking into account the smaller area, one seismic survey could be undertaken in the winter area.

8.4.1.6.2.5.1 Spatial assessment for the Southern North Sea SAC

568. If two seismic surveys were undertaken within the summer area (with an area of 452.4km^2 each), at the same time as piling at DEP within the summer area (an area of 355.7km^2), the potential area of disturbance could be (1,260.5km^2) which would be approximately 4.7% of the summer area.

569. If one seismic survey was undertaken within the winter area (with an area of 452.4km^2), at the same time as piling at SEP and DEP within the winter area (32.7km^2 and 0.15km^2 respectively), the potential area of disturbance could be 485.1km^2 which would be approximately 3.8% of the winter area.

570. The displacement of harbour porpoise therefore would not exceed 20% of either the summer or winter seasonal component of the SNS SAC during seismic surveys on the same day as piling at SEP and DEP. Therefore, under these circumstances, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with seismic surveys**.

8.4.1.6.2.5.2 Seasonal Average Assessment for the Southern North Sea SAC

571. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which seismic surveys could occur on the same day as construction at SEP and DEP (**Table 8-49**).

Table 8-49: Estimated Seasonal Averages with the SNS SAC Summer and Winter Areas from Seismic Surveys on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: Two seismic surveys in at the same time as piling at DEP	1,260.5km^2 (4.66% of the summer area)	33 days for piling at DEP	0.84% of the summer season
Winter area: One seismic survey at the same time as piling at SEP and DEP	485.1km^2 (3.8% of the winter area)	33 days for piling at DEP	0.69% of the winter season

572. The assessment indicates that on average less than 10% of the summer and winter areas of the SNS SAC could be affected, due to seismic surveys being undertaken on the same day as piling at SEP or DEP (**Table 8-49**). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with seismic surveys**.

8.4.1.6.2.5.3 Assessment for the North Sea MU reference population

573. The SCANS-III harbour porpoise density estimate for the North Sea MU is 0.52/km^2 (Hammond *et al.*, 2021). Without knowing the actual location for any seismic surveys, this density estimate has been used to estimate the potential number of individuals that could potentially be disturbed.

574. **Table 8-50** presents the in-combination assessment for two seismic surveys occurring on the same day as piling at SEP and DEP within the North Sea MU for harbour porpoise.

Table 8-50: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during Seismic Surveys on the Same Day as Piling at SEP and DEP

Activity	Area of disturbance	Density estimate	Potential number of harbour porpoise at risk of disturbance
Piling at SEP	2,123.7km^2	0.888/km^2	1,886
Piling at DEP	2,123.7km^2	0.888/km^2	1,886
Disturbance from two seismic surveys in the North Sea area	904.8km^2	0.52/km^2	470
Total number of harbour porpoise at risk of disturbance			**4,242**
% of reference population			**1.22%**

As assessed in **Table 8-50**, the number of harbour porpoise that could potentially be temporarily disturbed during two seismic surveys at the same time as piling at SEP and DEP could be up to 4,242 harbour porpoise (1.22% of the NS MU reference population). Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with seismic surveys**.

8.4.1.6.2.6 Potential for Disturbance from UXO Clearance

575. As for piling, the potential risk of PTS from in-combination effects due to UXO clearance has been screened out. As if there is the potential for any PTS, suitable mitigation would be put in place to reduce any risk to marine mammals. Therefore, the in-combination assessment only considers potential disturbance effects.

576. This assessment has been based on the potential for disturbance due to UXO clearance activities at other OWFs, in-combination with piling at SEP and DEP. The potential disturbance from UXO clearance at other OWFs has been estimated based on the current SNCB guidance for the assessment of effects of disturbance to harbour porpoise in the SNS SAC (JNCC *et al*., 2020), and uses a potential worst-case impact area of 2,123.7km^2 per UXO, based on a 26km EDR for high-order detonation with no mitigation.

577. However, as outlined in the BEIS (2020) Review of Consents HRA, due to the nature of the sound arising from the detonation of UXO, i.e. each blast lasting for a very short duration, marine mammals, including harbour porpoise, are not predicted to be significantly displaced from an area, any changes in behaviour, if they occur, would be an instantaneous response and short-term. Existing guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010a).

578. It is important to note that the assessments are based on the worst-case scenario for high-order UXO detonation with no mitigation (26km EDR). However, for UXO clearance, low-order techniques, such as deflagration, would most likely be used and any disturbance would be as a result of the small charge weight. If high-order UXO detonation is required, this would most likely be undertaken with a bubble curtain which would reduce the potential disturbance area.

8.4.1.6.2.6.1 Spatial assessment for the Southern North Sea SAC

579. If one UXO detonation was undertaken within the summer area (with an area of 2,123.7km^2), at the same time as piling at DEP (maximum overlap area of 355.7km^2), the potential area of disturbance could be (2,479.4km^2) which would be approximately 9% of the summer area.

580. If one UXO detonation was undertaken within the winter area (with an area of 2,123.7km^2), at the same time as piling at SEP and DEP (maximum overlap area of 32.7km^2 and 0.15km^2 respectively), the potential area of disturbance could be 2,156.4km^2 which would be approximately 17% of the winter area.

581. The displacement of harbour porpoise therefore would not exceed 20% of either the summer or winter seasonal component of the SNS SAC on any given day during single high-order UXO detonations with no mitigation in the summer and winter areas at the same time as piling at SEP and DEP. Therefore, under these circumstances, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with UXO clearance activities at other OWF projects.**

8.4.1.6.2.6.2 Seasonal average assessment for the Southern North Sea SAC

582. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which UXO clearance could occur at the same time as piling at SEP and DEP (**Table 8-51**).

Table 8-51: Estimated Seasonal Averages With the SNS SAC Summer and Winter Areas from UXO Clearance on the Same Day as Single Piling at SEP and DEP

In-combination assessment scenario	Maximum overlap with seasonal area	Number of piling days for in-combination effects with SEP & DEP	Estimated seasonal average
Summer area: One UXO clearance at the same time as piling at DEP	2,479.4km^2 (9.17% of the summer area)	33 days	1.65% of the summer season
Winter area: One UXO clearance at the same time as piling at SEP and DEP	2,156.4km^2 (16.98% of the winter area)	26 days	2.42% of the winter season

583. The assessment (**Table 8-51**) indicates that on average less than 10% of the summer or winter areas of the SNS SAC could be affected, if there was one high-order UXO detonation with no mitigation at the same time as piling at SEP and DEP. Therefore, under these circumstances there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with UXO clearance activities at other OWF projects**.

8.4.1.6.2.6.3 Assessment for the North Sea MU reference population

584. **Table 8-52** presents the in-combination assessment for one UXO clearance event occurring on the same day as piling at SEP and DEP within the North Sea MU for harbour porpoise.

Table 8-52: In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during UXO Clearance on the Same Day as Piling at SEP and DEP

Activity	Area of disturbance	Density estimate	Potential number of harbour porpoise at risk of disturbance
Piling at SEP	2,123.7km^2	0.888/km^2	1,886
Piling at DEP	2,123.7km^2	0.888/km^2	1,886
Disturbance from one high-order UXO detonation with no mitigation in the North Sea area	2,123.7km^2	0.52/km^2	1,104
Total number of harbour porpoise at risk of disturbance			**4,876**
% of reference population			**1.4**

585. As assessed in **Table 8-52**, the number of harbour porpoise that could potentially be temporarily disturbed during one high-order UXO detonation with no mitigation at the same time as piling at SEP and DEP could be up to 4,876 harbour porpoise (1.4% of the NS MU reference population). However, with the use of low-order clearance techniques or the use of a bubble curtain if high-order UXO detonation is required, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from SEP and DEP in-combination with UXO clearance activities at other OWF projects**.

8.4.1.6.3 Overall In-Combination Disturbance Effects from All Noise Sources

586. The potential in-combination effects from all potential noise sources during piling at SEP and DEP is summarised in **Table 8-53**.

587. Based on the worst-case scenarios and very precautionary approach, there is the potential for up to 34.5% of the summer area, with a seasonal average of 6.21%, or up to 69.6% of the winter area, with a seasonal average of 12.0%, to be affected. With up to 18,181 harbour porpoise (5.25% of the NS MU reference population) potentially disturbed (**Table 8-53**).

588. With the development of SIPs to deliver the appropriate mitigation and management measures across projects and management by the MMO, there would be no significant disturbance and **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of SEP and DEP in-combination with other plans and projects**.

589. As both SEP and DEP are located outside of the SNS SAC summer and winter areas, there is the potential for several options to reduce the potential contribution to the underwater noise in-combination effects, for example:

- Scheduling of piling based on location to avoid maximum overlap with seasonal areas, for example, piling at a location which could have potential overlap with the winter area in the summer period.

590. As outlined in **Section 8.3.1.2**, an **In-Principle SIP for the SNS SAC** (document reference 9.6) has been submitted with the DCO application which sets 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 SNS SAC conservation objectives.

591. The SIP will be developed and finalised 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.

Table 8-53: Overall In-Combination Assessment for the Potential Disturbance of Harbour Porpoise from All Possible Noise Sources during Piling at SEP and DEP

Potential noise source	Area of disturbance of the SNS SAC summer area	Area of disturbance of the SNS SAC winter area	Seasonal average for summer area	Seasonal average for winter area	Potential number of harbour porpoise disturbed (% of NS MU)
Piling at OWFs including piling at SEP and DEP	5,733.75km^2	5,978.7km^2	3.82%	8.54%	16,310 (4.7% of the NS MU)
Non-piling construction activities and vessels at other OWFs	11.52km^2	0	0.01%	0	14 (0.004% of the NS MU)
Geophysical surveys	512km^2	256km^2	0.34%	0.37%	266 (0.08% of the NS MU)
Aggregate extraction and dredging	12.43km^2	12.43km^2	0.008%	0.018%	6 (0.002% of the NS MU)
Subsea cables and pipelines	18.84km^2	18.84km^2	0.013%	0.027%	10 (0.003% of the NS MU)
Seismic surveys	904.8km^2	452.4km^2	0.60%	0.65%	470 (0.1% of the NS MU)
UXO clearance	2,123.7km^2	2,123.7km^2	1.42%	2.39%	1,104 (0.3% of the NS MU)
Total (seasonal average based on up to 33 days in summer and 26 days in winter for piling at SEP and DEP)	**9,317km^2 (34.5% of the summer area)**	**8,842km^2 (69.6% of the winter area)**	**6.21%**	**12.0%**	**18,181 (5.25% of the NS MU)**

8.4.1.7 Summary of Potential Effects on Site Integrity

592. The assessment of the potential effects for SEP and DEP has been summarised in relation to the SNS SAC conservation objectives for harbour porpoise (**Table 8-54**).

593. The SIP for SEP and DEP will provide Project mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise as a result of in-combination effects from underwater noise, to ensure that:

- Displacement of harbour porpoise does not exceed 20% of the seasonal component of the SAC area in any given day or on average exceed 10% of the seasonal component of the SAC area over the duration of that season; and
- There would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise either alone or in-combination with other plans and projects**.

Table 8-54 Summary of the Potential Effects of SEP and DEP, Including In-Combination Effects on the SNS SAC in Relation to the Conservation Objectives for Harbour Porpoise

Conservation Objectives	SEP and DEP Effects			In-combination Effects
	Disturbance from underwater noise	Increased collision risk	Changes to prey availability	Disturbance from underwater noise during construction
Harbour porpoise is a viable component of the site	×	×	×	×
There is no significant disturbance of the species	×	×	×	× (with SIP)
The condition of supporting habitats and processes and the availability of prey is maintained	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives

8.4.2 Moray Firth SAC

594. The potential effects of SEP and DEP (in isolation and combined) that are assessed to determine any potential for an adverse effect on the integrity of the Moray Firth SAC in relation to the Conservation Objectives for bottlenose dolphin are:

- Underwater noise (including piling, other construction activities, vessels, operational turbines, O&M activities and decommissioning activities);
- Any barrier effects from underwater noise;
- Any increased collision risk with vessels;
- Changes to water quality;

- Changes to prey availability; and
- In-combination effects.

8.4.2.1 Potential Effects During Construction

8.4.2.1.1 Potential Effects of Underwater Noise during Piling

595. Underwater noise modelling was carried out by Subacoustech Ltd to estimate the noise levels likely to arise during piling and determine the maximum potential areas of effect (see **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) for further details).

596. The assessments are based on the latest Southall *et al*. (2019) thresholds and criteria for marine mammals. The maximum impact ranges and areas are used to inform the assessments.

597. The maximum predicted impact auditory injury impact area for bottlenose dolphin is 0.44km^2 for TTS from cumulative SEL (including soft-start and ramp-up) of monopile with maximum hammer energy of 5,500kJ at SEP or DEP.

598. There is no potential for any direct overlap with the Moray Firth SAC. However, it is assumed that bottlenose dolphin in and around SEP and DEP could be from the Moray Firth SAC due to the known connectivity of the north-east and east coasts of England with the bottlenose dolphins resident within the Moray Firth SAC. This is a precautionary and worst-case approach, as it is more likely that bottlenose dolphin at SEP and DEP would be from the wider population, rather than the Moray Firth population, due to the distance of the Projects offshore. The maximum potential number of bottlenose dolphin that could be at possible risk of PTS during piling at SEP or DEP is up to 0.0003 individuals (which represents 0.00013% of the latest east coast of Scotland count of 224 bottlenose dolphin) (**Table 8-55**).

599. The maximum potential number of bottlenose dolphin that could be at possible risk of TTS during piling at SEP or DEP is up to 0.013 individuals (which represents 0.006% of the latest east coast of Scotland count of 224 bottlenose dolphin) (**Table 8-55**).

Table 8-55: Maximum Number of Bottlenose Dolphin Potentially at Risk of PTS or TTS During Piling at SEP or DEP

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Bottlenose dolphin	PTS = 0.01km^2	0.0003 (SCANS-III density of 0.0298/km^2) (0.00013% of east coast of Scotland population)	**No** MMMP would reduce risk of PTS
	TTS = 0.44km^2	0.013 (SCANS-III density of 0.0298/km^2)	**No** Temporary effect MMMP would reduce risk of TTS

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
		(0.006% of east coast of Scotland population)	

600. As outlined in **Section 8.3.1**, a MMMP for piling in accordance with the **Draft MMMP** (document reference 9.4) will be produced post-consent in consultation with the MMO and relevant SNCBs, and will be based on the latest scientific understanding and guidance, as well as detailed Project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of any permanent auditory injury (PTS) from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

601. The maximum predicted impact area for TTS from cumulative SEL during sequential piling at SEP and DEP in same 24-hour period is up to 17km^2 (**Table 8-56**).

602. As a worst-case the maximum number of bottlenose dolphin that could be affected during piling at SEP and DEP, is up to 0.5 individuals (which represents 0.23% of the of the latest east coast of Scotland count of 224 bottlenose dolphin) (**Table 8-56**).

Table 8-56: Maximum Number of Bottlenose Dolphin Potentially at Risk of TTS During Piling at SEP and DEP

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Bottlenose dolphin	TTS = 17km^2	0.5 (SCANS-III density of 0.0298/km^2) (0.23% of east coast of Scotland population)	No Temporary effect MMMP would reduce risk of TTS

603. The effective implementation of the MMMP for piling will reduce the risk of PTS or TTS for bottlenose dolphin during piling at SEP and DEP, therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS or TTS) as a result of underwater noise during piling at SEP and / or DEP**.

8.4.2.1.2 Potential Effects of Underwater Noise during Other Construction Activities

604. Potential sources of underwater noise during construction activities, other than piling, include sea bed preparation, dredging, rock dumping, drilling (if piling is refused at any location), trenching and cable installation.

605. Underwater noise modelling was undertaken to assess the impact ranges of construction activities, other than piling, on bottlenose dolphin, and this has been used to determine the potential area of effect (for further information see **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) for further details).

606. For SEL_{cum} calculations, the duration of the noise is also considered, with all sources operating for a worst-case of 24 hours in any given 24-hour period for non-impulsive noise.

607. The cumulative impact ranges are to the nearest 100m, however, they are likely to be less than 100m especially for PTS impact ranges.

608. The results of the underwater noise modelling indicate that bottlenose dolphin 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 based on the Southall *et al*. (2019) non-impulsive thresholds and criteria for SEL_{cum}.

609. PTS as a result of construction activity, other than piling, is highly unlikely. Similarly, there is unlikely to be any significant risk of TTS.

610. The maximum potential impact area for PTS or TTS for each activity (cable laying, trenching, rock placement, drilling and dredging) is less than $0.03km^2$.

611. There is the potential that more than one of these activities could be underway at either site or the export cable corridor area at the same time. As a worst-case and unlikely scenario, an assessment for all five activities ($0.15km^2$) has been undertaken (**Table 8-57**).

612. The potential 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 periods for SEP and DEP and would be limited to only part of the overall construction period and area at any one time.

613. The assessment indicates (**Table 8-57**) that there would be no significant effects on bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) as a result of underwater noise during construction activities, other than piling, for SEP or DEP in isolation.**

614. No additional mitigation is required or proposed for underwater noise for construction activities, other than piling.

Table 8-57: Maximum Number of Bottlenose Dolphin (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities, Based on all Activities at the Same Time at SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging ($0.15km^2$)	Bottlenose dolphin (HF)	SEP or DEP	0.0045 (SCANS-III density of $0.0298/km^2$) (0.002% of east coast of Scotland population)	No

615. As a worst-case the maximum number of bottlenose dolphin from each Project has been assessed to indicate the maximum number that could be impacted from SEP and DEP, if they are built concurrently (**Table 8-58**).

Table 8-58: Maximum Number of Bottlenose Dolphin (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 SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging ($0.3km^2$)	Bottlenose dolphin (HF)	SEP & DEP	0.009 (SCANS-III density of $0.0298/km^2$) (0.004% of east coast of Scotland population)	No

616. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project, therefore four years for SEP and DEP. However, construction activities would not be underway constantly throughout this period.

617. The duration of offshore export cable installation and trenching activities is expected to take approximately 100 days for SEP and DEP.

618. The assessment indicates (**Table 8-58**) that there would be no significant disturbance of bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) as a result of underwater noise during construction activities, other than piling, for SEP and DEP**.

619. No additional mitigation is required or proposed for underwater noise from construction activities, other than piling.

8.4.2.1.3 Potential Effects of Underwater Noise and Disturbance from Construction Vessels

620. During the construction phase there will be an increase in the number of vessels. This is estimated to be up to 16 vessels within the SEP or DEP wind farm sites and export cable corridor at any one time. The number, type and size of vessels will vary depending on the activities taking place at any one time.

621. 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 SEP and DEP wind farm sites and offshore cable corridor area.

622. The results of the underwater noise modelling (**ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) indicate that bottlenose dolphin would have to be less than 100m (precautionary maximum range) from the vessel for 24 hours to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al*. (2019) thresholds and criteria.

623. The maximum potential impact area for PTS or TTS for each vessel is less than 0.03km^2. The total impact area for up to 16 vessels is 0.48km^2.

624. PTS is unlikely as the modelling indicates that bottlenose dolphin would have to remain less than 100m for 24 hours for any potential risk.

625. The number of bottlenose dolphin that could be impacted from any TTS as a result of underwater noise during construction from vessels has been assessed based on the maximum impact area for SEP or DEP in isolation of up to 16 vessels (**Table 8-59**).

Table 8-59: Maximum Number of Bottlenose Dolphin (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Construction Vessels at SEP or DEP in Isolation

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for all vessels	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure for 16 vessels (0.48km^2)	Bottlenose dolphin (HF)	SEP or DEP	0.014 (SCANS-III density of 0.0298/km^2) (0.0064% of east coast of Scotland population)	No

626. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project. Therefore, it is assumed that construction vessels could be on either SEP or DEP wind farm site or the export cable corridor, for two years.

627. If the behavioural response is displacement from the area, it is predicted that bottlenose dolphin will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on bottlenose dolphin.

628. The assessment indicates (**Table 8-59**) that there would be no significant disturbance of bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) as a result of underwater noise from construction vessels for SEP or DEP in isolation**.

629. No additional mitigation is required or proposed for underwater noise from construction vessels.

630. As a worst-case the maximum number of bottlenose dolphin from each Project has been assessed to indicate the maximum number that could be impacted from SEP and DEP, if they are developed concurrently, based on up to 25 vessels at the two sites (**Table 8-60**).

Table 8-60: Maximum Number of Bottlenose Dolphin (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Construction Vessels at SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of reference population) for all vessels	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for 25 vessels (0.75km^2)	Bottlenose dolphin (HF)	SEP & DEP	0.022 (SCANS-III density of 0.0298/km^2) (0.01% of east coast of Scotland population)	No

631. The assessment indicates that there would be no significant disturbance of bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) as a result of underwater noise from construction vessels for SEP and DEP**.

8.4.2.1.4 Potential Barrier Effects from Underwater Noise

632. Underwater noise during construction could have the potential to create a barrier effect, preventing movement of bottlenose dolphin or potentially increasing swimming distances if they avoid the area. Bottlenose dolphin are known to move along the coast and are therefore unlikely to be affected as a result of underwater noise at the OWF sites.

633. The worst-case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area and longest duration) scenarios.

634. For bottlenose dolphin this would be the maximum predicted impact area for TTS from cumulative SEL during sequential piling at SEP and DEP in the same 24 hour period of up to 17km^2 (**Table 8-56**).

635. As previously assessed, the maximum number of bottlenose dolphin that could be affected during piling at SEP and DEP, is up to 0.5 (which represents 0.23% of the of the latest east coast of Scotland count of 224 bottlenose dolphin) (**Table 8-56**).

636. Therefore, there would be no significant disturbance of bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential barrier effects as a result of underwater noise during construction for SEP and / or DEP**.

8.4.2.1.5 Potential Effects of Any Increased Collision Risk with Construction Vessels

637. During the offshore construction phase of SEP and DEP there will be an increase in vessel traffic within and on transit to the offshore sites. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

638. Although the risk of collision is likely to be low, as a precautionary worse-case scenario, the number of bottlenose dolphin that could be at increased collision risk with vessels during construction has been assessed based on 5% of the number of animals that could be present in the SEP and DEP wind farm sites and export cable corridors potentially being at increased collision risk (**Table 8-61**). This has been based on the percentage of harbour porpoise post mortem examinations with evidence of interaction with vessels, as there is currently no information on the potential collision risk for bottlenose dolphin.

639. This is a highly precautionary assumption, as it is unlikely that all bottlenose dolphin present in the SEP and DEP wind farm sites and export cable corridors could be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number of vessel movements in the area and that vessels within the wind farm sites and cable corridor areas would be stationary or very slow moving. In addition, based on the assumption that bottlenose dolphin would be disturbed as a result of the vessel noise and presence, there should be no potential for increased collision risk with construction vessels.

640. As previously outlined, the assessments for bottlenose dolphin have been based on a very precautionary approach, as there is currently no density estimate for the area in and around SEP and DEP. In addition, bottlenose dolphin are more likely to be present close to shore, rather than the offshore areas. Therefore, the risk to bottlenose dolphin is likely to be a lot less than in the worst-case assessment.

641. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk (see the **Draft MMMP** (document reference 9.4)). 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 (see the **Draft MMMP** (document reference 9.4)).

642. Therefore, there would be no increased collision risk of bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential collision risk with vessels for SEP and / or DEP**.

Table 8-61: Estimated Number of Bottlenose Dolphin (and % of Reference Population) that Could be at Increased Collision Risk with Construction Vessels, based on 5% of Individuals Present in SEP or DEP and Export Cable Corridor

Species	Location (impact areas)	5% vessel collision risk Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Bottlenose dolphin	SEP wind farm site and export cable corridor area (160.8km^2)	24 (SCANS-III density of 0.0298/km^2) (0.11% of east coast of Scotland population)	No
	DEP wind farm site and export cable corridor area (211.6km^2)	0.32 (SCANS-III density of 0.0298/km^2) (0.14% of east coast of Scotland population)	No
	SEP & DEP wind farm sites and export cable corridor areas (372.4km^2)	0.55 (SCANS-III density of 0.0298/km^2) (0.25% of east coast of Scotland population)	No

8.4.2.1.6 Potential Effects of Any Changes to Water Quality

643. Sediment contamination levels across the offshore sites are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment (**Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Any potential changes to water quality during construction of SEP and DEP would be negligible.

644. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to changes in water quality as a result of all construction activities for SEP and / or DEP**.

8.4.2.1.7 Potential for Any Changes in Prey Availability

645. The potential effects on prey species during construction can result from physical disturbance and loss of sea bed habitat; increased suspended sediment concentrations (SSC) and sediment re-deposition; and underwater noise. **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. 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 SEP and DEP would result in detectable changes to bottlenose dolphin populations

646. Bottlenose dolphin are opportunistic feeders, feeding on wide range of prey species and have large foraging ranges (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)).

647. Any changes in prey availability, based on the worst-case for TTS SEL_{cum} for fish species with a swim bladder involved in hearing, using the fleeing response model is 330km^2 at DEP and 210km^2 at SEP. This is the largest potential impact range for prey (fish) species, and has therefore been used to inform the below worst-case and precautionary assessment. This assessment assumes that all bottlenose dolphin within the largest impact area for fish (as noted above) would be at risk of a reduction in prey availability, due to the prey (fish) species themselves being potentially affected within that area.

648. The number of bottlenose dolphin that could potentially be affected by any changes in prey availability is up to 16 individuals (7.2% of east coast of Scotland population; **Table 8-62**) for SEP and DEP. This means that, under the precautionary assumptions of this assessment, up to 16 bottlenose dolphin could be at risk of a reduced (or removed) potential to forage within that area. More realistically, however, the reduction of prey (fish) species availability would not be for all fish within that area, and bottlenose dolphin would be able to forage within that area still, or, would be able to travel outside of that area to forage, with no reduction or impact to the overall population anticipated.

649. However, as previously outlined, the assessments for bottlenose dolphin have been based on a very precautionary approach, as there is currently no density estimate for the area in and around SEP and DEP. In addition, bottlenose dolphin are more likely to be present close to shore, rather than the offshore areas. Therefore, any potential effects on bottlenose dolphin as a result of any changes to prey availability is likely to be a lot less than in the worst-case assessment.

650. It is highly unlikely that there would be significant changes to prey over the entire area. It is more likely that effects would be restricted to an area around the working sites.

651. Mitigation to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species.

652. Therefore, there will be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin as a result of any changes to prey availability due to underwater noise during piling for SEP and / or DEP**.

653. No further mitigation is required or proposed in relation to any changes in prey availability.

Table 8-62: Maximum Number of Bottlenose Dolphin (and % of Reference Population) that Could be Impacted as a Result of Changes in Prey Availability During Piling at SEP or DEP

Potential Impact	Location (impact areas)	Maximum number of individuals (% of SAC count and reference population)	Potential adverse effect on site integrity
Changes in prey availability	SEP (210km^2)	6.3 (SCANS-III density of 0.0298/km^2) (2.79% of east coast of Scotland population)	**No** It is highly unlikely that there would be significant changes to prey over the entire area. It is more likely that effects would be restricted to an area around the working sites. Mitigation to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species
	DEP (330km^2)	9.8 (SCANS-III density of 0.0298/km^2) (4.39% of east coast of Scotland population)	
	SEP & DEP (540km^2)	16.1 (7.18% of east coast of Scotland population)	

8.4.2.2 Potential Effects During Operation and Maintenance

8.4.2.2.1 Potential Effects of Underwater Noise from Operational Turbines

654. The operational turbines will operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The SEP and DEP design life is 40 years. Therefore, there is concern that underwater noise from operational turbines could contribute a consistent, long duration of sound to the marine environment.

655. However, 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 turbine (Tougaard *et al*., 2009a; Sigray and Andersson, 2011). Although, bottlenose dolphin are frequently observed in and around the Aberdeen OWF (European Offshore Wind Deployment Centre).

656. The results of the underwater noise modelling indicate that bottlenose dolphin would have to be less than 100m (precautionary maximum range) for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

657. The maximum potential impact area for PTS or TTS for each operational turbine is less than $0.03km^2$.

658. The potential effect for any TTS as a result of underwater noise from all operational wind turbines at each site (23 at SEP and 30 at DEP) has been assessed (**Table 8-63**).

659. The indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.05km (maximum of 3.3km) therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine.

660. Taking into account the number of bottlenose dolphin potentially affected as a result of underwater noise from operational turbines (**Table 8-63**) there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) from increased underwater noise from operational turbines at SEP and / or DEP**.

661. No additional mitigation is required or proposed for underwater noise from operational turbines.

Table 8-63: Maximum Number of Bottlenose Dolphin (and % of Reference Population) that Could be at Risk of TTS from Cumulative Exposure for All Operational Turbines at SEP and DEP

Species	Location (impact areas)	Operational turbines Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Bottlenose dolphin	SEP (up to 23 wind turbines; $0.69km^2$)	0.021 (SCANS-III density of $0.0298/km^2$) (0.009% of east coast of Scotland population)	No
	DEP (up to 30 wind turbines; $0.90km^2$)	0.027 (SCANS-III density of $0.0298/km^2$) (0.012% of east coast of Scotland population)	No
	SEP & DEP (up to 53 wind turbines; $1.59km^2$)	0.047 (SCANS-III density of $0.0298/km^2$) (0.021% of east coast of Scotland population)	No

8.4.2.2.2 Potential Effects of Underwater Noise during Operation and Maintenance Activities

662. The underwater noise from maintenance activities are considered to be the same or less than those assessed for underwater noise from other construction activities.
663. Therefore, there would be no significant effects on bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) from increased underwater noise during operation and maintenance activities for SEP and / or DEP.**
664. No additional mitigation is required or proposed for underwater noise during maintenance activities.

8.4.2.2.3 Potential Effects of Underwater Noise and Disturbance from Operation and Maintenance Vessels

665. The underwater noise from operation and maintenance activities are considered to be the same or less than those assessed for underwater noise from construction vessels.
666. Therefore, there would be no significant effects on bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS and TTS) and disturbance due to increased underwater noise from operation and maintenance vessels for SEP and / or DEP.**
667. No additional mitigation is required or proposed for underwater noise from operation and maintenance vessels.

8.4.2.2.4 Potential Barrier Effects from Underwater Noise during Operation and Maintenance

668. No barrier effects as a result of underwater noise during operation and maintenance are anticipated.
669. Any potential barrier effects from underwater noise during operation and maintenance would be less than those assessed for barrier effects from underwater noise during construction.
670. Therefore, there would be no significant effects on bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to barrier effects from underwater noise during operation and maintenance for SEP and / or DEP**.
671. No additional mitigation is required or proposed for barrier effects from underwater noise during operation and maintenance.

8.4.2.2.5 Potential Effects of Any Increased Collision Risk with Operation and Maintenance Vessels

672. 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 seven, which is considerably less than the 16 vessels that could be on site during construction. However, as a precautionary approach the assessment for construction has been used for the operational and maintenance assessment, as a worst-case scenario. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

673. The assessment of collision risk, as presented for the construction phase (**Section 8.4.2.1.5**), is based on the total project area, within which additional vessels may be present, and is not based on the number of vessels present within that area. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

674. In line with the construction assessment, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to increased collision risk from operation and maintenance vessels for SEP and / or DEP**.

8.4.2.2.6 Potential Effects of Any Changes to Water Quality during Operation and Maintenance

675. Sediment contamination levels across the offshore sites are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment (**Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Any potential changes to water quality during construction of SEP and DEP would be negligible. Any changes in water quality during operation and maintenance would be less than during construction.

676. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphins due to any changes in water quality during the operation and maintenance phase for SEP and / or DEP**.

8.4.2.2.7 Potential for Any Changes in Prey Availability during Operation and Maintenance

677. The potential impacts of permanent loss or change of habitat, physical disturbance, temporary habitat loss, EMF, increased SSC, re-mobilisation of contaminated sediment and underwater noise on changes in prey availability are localised and, in some cases, short in duration. **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. Therefore, there will be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to changes in prey availability during the operation and maintenance phase for SEP and / or DEP**.

8.4.2.3 Potential Effects During Decommissioning

678. Potential effects on bottlenose dolphin 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 the regulator prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

679. Decommissioning would most likely involve the removal of the accessible installed components comprising: all of the wind turbine components; part of the foundations (those above sea bed level); and the sections of the infield cables close to the offshore structures, as well as sections of the export cables. The process for removal of foundations is generally the reverse of the installation process. There would be no piling, and foundations may be cut to an appropriate level.

680. 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).

681. The potential effects on bottlenose dolphin during decommissioning would be the same or less than those assessed for construction, meaning no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin.

8.4.2.4 Potential In-Combination Effects

682. The in-combination assessment is based on both SEP and DEP being constructed, as the worst-case scenario. If only SEP or DEP were to be developed, all potential in-combination effects would be less than as assessed.

683. The in-combination assessment considers plans or projects where the potential effects from SEP and DEP have the potential to interact with potential effects from the proposed construction, operation and maintenance or decommissioning of other projects.

684. The projects screened into the in-combination assessment for bottlenose dolphin are those that are located in the Greater North Sea MU (IAMMWG, 2015).

685. Full information on the screening of other projects and in-combination effects (including increased collision risk and changes to prey availability) is provided in **ES Appendix 10.3 Marine Mammal CIA Screening** (document reference 6.3.10.3). For bottlenose dolphin, all other potential effects, including PTS from underwater noise, TTS from underwater noise, changes to prey availability, increased collision risk with vessels and all operational effects have been screened out, with no potential for in-combination effects (see **Section 8.4.1.6**). Note that the potential for TTS / fleeing response has been used as a proxy for disturbance where disturbance specific thresholds are not available.

686. The potential in-combination effect for foraging bottlenose dolphin from the Moray Firth SAC screened in for assessment is:

- Disturbance from underwater noise.

687. See **Section 8.4.1.6** for further details on the approach to the inclusion of relevant effects to the in-combination assessment.

688. For each project or activity located within the wider bottlenose dolphin Greater North Sea MU, the number of bottlenose dolphin that could be within the potential area of effect, has been estimated using the latest SCANS-III density estimates (Hammond *et al.,* 2021) for the relevant survey block within which each project or activity is located. For any project or activity located within a survey block with no bottlenose dolphin density estimate, the nearest block has been used, e.g. density estimate for block R for projects and activities located in block O and density estimate for block S for project and activities located in block T (**Table 8-64**).

689. The potential disturbance from piling activities has been estimated for each individual project screened in for assessment, based on the maximum impact range and area for the worst-case modelled at SEP and DEP for TTS (weighted SEL_{cum}) of 0.44km^2 for each OWF project. Piling at both SEP and DEP has been included in the in-combination assessment as a worst-case scenario.

690. The potential temporary disturbance during OWF construction activities, other than piling, has been based on worst-case areas used in assessments for SEP and DEP for all construction activities other than piling (with a disturbance area of 0.15km^2 for bottlenose dolphin) and all construction vessels (0.63km^2), totalling a potential disturbance area of 0.8km^2 for each OWF. This is a very precautionary approach, as it is highly unlikely that all non-piling construction activities and all vessels would be on site at any one time. Any disturbance is likely to be limited to the area in and around where the activity is actually taking place.

691. The potential disturbance from UXO clearance has been estimated based on the potential impact area during a single UXO clearance event, based on the modelled worst-case impact range at SEP and DEP for TTS (unweighted SPL_{peak}) of 5.3km^2.

692. There is little available information on the potential for disturbance ranges from seismic surveys for bottlenose dolphin, however, observations of behavioural changes in common dolphins in the Irish Sea show a reduced vocalisation rate and / or exclusion within 1km of a 2D seismic survey (of 2,120 cubic inches) (Goold, 1996). Strong avoidance of bottlenose dolphin from a 2D seismic survey (with 470 cubic inch airguns, and a peak sound source level of 243 dB re 1 µPa @1m) was also modelled at between 1.8km and 11km (based on site specific underwater noise modelling using the dBht method) (DECC, 2011d). This equates to an area of 380.13km^2, assuming the largest potential disturbance range of 11km. A potential disturbance range of 11km (disturbance area of 380.13km^2) has therefore been used in the assessment for each seismic survey.

693. As a worst-case for geophysical surveys, it has been assumed that bottlenose dolphin within a total area of 3.1km^2, could also be disturbed for each geophysical survey.

694. The potential in-combination effects from all possible noise sources during piling at SEP and DEP is summarised in **Table 8-64**.

695. Based on the worst-case scenarios and precautionary approach, there is the potential for up 23.2 bottlenose dolphin (10.3% of the east coast of Scotland count; 1.15% of GNS MU) to be disturbed (**Table 8-64**). However, it should be noted that it is considered highly unlikely that all activity, and all bottlenose dolphin potentially affected, would be from the Moray Firth SAC, as the potential for effect would most likely occur offshore, where the Moray Firth bottlenose dolphin population are unlikely to be (given their preference of the nearshore area). In addition, a number of the in-combination projects included below are in locations with no known connectivity with the Moray Firth bottlenose dolphin population. Therefore, the assessment against the GNS MU is considered more appropriate for in-combination effects.

696. Therefore, there would be no significant disturbance and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to any potential effects mentioned in Section 8.4.2.1 and 8.4.2.2 for SEP and DEP in-combination with other plans and projects**.

Table 8-64: In-Combination Assessment for the Potential Disturbance of Bottlenose Dolphin from All Possible Noise Sources during Piling at SEP and DEP

In-combination Effects	Area (km^2)	SCANS-III survey block	Density estimate/km^2	Number of bottlenose dolphin	% of east coast of Scotland population	% GNS MU
Piling at OWFs						
SEP	0.44	O/R	0.0298	0.013	0.0059	0.000648
DEP	0.44	O/R	0.0298	0.013	0.0059	0.000648
Berwick Bank	0.44	R	0.0298	0.013	0.0059	0.000648
Dogger Bank South	0.44	O/R	0.0298	0.013	0.0059	0.000648
East Anglia ONE North	0.44	L	0	0	0	0
East Anglia TWO	0.44	L	0	0	0	0
Five Estuaries	0.44	L	0	0	0	0
Hornsea Project Four	0.44	O/R	0.0298	0.013	0.0059	0.000648
North Falls	0.44	L	0	0	0	0
Outer Dowsing	0.44	O/R	0.0298	0.013	0.0059	0.000648
Other OWF construction activities and vessels						
Norfolk Boreas	0.63	O/R	0.0298	0.019	0.0084	0.000928
Norfolk Vanguard	0.63	O/R	0.0298	0.019	0.0084	0.000928
Dolphyn Project	0.63	T/S	0.0037	0.002	0.0010	0.000115
Salamander	0.63	R	0.0298	0.019	0.0084	0.000928

In-combination Effects	Area (km^2)	SCANS-III survey block	Density estimate/km^2	Number of bottlenose dolphin	% of east coast of Scotland population	% GNS MU
Two geophysical surveys	760.3	O/R	0.0298	22.7	10.1	1.1
Two seismic surveys	6.2	O/R	0.0298	0.185	0.0825	0.0091
UXO clearance	5.3	O/R	0.0298	0.16	0.071	0.0078
Total				**23.2**	**10.3%**	**1.15%**

8.4.2.5 Summary of Potential Effects on Site Integrity

697. The assessment of the potential effects for SEP and DEP has been summarised in relation to the Moray Firth SAC conservation objectives for bottlenose dolphin (**Table 8-65**).

698. There would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to any potential effects mentioned in Section 8.4.2.1 and 8.4.2.2 for SEP and DEP either alone or in-combination with other plans and projects**.

Table 8-65: Summary of the Potential Effects of SEP and DEP, Including In-Combination Effects on the Moray Firth SAC in Relation to the Conservation Objectives for Bottlenose Dolphin

Conservation Objectives	SEP and DEP Effects			In-combination Effects
	Disturbance from underwater noise	Increased collision risk	Changes to prey availability	Disturbance from underwater noise during construction
Population of the species (including range of genetic types where relevant) as a viable component of the site	×	×	×	×
Distribution of the species within site	×	×	×	×
Distribution and extent of habitats supporting the species	×	×	×	×
Structure, function and supporting processes of habitats supporting the species	×	×	×	×
No significant disturbance of the species	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives

8.4.3 Humber Estuary SAC

699. The potential effects during the construction, operation, maintenance and decommissioning of SEP and DEP in relation to grey seal from the Humber Estuary SAC were agreed in consultation with the marine mammal ETG as part of the EPP. The potential effects of SEP and / or DEP are assessed to determine any potential for an adverse effect on the integrity of the Humber Estuary SAC in relation to the Conservation Objectives for grey seal are:

- Underwater noise (including piling, other construction activities, vessels, operational turbines, O&M activities and decommissioning activities)
- Any barrier effects from underwater noise
- Any increased collision risk with vessels
- Disturbance at seal haul-out sites
- Disturbance of foraging seals at sea
- Changes to water quality
- Changes to prey availability
- In-combination effects

8.4.3.1 Potential Effects During Construction

8.4.3.1.1 Potential Effects of Underwater Noise during Piling

700. Impact piling is a source of high-level underwater noise and causes both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals. The potential for permanent auditory injury (PTS) and disturbance have therefore been assessed in the following sections. Due to the lack of a threshold of disturbance for grey seal, the assessment of disturbance for this species is based in using temporary auditory injury (TTS / fleeing response) thresholds where appropriate.

701. Underwater noise modelling was carried out by Subacoustech to estimate the noise levels likely to arise during piling and determine the maximum potential areas of effect (see **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) for further details).

702. The maximum predicted impact range for PTS and TTS is 0.7km and 9.7km, respectively, for cumulative SEL (including soft-start and ramp-up) of a monopile with maximum hammer energy of 5,500kJ.

703. The Humber Estuary SAC is approximately 62.2km from DEP, 59.7km from SEP and 77.1km from the export cable corridors, at the closest point. Therefore, there is no direct overlap with the Humber Estuary SAC. However, it is assumed that grey seal in and around SEP and DEP could be from the Humber Estuary SAC.

704. The maximum potential number of grey seal that could be at possible risk of PTS from SEL_{cum} during piling, without any mitigation, could be up to 1.03 individuals (0.03% of SAC count; 0.012% of South East (SE) MU) at DEP (**Table 8-66**). For SEP, the maximum potential number of grey seal that could be at possible risk of PTS from SEL_{cum} during piling, without any mitigation, could be up to 0.72 individuals (0.018% of SAC count; 0.008% of SE MU) (**Table 8-66**).

Table 8-66: Maximum Number of Grey Seal Potentially at Risk of PTS or TTS during Piling at SEP or DEP

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Grey seal	PTS at SEP = 0.84km^2	0.72 (SEP density of 0.853/km^2) (0.018% of SAC count; 0.008% of SE MU)	**No** MMMP would reduce risk of PTS
	PTS at DEP = 1.44km^2	1.03 (DEP density of 0.739/km^2) (0.03% of SAC count; 0.012% of SE MU)	
	TTS at SEP = 140km^2	119.4 (SEP density of 0.853/km^2) (3.1% of SAC count; 1.4% of SE MU)	**No** Less than 5% of population temporary disturbed MMMP would reduce risk of TTS
	TTS at DEP = 220km^2	162.6 (DEP density of 0.739/km^2) (4.2% of SAC count; 1.9% of SE MU)	

705. As outlined in **Section 8.3.1**, a MMMP for piling in accordance with the **Draft MMMP** (document reference 9.4) will be produced post-consent in consultation with the MMO and relevant SNCBs, and will be based on the latest scientific understanding and guidance, as well as detailed Project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of any permanent auditory injury (PTS) from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

706. The effective implementation of the MMMP for piling will reduce the risk of PTS and TTS to grey seal during piling at SEP or DEP, therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS) from increased underwater noise during construction (piling) for SEP or DEP in isolation**.

707. There are currently no agreed thresholds or criteria for modelling the potential disturbance of other marine mammal species from underwater noise. For marine mammals, including grey seal, a fleeing response is assumed to occur at the same noise levels as TTS.

708. Disturbance during piling would be temporary and for a relatively short duration (i.e. during active piling). It is unlikely that all grey seal potentially affected would be from the Humber Estuary SAC, which is located over 59km from SEP and DEP (at closest point).

709. With less than 5% of the Humber Estuary SAC count temporarily disturbed there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise during construction (piling) for SEP or DEP in isolation**.

710. The maximum predicted impact area for PTS or TTS from cumulative SEL during sequential piling (see **Section 8.3.2**) at SEP and DEP in the same 24 hour period is up to 18km^2 or 370km^2, respectively (**Table 8-67**).

711. The maximum predicted impact area for PTS or TTS from cumulative SEL during simultaneous piling at SEP and DEP in the same 24 hour period is up to 33km^2 or 520km^2, respectively (**Table 8-67**).

712. As a worst-case, the maximum number of grey seal that could be affected during piling at SEP and DEP, is up to 382 individuals (9.8% of SAC count; 4.4% of SE MU) (**Table 8-67**).

Table 8-67: Maximum Number of Grey Seal Potentially at Risk of PTS or TTS during Piling at SEP and DEP

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Grey seal	PTS from sequential piling at SEP & DEP = 18km^2	13.23 (density of 0.735/km^2) (0.34% of SAC count; 0.15% of SE MU)	**No** MMMP would reduce risk of PTS
	PTS from simultaneous piling at SEP & DEP = 33km^2	24.3 (density of 0.735/km^2) (0.62% of SAC count; 0.28% of SE MU)	
	TTS from sequential piling at SEP & DEP = 370km^2	272 (density of 0.735/km^2) (7% of SAC count; 3.14% of SE MU)	**No** Temporary effect MMMP would reduce risk of TTS
	TTS from simultaneous piling at SEP & DEP = 520km^2	382 (density of 0.735/km^2) (9.8% of SAC count; 4.4% of SE MU)	

713. The effective implementation of the MMMP for piling will reduce the risk of PTS and TTS for grey seal during piling at SEP and DEP, therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS) or disturbance from increased underwater noise during construction (piling) for SEP and DEP**.

8.4.3.1.2 Potential Effects of Underwater Noise during Other Construction Activities

714. The results of the underwater noise modelling indicate that grey seal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al*. (2019) non-impulsive thresholds and criteria for SELcum.

715. PTS as a result of construction activity, other than piling, is highly unlikely. Similarly, there is unlikely to be any significant risk of TTS.

716. The maximum potential impact area for PTS or TTS for each activity (cable laying, trenching, rock placement, drilling and dredging) is less than 0.03km^2.

717. There is the potential that more than one of these activities could be underway at either wind farm site or the export cable corridor area at the same time. As a worst-case and unlikely scenario, an assessment for all five activities (0.15km^2) has also been undertaken (**Table 8-68**).

718. The potential 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 periods for SEP and DEP and would be limited to only part of the overall construction period and area at any one time.

719. If grey seal are displaced from the area, it is predicted that they 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 impact on grey seal.

720. The assessment indicates (**Table 8-68**) that there would be no significant disturbance of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS and TTS) from increased underwater noise from other construction activities, other than piling, for SEP or DEP in isolation**.

721. No additional mitigation is required or proposed for underwater noise for construction activities, other than piling.

Table 8-68: Maximum Number of Grey Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Non-Piling Construction Activities at the Same Time at SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC count and SE MU) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging ($0.15km^2$)	Grey seal	SEP or DEP	0.11 (density of $0.735/km^2$) (0.0028% of SAC count; 0.0013% of SE MU)	**No**

722. As a worst-case the maximum number of grey seal from each Project has been assessed to indicate the maximum number that could be impacted from SEP and DEP, if they are developed concurrently (**Table 8-69**).

Table 8-69: Maximum Number of Grey Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with all Non-Piling Construction Activities at the Same Time at SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC count and SE MU) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging ($0.3km^2$)	Grey seal	SEP & DEP	0.22 (0.006% of SAC count; 0.003% of SE MU)	**No**

723. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project, therefore four years for SEP and DEP. However, construction activities would not be underway constantly throughout this period.

724. The duration of offshore export cable installation and trenching activities is expected to take approximately 100 days for SEP and DEP.

725. The assessment indicates that there would be no significant disturbance of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS and TTS) from increased underwater noise from other construction activities, other than piling, for SEP and DEP**.

726. No additional mitigation is required or proposed for underwater noise from construction activities, other than piling.

8.4.3.1.3 Potential Effects of Underwater Noise and Disturbance from Construction Vessels

727. During the construction phase there will be an increase in the number of vessels. This is estimated to be up to 16 vessels on site at the wind farm sites and offshore cable corridors at any one time. The number, type and size of vessels will vary depending on the activities taking place at any one time.

728. 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 SEP and DEP wind farm sites and offshore cable corridor area.

729. The results of the underwater noise modelling indicate that grey seal would have to be less than 100m (precautionary maximum range) from the vessel for 24 hours, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al*. (2019) thresholds and criteria.

730. The maximum potential impact area for PTS or TTS for each vessel is less than 0.03km^2. The total impact area for up to 16 vessels is 0.48km^2.

731. PTS is unlikely as the modelling indicates that grey seal would have to remain less than 100m for 24 hours for any potential risk.

732. The number of grey seal that could be impacted from any TTS as a result of underwater noise during construction from vessels has been assessed based on the maximum impact area for up to 16 vessels (**Table 8-70**).

Table 8-70: Maximum Number of Grey Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Construction Vessels at SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC and SE MU) for all vessels	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure for 16 vessels (0.48km^2)	Grey seal	SEP or DEP	0.35 (density of 0.735/km^2) (0.009% of SAC count; 0.004% of SE MU)	No

733. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project. Therefore, it is assumed that construction vessels could be on either the SEP or DEP wind farm site or export cable corridor area, for two years.

734. If the behavioural response is displacement from the area, it is predicted that grey seal will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on grey seal.

735. No additional mitigation is required or proposed for underwater noise from construction vessels.

736. As a worst-case the maximum number of grey seal from each Project has been assessed to indicate the maximum number that could be impacted from SEP and DEP, if they are developed concurrently, based on up to 25 vessels (**Table 8-71**).

737. The assessment indicates that there would be no significant disturbance of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS and TTS) and disturbance from increased underwater noise from construction vessels for SEP and / or DEP**.

Table 8-71: Maximum Number of Grey Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Construction Vessels at SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC and SE MU) for all vessels	Potential adverse effect on site integrity
TTS response from cumulative SEL, based on 24 hour exposure, for 25 vessels (0.75km^2)	Grey seal	SEP & DEP	0.55 (density of 0.735/km^2) (0.014% of SAC count; 0.0064% of SE MU)	No

8.4.3.1.4 Potential Barrier Effects from Underwater Noise

738. Underwater noise during construction could have the potential to create a barrier effect, preventing movement of grey seal between feeding and / or breeding areas, or potentially increasing swimming distances if grey seal avoid the site and go around it.

739. The worst-case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area and longest duration) scenarios.

740. For grey seal, this would be the maximum predicted impact area for TTS from cumulative SEL during simultaneous piling at SEP and DEP in the same 24 hour period of up to 520km^2 (**Table 8-67**).

741. Disturbance and any barrier effects during piling would be temporary and for a relatively short duration (i.e. during active piling). It is unlikely that all grey seal potentially affected would be from the Humber Estuary SAC, which is located over 59km from SEP and DEP (at closest point).

742. Therefore, there would be no significant disturbance of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential barrier effects from increased underwater noise during construction for SEP and / or DEP**.

8.4.3.1.5 Potential Effects of Any Increased Collision Risk with Construction Vessels

743. During the offshore construction phase of SEP and DEP there will be an increase in vessel traffic within and on transit to the offshore sites. However, it is anticipated that vessels would follow an established shipping route to and from the relevant ports in order to minimise vessel traffic in the wider area. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

744. Although the risk of collision is likely to be low, as a precautionary worse-case scenario, the number of grey seal that could be at increased collision risk with vessels during construction has been assessed based on 5% of the number of animals that could be present in the SEP wind farm site, DEP wind farm site and export cable corridor potentially being at increased collision risk (**Table 8-72**). This has been based on the percentage of harbour porpoise post mortem examinations with evidence of interaction with vessels, as there is currently no information on the potential collision risk for grey seal.

745. This is a highly precautionary assumption, as it is unlikely that all grey seal present in the SEP wind farm site, DEP wind farm site and export cable corridor could be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number vessel movements in the area and that vessels within the wind farm site and cable corridor areas would be stationary or very slow moving. In addition, based on the assumption that grey seal would be disturbed as a result of the vessel noise and presence, there should be no potential for increased collision risk with construction vessels.

746. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to 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 (see the **Draft MMMP** (document reference 9.4)).

747. As outlined above, it is unlikely that all grey seal potentially affected would be from the Humber Estuary SAC, which is located over 59km from SEP and DEP (at closest point).

748. Therefore, there would be no increased collision risk of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential vessel collision risk during construction for SEP and / or DEP**.

Table 8-72: Estimated Number of Grey Seal (and % of Reference Population) that Could be at Increased Collision Risk with Construction Vessels, Based on 5% of Individuals Present in SEP and / or DEP and Export Cable Corridor

Species	Location (impact area)	5% Vessel Collision Risk Maximum number of individuals (% of SAC count and SE MU)	Potential adverse effect on site integrity
Grey seal	SEP wind farm site and export cable corridor (160.8km^2)	6.9 (SEP wind farm site & export cable corridor density of 0.835/km^2) (0.18% of SAC count; 0.08% of SE MU)	**No** vessel movements will be kept to the minimum number and vessel operators will use good practice to reduce any risk of collisions with marine mammals
	DEP wind farm site and export cable corridor (211.6km^2)	7.8 (DEP & export cable corridor density of 0.739/km^2) (0.20% of SAC count; 0.09% of SE MU)	
	SEP & DEP wind farm sites and export cable corridor areas (372.4km^2)	14.7 (SEP, DEP & export cable corridor density of 0.735/km^2) (0.38% of SAC count; 0.17% of SE MU)	

8.4.3.1.6 Potential for Disturbance at Grey Seal Haul-Out Sites

749. The Humber Estuary SAC is located 59.7km from SEP and DEP at its closest point. The construction port(s) to be used for SEP and DEP will be Great Yarmouth which is currently used for SOW and DOW operation and maintenance activities. Vessel movements to and from any port will be incorporated within existing vessel routes. Taking into account the proximity of shipping channels to and from existing ports, 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.

750. Grey seal are more likely to respond to nearby vessels by moving into the water, due the speed of the vessel, rather than the distance, although movement into the water was generally observed to occur at distances of between 20 and 70m, with no detectable disturbance at 150m (Wilson, 2014; Strong and Morris, 2010). However, grey seal have been reported to move into the water when vessels are at a distance of approximately 200m to 300m (Wilson, 2014). Therefore, it is considered that, for grey seal, vessels travelling within 300m of a haul-out site may cause a grey seal to flee into water, and significant disturbance would be expected at a distance of less than 150m.

751. There is an existing relatively high level of vessel traffic within the navigational study area (SEP and DEP plus 10km buffer), including close to the coastline. In summer, an average of 82 vessels were recorded per day within the study area, and in winter an average of 81 vessels were recorded. High density navigation routes show an average of up to 111 vessels per day (per 4km^2) passing along a vessel route within 6km of Donna Nook (UK Government, 2022).

752. Vessel movements to and from any port will be incorporated within existing vessel routes, and would therefore be considerably further from the Donna Nook haul-out site than the 300m that is noted as being the distance at which grey seal will react to vessel presence. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels, and the additional construction vessels using these existing vessel routes while transiting to port would not make a significant increase in the potential for disturbance at grey seal haul-out sites.

753. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance at seal haul-out sites during construction for SEP and / or DEP**.

8.4.3.1.7 Potential for Disturbance of Foraging Grey Seals at Sea

754. Foraging grey seals have the potential to be disturbed due to underwater noise generating activities, and due to the increased presence of vessels at SEP and DEP, and in the vicinity of the vessel transit route from the construction port to SEP and DEP.

755. The potential for grey seal to be disturbed from foraging at sea during construction relates to both the potential direct disturbance of grey seal, and the potential for an effect on fish (prey species). In total, the greatest area of effect for any disturbance of foraging grey seal is up to 520km^2 for simultaneous piling at SEP and DEP (based on maximum TTS impact area).

756. If it is assumed, as an unlikely and worst-case scenario, that all grey seal within the total area would be disturbed, and that any disturbance could result in the cessation of foraging within that area, then a total of 382 grey seal could potentially be disturbed from foraging during simultaneous piling at SEP and DEP[12]. This effect could occur for up to 33 days, taking into account the duration of piling activities occurring at the same time.

757. For activities not including piling, which have the potential to take place over a longer time frame, of up to four years, less than one (0.22) harbour seal could be restricted from foraging throughout the entire construction period.

758. Therefore, between one and 382 grey seal (0.006-9.8% of SAC count; 0.003-4.4% of SE MU), could be temporarily disturbed from foraging at SEP and DEP, due to construction.

[12] Calculated from the density of grey seal, and the total piling disturbance areas. If a total of 382 grey seal could be disturbend from the area due to pilng, then they could also be disturbed from foraging within that area. This is highly precautionary, as it is unlikely that all grey seal present within those piling disturbance areas would be actively foraging at the time that the disturbing activity (i.e. piling) takes place.

759. It is however unlikely that there would be the potential for any significant disturbance of foraging grey seal from the Humber Estuary SAC, given the distance of 59.7km from the closest point of SEP and DEP to the SAC, and that grey seal are generalist feeders with wide foraging ranges. Any disturbance of foraging grey seals would be restricted to the area and duration of the activity, and there are other suitable habitats and prey available in the surrounding area. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance of foraging grey seals during construction for SEP and / or DEP.**

8.4.3.1.8 Potential Effects of Any Changes to Water Quality

760. Sediment contamination levels across the offshore sites are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment (**Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Any potential changes to water quality during construction of SEP and DEP would be negligible.

761. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to any changes in water quality during construction for SEP and / or DEP**.

8.4.3.1.9 Potential for Any Changes in Prey Availability

762. Grey seal feed on a variety of prey species and are considered to be opportunistic feeders, feeding on a wide range of prey species and have relatively large foraging ranges (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)).

763. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment on changes in prey availability are localised and short in duration **there will therefore be no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal from changes to prey availability for SEP and / or DEP**.

764. Any changes in prey availability during piling as a result of underwater noise, based on the worst-case for TTS SEL_{cum} for fish species with a swim bladder involved in hearing, using the fleeing response model is 330km^2 at DEP and 210km^2 at SEP. This is the largest potential impact range for prey (fish) species, and has therefore been used to inform the below worst-case and precautionary assessment. This assessment assumes that all grey seal within the largest impact area for fish (as noted above) would be at risk of a reduction in prey availability, due to the prey (fish) species themselves being potentially affected within that area.

765. As a worst-case, the number of grey seal that could potentially be affected by any changes in prey availability is up to 423 individuals (10.85% of SAC count; 4.88% of SE MU) for SEP and DEP. This means that, under the precautionary assumptions of this assessment, up to 423 grey seal could be at risk of a reduced (or removed) potential to forage within that area. More realistically, however, the reduction of prey (fish) species availability would not be for all fish within that area, and grey seal would be able to forage within that area still, or, would be able to travel outside of that area to forage, with no reduction or impact to the overall population anticipated.

766. It is highly unlikely that there would be significant changes to prey over the entire area. It is more likely that effects would be restricted to an area around the working sites, and the potential areas for habitat loss. The temporary habitat disturbance footprint is up to 7.87km^2 for SEP and DEP, and the permanent footprint is 1.159km^2, which represents a very small proportion of the area available for grey seal foraging from the Humber Estuary SAC; as noted above, grey seal typically forage up to 100km from their haul-out sites, which equates to a significantly large total foraging area for the individuals associated with the site.

767. Mitigation to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species.

768. As outlined above, it is unlikely that all individuals would be from the Humber Estuary SAC, therefore, it is predicted that there will be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal as a result of any changes to prey availability during construction for SEP and / or DEP**.

8.4.3.2 Potential Effects During Operation and Maintenance

8.4.3.2.1 Potential Effects of Underwater Noise from Operational Turbines

769. The underwater noise levels emitted during the operation of wind 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 turbine (Tougaard *et al.,* 2009a; Sigray and Andersson, 2011).

770. Currently available data indicates that there is no lasting disturbance or exclusion of seals around wind farm sites during operation (Russell *et al*., 2014). Data collected suggests that any behavioural responses for seals may only occur up to a few hundred metres away (McConnell *et al*., 2012).

771. Monitoring studies at Nysted and Rødsand have indicated that operational activities have had no impact on regional seal populations (Teilmann *et al*., 2006; McConnell *et al*., 2012). Tagged harbour seals have been recorded within two operational wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around wind turbine structures (Russell *et al*., 2014).

772. Furthermore, Russell *et al.,* (2014) report that seals have been shown to forage within operational wind farm sites, indicating no restriction to movements in operational OWF sites.

773. The results of the underwater noise modelling indicate that grey seal would have to be less than 100m (precautionary maximum range) for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al*. (2019) non-impulsive thresholds and criteria for SEL_{cum}.

774. The maximum potential impact area for PTS or TTS for each operational turbine is less than $0.03km^2$.

775. The potential effect for any TTS as a result of underwater noise from all operational wind turbines at each site (23 at SEP and 30 at DEP) has been assessed (**Table 8-73**).

776. The indicative separation distance between wind turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.05km (maximum of 3.3km) and therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine.

777. Taking into account the number of grey seal potentially affected as a result of underwater noise from operational turbines (**Table 8-73**) there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to operational noise from turbines for SEP and / or DEP**.

778. No additional mitigation is required or proposed.

Table 8-73: Maximum Number of Grey Seal (and % of Reference Population) that Could be at Risk of TTS from Cumulative Exposure for All Operational Turbines at SEP and / or DEP

Species	Location	Operational Turbines Maximum number of individuals (% of SAC count and SE MU)	Potential adverse effect on site integrity
Grey seal	SEP (up to 23 wind turbines; $0.69km^2$)	0.59 (SEP density of $0.853/km^2$) (0.015% of SAC count; 0.007% of SE MU)	No
	DEP (up to 30 wind turbines; $0.90km^2$)	0.67 (DEP density of $0.739/km^2$) (0.017% of SAC count; 0.008% of SE MU)	No
	SEP & DEP (up to 53 wind turbines; $1.59km^2$)	1.25 (0.032% of SAC count; 0.015% of SE MU)	No

8.4.3.2.2 Potential Effects of Underwater Noise during Operation and Maintenance Activities

779. The underwater noise from maintenance activities are considered to be the same or less than those assessed for underwater noise from for other construction activities.

780. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to increased underwater noise during operation and maintenance activities for SEP and / or DEP**.

781. No additional mitigation is required or proposed for underwater noise during maintenance activities.

8.4.3.2.3 Potential Effects of Underwater Noise and Disturbance from Operation and Maintenance Vessels

782. The underwater noise from operation and maintenance vessels are considered to be the same or less than those assessed for underwater noise from construction vessels.

783. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to increased underwater noise from operation and maintenance vessels for SEP and / or DEP**.

784. No additional mitigation is required or proposed for underwater noise from operation and maintenance vessels.

8.4.3.2.4 Potential Barrier Effects from Underwater Noise

785. No barrier effects as a result of underwater noise during operation and maintenance are anticipated.

786. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential barrier effects from underwater noise during operation and maintenance for SEP and / or DEP**.

787. No additional mitigation is required or proposed for barrier effects from underwater noise during operation and maintenance.

8.4.3.2.5 Potential Effects of Any Increased Collision Risk with Operation and Maintenance Vessels

788. 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 seven, which is considerably less than the 16 vessels that could be on site during construction. However, as a precautionary approach the assessment for construction has been used for the operational and maintenance assessment, as a worst-case scenario. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

789. The assessment of collision risk, as presented for the construction phase (**Section 8.4.3.1.5**), is based on the total project area, within which additional vessels may be present, and is not based on the number of vessels present within that area. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

790. In line with the construction assessment, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to increased collision risk from operation and maintenance vessels for SEP and / or DEP**.

8.4.3.2.6 Potential for Disturbance at Grey Seal Haul-Out Sites during Operation and Maintenance

791. Any potential disturbance at grey seal haul-out sites during operation and maintenance would be less than those assessed for during construction, as there are fewer vessels.

792. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential disturbance at haul-out sites from operation and maintenance vessels for SEP and / or DEP**.

8.4.3.2.7 Potential for Disturbance of Foraging Grey Seals at Sea during Operation and Maintenance

793. Any potential disturbance of foraging grey seal during operation and maintenance would be less than those assessed for during construction.

794. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential disturbance of foraging seals during operation and maintenance for SEP and / or DEP**.

8.4.3.2.8 Potential for Any Changes in Water Quality during Operation and Maintenance

795. Sediment contamination levels across the offshore sites are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment (**Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Any potential changes to water quality during construction of SEP and DEP would be negligible. Any changes in water quality during operation and maintenance would be less than during construction.

796. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to any changes in water quality during operation and maintenance for SEP and / or DEP**.

8.4.3.2.9 Potential for Any Changes in Prey Availability during Operation and Maintenance

797. The potential impacts of permanent loss or change of habitat, physical disturbance, temporary habitat loss, EMF, increased SSC, re-mobilisation of contaminated sediment and underwater noise on changes in prey availability are localised and, in some cases, short in duration. **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms.

798. Therefore, there would be no significant effects on grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential changes in prey availability from operation and maintenance vessels for SEP and / or DEP**.

8.4.3.3 Potential Effects During Decommissioning

799. Potential effects on grey seal 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 the regulator prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

800. Decommissioning would most likely involve the removal of the accessible installed components comprising: all of the wind turbine components; part of the foundations (those above sea bed level); and the sections of the infield cables close to the offshore structures, as well as sections of the export cables. The process for removal of foundations is generally the reverse of the installation process. There would be no piling, and foundations may be cut to an appropriate level.

801. 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).

802. The potential effects on grey seal during decommissioning would be the same or less than those assessed for construction meaning there would be no significant effects on grey seal and no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal at SEP and DEP.

8.4.3.4 Potential In-Combination Effects

803. The in-combination assessment is based on both SEP and DEP being built, as the worst-case scenario. If SEP or DEP were developed in isolation, all potential in-combination effects would be less than as assessed.

804. The in-combination assessment considers plans or projects where the potential effects from SEP and DEP alone have the potential to interact with potential effects from the proposed construction, operation and maintenance or decommissioning of other projects.

805. The projects screened into the in-combination assessment for grey seal are those that are located in the NE MU, SE MU and wider North Sea area.

806. Full information on the screening of other projects and in-combination effects (including increased collision risk and changes to prey availability) is provided in **ES Appendix 10.3 Marine Mammal CIA Screening** (document reference 6.3.10.3). For grey seal, all other potential effects, including PTS from underwater noise, TTS from underwater noise, changes to prey availability, increased collision risk with vessels and all operational effects have been screened out, with no potential in-combination effects.

807. The potential in-combination effect for foraging grey seal from the Humber Estuary SAC screened in for assessment is:

- Disturbance from underwater noise.

808. See **Section 8.4.1.6** for further details on the approach to in-combination assessment.

809. For each project or activity the number of grey seal that could be within the potential area of effect has been estimated, using the latest seal at sea usage maps to estimate densities (Carter *et al.,* 2020). Densities were calculated based on the grid cells that overlap with the relevant project or area, and the most recent grey and harbour seal population estimates were used to convert the Carter *et al.* (2020) relative densities to absolute densities. See **Section 8.2.3.1** for more information. For the wider area, densities were calculated for the entire area of the English North Sea, approximately covering the SE England and NE England MUs.

810. The potential disturbance from piling activities has been estimated for each OWF, based on the maximum impact range and area for the worst-case modelled at DEP for TTS (weighted SEL_{cum}) of 9.7km from each piling location (220km^2 for each OWF). Piling at both SEP and DEP has been included in the in-combination assessment as a worst-case scenario.

811. The potential temporary disturbance during OWF construction activities, other than piling, has been based on worst-case areas used in assessments for SEP and DEP for all construction activities (with a disturbance area of 0.15km^2 for grey seal) and all construction vessels (0.63km^2). With a total potential disturbance area of 0.8km^2 at each OWF. This is a very precautionary approach, as it is highly unlikely that all non-piling construction activities and all vessels would be on site at any one time. Any disturbance is likely to be limited to the area in and around where the activity is actually taking place.

812. There is little available information on the potential for disturbance from seismic surveys for grey seal, however, observations of behavioural changes in other seal species have shown avoidance reactions up to 3.6km from the source (for a seismic survey of 1,600 cu. in.) (Harris *et al*., 2001). A more recent assessment of potential for disturbance to seal species, as a result of seismic surveys, shows potential disturbance ranges from 13.3km to 17.0km from source (BEIS, 2020d). These ranges are based on modelled impact ranges, using the NMFS Level B harassment threshold of 160dB, for a noise source of 3,070 cubic inches, 4,240 cubic inches, or 8,000 cubic inches. A potential disturbance range of 17.0km (disturbance area of 907.9km^2) has therefore been used in the in-combination assessment for grey seal, due to a lack of species-specific information.

813. As a worst-case for geophysical surveys, it has been assumed that grey seal within 1km (a total area of 3.1km^2), could be disturbed for each geophysical survey

814. The potential impact area during a high-order UXO detonation, based on the modelled worst-case impact range at SEP and DEP for TTS (unweighted SPL_{peak}) is 20km (1,256.6km^2).

815. The potential in-combination effects from all possible noise sources during piling at SEP and DEP is summarised in **Table 8-74**.

816. Based on the worst-case scenarios and precautionary approach, there is the potential for up to 1,611 grey seal (up to 6.68% of the reference population) to be disturbed (**Table 8-74**). However, this should be considered a highly precautionary (and unrealistic) assessment, with actual in-combination effects likely to be lower, due to not all activities and projects taking place at the same time, and due to assessed disturbance ranges likely being smaller than those presented here, on an absolute worst-case basis only.

817. Taking into account mitigation for UXO and the SIP to reduce the significant disturbance of harbour porpoise from underwater noise in-combination effects, **there** would be no significant disturbance and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal from SEP and DEP in-combination with other plans and projects**.

Table 8-74: In-Combination Assessment for the Potential Disturbance of Grey Seal from All Possible Noise Sources during Piling at SEP and DEP

In-combination Effects	Area (km^2)	Density estimate/km^2	Number of grey seal
Piling at OWFs			
SEP	140	0.853	119.42
DEP	220	0.739	162.58
Dogger Bank South	220	0.213	46.9
East Anglia ONE North	220	0.127	27.9
East Anglia TWO	220	0.087	19.1
Five Estuaries	220	0.048	10.6
Hornsea Project Four	220	0.472	103.8
North Falls	220	0.103	22.7
Outer Dowsing	220	0.776	170.7
Other OWF construction activities and vessels			
Norfolk Boreas	0.8	0.101	0.08
Norfolk Vanguard	0.8	0.141	0.11
Two geophysical surveys*	6.2	0.301	1.9
Two seismic surveys*	1,815.8	0.301	546.6
UXO clearance*	1,256.6	0.301	378.2
Total			**1,610.6**
% SAC count			**41.3%**
% wider reference population			**6.68%**

*Average density across the English North Sea area, approximately covering the combined SE and NE England MUs, calculated using the seal habitat preference map (Carter *et al*., 2020)

8.4.3.5 Summary for Effects on Site Integrity of the Humber Estuary SAC

818. The assessment of the potential effects for SEP and DEP has been summarised in relation to the Humber Estuary SAC conservation objectives for grey seal (**Table 8-75**).

819. For the reasons mentioned in **Sections 8.4.3.1** to **8.4.3.4**, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal from SEP and / or DEP either alone or in-combination.**

Table 8-75: Summary of the Potential Effects of SEP and DEP, Including In-Combination Effects on the Humber Estuary SAC in Relation to the Conservation Objectives for Grey Seal

Conservation Objectives	SEP and DEP Effects			In-combination Effects
	Disturbance from underwater noise	Increased collision risk	Changes in prey availability	Disturbance from underwater noise during construction
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	×	×	×	×
The structure and function (including typical species) of qualifying natural habitats.	×	×	×	×
The structure and function of the habitats of qualifying species.	×	×	×	×
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	×	×	×	×
The populations of qualifying species.	×	×	×	×
The distribution of qualifying species within the site.	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives

8.4.4 The Wash and North Norfolk Coast SAC

820. The potential effects during the construction, operation, maintenance and decommissioning of SEP and DEP in relation to harbour seal from The Wash and North Norfolk SAC were agreed in consultation with the marine mammal ETG as part of the EPP. The potential effects of SEP and DEP (in isolation and if both are constructed) is assessed to determine any potential for an adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the Conservation Objectives for harbour seal are:

- Underwater noise (including piling, other construction activities, vessels, operational turbines, O&M activities and decommissioning activities);
- Any barrier effects from underwater noise;
- Any increased collision risk with vessels;
- Disturbance at seal haul-out sites;

- Disturbance of foraging seals at sea;
- Changes to water quality;
- Changes to prey availability; and
- In-combination effects.

8.4.4.1 Potential Effects During Construction

8.4.4.1.1 Potential Effects of Underwater Noise during Piling

821. Impact piling is a source of high-level underwater noise and cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals. The potential for permanent auditory injury (PTS) and disturbance have therefore been assessed in the following sections. Due to the lack of a threshold of disturbance for harbour seal, the assessment of disturbance for this species is based in using temporary auditory injury (TTS / fleeing response) thresholds where appropriate.

822. Underwater noise modelling was carried out by Subacoustech to estimate the noise levels likely to arise during piling and determine the maximum potential areas of effect (see **ES Chapter 10 Marine Mammal Ecology** (document reference 6.1.10) and **ES Appendix 10.2 Underwater Noise Modelling Report** (document reference 6.3.10.2) for further details).

823. The maximum predicted impact range for PTS and TTS is 0.7km and 9.7km, respectively, for cumulative SEL (including soft-start and ramp-up) for a monopile with maximum hammer energy of 5,500kJ.

824. The Wash and North Norfolk SAC is approximately 24.3km from DEP, 8.3km from SEP and 1.3km from the export cable corridors, at the closest point. Therefore, there is the potential for direct overlap with the SAC. It is assumed that harbour seal in and around SEP and DEP could be from The Wash and North Norfolk SAC.

825. The maximum potential number of harbour seal that could be at possible risk of PTS from SEL_{cum} during piling, without any mitigation, could be up to 0.23 individuals (0.008% of SAC count; 0.006% of SE MU) at SEP (**Table 8-76**). For DEP, the maximum potential number of harbour seal that could be at possible risk of PTS from SEL_{cum} during piling, without any mitigation, could be up to 0.11 individuals (0.004% of SAC count; 0.003% of SE MU; **Table 8-76**).

Table 8-76: Maximum Number of Harbour Seal (and % of Reference Population) that Could be at Risk of PTS or TTS during Piling at SEP or DEP

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour seal	PTS at SEP = 0.84km^2	0.23 (SEP density of 0.274/km^2) (0.008% of SAC count; 0.006% of SE MU)	**No** MMMP would reduce risk of PTS
	PTS at DEP = 1.44km^2	0.11 (DEP density of 0.080/km^2)	

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
		(0.004% of SAC count; 0.003% of SE MU)	
	TTS at SEP = 140km^2	38.4 (SEP density of 0.274/km^2) (1.3% of SAC count; 1.0% of SE MU)	**No** Less than 5% of population temporary disturbed MMMP would reduce risk of TTS
	TTS at DEP = 220km^2	17.6 (DEP density of 0.080/km^2) (0.6% of SAC count; 0.5% of SE MU)	

826. As outlined in **Section 8.3.1**, a MMMP for piling in accordance with the **Draft MMMP** (document reference 9.4) will be produced post-consent in consultation with the MMO and relevant SNCBs, and will be based on the latest scientific understanding and guidance, as well as detailed Project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of any permanent auditory injury (PTS) from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

827. The effective implementation of the MMMP for piling will reduce the risk of permanent auditory injury (PTS) to harbour seal during piling at SEP or DEP, therefore, there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS) from increased underwater noise during construction (piling) for SEP or DEP in isolation**.

828. There are currently no agreed thresholds or criteria for modelling the potential disturbance of other marine mammal species from underwater noise. For marine mammals, including harbour seal a fleeing response is assumed to occur at the same noise levels as TTS.

829. Disturbance during piling would be temporary and for a relatively short duration (i.e. during active piling). Therefore, there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to disturbance from underwater noise during construction (piling) for SEP and DEP.**

830. As a worst-case the maximum number of harbour seal from each Project has been assessed to indicate the maximum number that could be affected from SEP and DEP, if they are developed concurrently (**Table 8-77**).

831. The maximum predicted impact area for PTS or TTS from cumulative SEL during sequential piling at SEP and DEP in same 24 hour period is up to 18km^2 or 370km^2, respectively (**Table 8-77**).

832. The maximum predicted impact area for PTS or TTS from cumulative SEL during simultaneous piling at SEP and DEP in the same 24 hour period is up to 33km^2 or 520km^2, respectively (**Table 8-77**).

833. The maximum number of harbour seal that could be affected during piling at SEP and DEP, is up to 98 individuals (3.45% of SAC count; 2.62% of SE MU) (**Table 8-77**).

Table 8-77: Maximum Number of Harbour Seal (and % of Reference Population) that Could be at Risk of PTS or TTS during Piling at SEP and DEP

Species	Maximum area	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour seal	PTS from sequential piling at SEP & DEP = $18km^2$	3.4 (density of $0.189/km^2$) (0.12% of SAC count; 0.09% of SE MU)	**No** MMMP would reduce risk of PTS
	PTS from simultaneous piling at SEP & DEP = $33km^2$	6.2 (density of $0.189/km^2$) (0.22% of SAC count; 0.17% of SE MU)	
	TTS from sequential piling at SEP & DEP = $370km^2$	70 (density of $0.189/km^2$) (2.46% of SAC count; 1.86% of SE MU)	**No** Less than 5% of population temporary disturbed MMMP would reduce risk of TTS
	TTS from simultaneous piling at SEP & DEP = $520km^2$	98.3 (density of $0.189/km^2$) (3.45% of SAC count; 2.62% of SE MU)	

834. The effective implementation of the MMMP for piling will reduce the risk of PTS and TTS for harbour seal during piling at SEP and DEP and therefore there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS) or disturbance from increased underwater noise during construction (piling) for SEP and DEP**.

8.4.4.1.2 Potential Effects of Underwater Noise during Other Construction Activities

835. The results of the underwater noise modelling indicate that harbour seal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS or TTS / fleeing response based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

836. PTS as a result of construction activity, other than piling, is highly unlikely. Similarly, there is unlikely to be any significant risk of any TTS.

837. The maximum potential impact area for PTS or TTS for each activity (cable laying, trenching, rock placement, drilling and dredging) is less than $0.03km^2$.

838. There is the potential that more than one of these activities could be underway at either wind farm site or the export cable corridor area at the same time. As a worst-case and unlikely scenario, an assessment for all five activities (0.15km^2) has also been undertaken (**Table 8-78**).

839. The potential 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 periods for SEP and DEP and would be limited to only part of the overall construction period and area at any one time.

840. If harbour seal are displaced from the area, it is predicted that they 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 impact on harbour seal.

841. The assessment indicates that there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS and TTS) from increased underwater noise during construction (other construction activities outside of piling) for SEP or DEP in isolation**.

842. No additional mitigation is required or proposed for underwater noise for construction activities, other than piling.

Table 8-78: Maximum Number of Harbour Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Non-Piling Construction Activities at the Same Time at SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC count and SE MU) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging (0.15km^2)	Harbour seal	SEP or DEP	0.028 (SEP, DEP & cable export area density of 0.189/km^2) (0.001% of SAC count; 0.0008% of SE MU)	No

843. As a worst-case the maximum number of harbour seal from each Project has been assessed to indicate the maximum number that could be impacted from SEP and DEP, if they are developed concurrently (**Table 8-79**).

Table 8-79: Maximum Number of Harbour Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Non-Piling Construction Activities at the Same Time at SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC count and SE MU) for TTS for all activities at the same time	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for: - Cable laying - Trenching - Rock placement - Drilling - Dredging ($0.3km^2$)	Harbour seal	SEP & DEP	0.06 (SEP, DEP & cable export area density of $0.189/km^2$) (0.002% of SAC count; 0.0015% of SE MU)	**No**

844. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project, therefore four years for SEP and DEP. However, construction activities would not be underway constantly throughout this period.

845. The duration of offshore export cable installation and trenching activities is expected to take approximately 100 days for SEP and DEP.

846. The assessment indicates that there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS and TTS) from increased underwater noise during other construction activities for SEP and DEP**.

847. No additional mitigation is required or proposed for underwater noise from construction activities, other than piling.

8.4.4.1.3 Potential Effects of Underwater Noise and Disturbance from Construction Vessels

848. During the construction phase there will be an increase in the number of vessels. This is estimated to be up to 16 vessels on the SEP wind farm site, DEP wind farm site and export cable corridor at any one time. The number, type and size of vessels will vary depending on the activities taking place at any one time.

849. 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 SEP and DEP offshore sites and offshore cable corridor area.

850. The results of the underwater noise modelling indicate that harbour seal would have to be less than 100m (precautionary maximum range) from the vessel for 24 hours, to be exposed to noise levels that could induce PTS or TTS based on the Southall *et al*. (2019) thresholds and criteria.

851. The maximum potential impact area for PTS or TTS for each vessel is less than 0.03km^2. The total impact area for up to 16 vessels is 0.48km^2.

852. PTS as a result of underwater noise from construction vessels is highly unlikely. Similarly, there is unlikely to be any significant risk of any TTS.

853. The number of harbour seal that could be impacted from any TTS as a result of underwater noise during construction from vessels has been assessed based on the maximum impact area for up to 16 vessels (**Table 8-80**).

Table 8-80: Maximum Number of Harbour Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Construction Vessels at SEP or DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC count and SE MU) for all vessels	Potential adverse effect on site integrity
TTS response from cumulative SEL, based on 24 hour exposure for 16 vessels (0.48km^2)	Harbour seal	SEP or DEP	0.09 (SEP, DEP & cable export area density of 0.189/km^2) (0.003% of SAC count; 0.002% of SE MU)	No

854. The maximum duration for the offshore construction period, including piling and export cable installation, is up to two years for each Project. Therefore, it is assumed that construction vessels could be on either the SEP wind farm site, DEP wind farm site or offshore cable corridors, for two years.

855. If the behavioural response is displacement from the area, it is predicted that harbour seal will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on harbour seal.

856. The assessment indicates that there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS and TTS) and disturbance from increased underwater noise from construction vessels for SEP or DEP in isolation**.

857. No additional mitigation is required or proposed for underwater noise from construction vessels.

858. As a worst-case the maximum number of harbour seal from each Project has been assessed to indicate the maximum number that could be impacted from SEP and DEP, if they are developed concurrently (**Table 8-81**).

Table 8-81: Maximum Number of Harbour Seal (and % of Reference Population) that Could be Impacted as a Result of Underwater Noise Associated with All Construction Vessels at SEP and DEP

Potential Impact	Species	Location	Maximum number of individuals (% of SAC count and SE MU) for all vessels	Potential adverse effect on site integrity
TTS from cumulative SEL, based on 24 hour exposure, for 25 vessels (0.75km^2)	Harbour seal	SEP & DEP	0.14 (SEP, DEP & cable export area density of 0.189/km^2) (0.005% of SAC count; 0.004% of SE MU)	No

859. The assessment indicates that there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS and TTS) and disturbance from increased underwater noise from construction vessels for SEP and DEP**.

8.4.4.1.4 Potential Barrier Effects from Underwater Noise

860. Underwater noise during construction could have the potential to create a barrier effect, preventing movement of harbour seal between feeding and / or breeding areas, or potentially increasing swimming distances if harbour seal avoid the site and go around it.

861. The worst-case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area longest duration) scenarios.

862. For harbour seal, this would be the maximum predicted impact area for TTS from cumulative SEL during simultaneous piling at SEP and DEP in same 24 hour period of up to 520km^2 (**Table 8-77**).

863. Disturbance and any barrier effects during piling would be temporary and for a relatively short duration (i.e. during active piling). Therefore, there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to potential barrier effects from increased underwater noise during construction (piling) for SEP and DEP**.

8.4.4.1.5 Potential Effects of Any Increased Collision Risk with Construction Vessels

864. During the offshore construction phase of SEP and DEP there will be an increase in vessel traffic within and on transit to the offshore sites. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

865. Although the risk of collision is likely to be low, as a precautionary worst-case scenario, the number of harbour seal that could be at increased collision risk with vessels during construction has been assessed based on 5% of the number of animals that could be present in the SEP wind farm site, DEP wind farm site and export cable corridor potentially being at increased collision risk (**Table 8-82**). This has been based on the percentage of harbour porpoise post mortem examinations with evidence of interaction with vessels, as there is currently no information on the potential collision risk for harbour seal.

866. This is a highly precautionary assumption, as it is unlikely that all harbour seal present in the SEP wind farm site, DEP wind farm site and export cable corridors would be at increased risk of collision with vessels during construction, considering the minimal number of vessel movements compared to the existing vessel movements in the area and that vessels within the wind farm and cable corridor areas would be stationary or very slow moving. In addition, based on the assumption that harbour seal would be disturbed as a result of the vessel noise and presence, there should be no potential for increased collision risk with construction vessels.

867. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to 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 (see the **Draft MMMP** (document reference 9.4)).

868. Therefore, there would be no increased collision risk of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to increased collision risk from construction vessels for SEP and DEP**.

Table 8-82: Estimated Number of Harbour Seal (and % of Reference Population) that Could be at Increased Collision Risk with Construction Vessels Based on 5% of Individuals Present in the SEP Wind Farm Site, DEP Wind Farm Site and Export Cable Corridor

Species	Location (impact area)	5% Vessel Collision Risk Maximum number of individuals (% of SAC count or SE MU)	Potential adverse effect on site integrity
Harbour seal	SEP and export cable corridor (160.8km^2)	2.2 (density of 0.189/km^2) (0.08% of SAC count; 0.06% of SE MU)	No vessel movements will be kept to the minimum number and vessel operators will use good

Species	Location (impact area)	5% Vessel Collision Risk Maximum number of individuals (% of SAC count or SE MU)	Potential adverse effect on site integrity
	DEP and export cable corridor (211.6km^2)	0.9 (density of 0.189/km^2) (0.03% of SAC count; 0.02% of SE MU)	practice to reduce any risk of collisions with marine mammals
	SEP & DEP and export cable corridor (372.4km^2)	3.1 (0.11% of SAC count; 0.0.08% of SE MU)	

8.4.4.1.6 Potential Effects of Any Disturbance at Seal Haul-Out Sites

869. The construction port(s) to be used for SEP and DEP will be Great Yarmouth which is currently used for SOW and DOW operation and maintenance activities. Vessel movements to and from any port will be incorporated within existing vessel routes. Taking into account the proximity of shipping channels to and from existing ports, 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.

870. The Blakeney Point haul-out site is located closest to SEP and DEP, 12km from the nearest Project boundary (including export cable corridors and landfall locations). Given the distances between SEP and DEP and the nearest known seal haul-out sites; there is very little potential for any direct disturbance as a result of construction activities. Also, given that the construction port will be at Great Yarmouth, vessels transiting to SEP and DEP would not pass within the vicinity of the Blakeney Point haul-out site.

871. There is an existing relatively high level of vessel traffic within the navigational study area (SEP and DEP plus 10km buffer), including close to the coastline. In summer, an average of 82 vessels were recorded per day within the study area, and in winter an average of 81 vessels were recorded. High density navigation routes show an average of up to 16 vessels per day (per 4km^2) travelling along an existing vessel route within 7km of Blakeney Point in 2015 (UK Government, 2022).

872. Studies on the distance of disturbance, on land or in the water, for hauled-out harbour seals have found that the closer the disturbance, the more likely seals are to move into the water. The estimated distance at which most seal movements into the water occurred, varies between study site and type of disturbance but has been estimated at typically less than 100m (Wilson, 2014).

873. 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 vessels 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).

874. 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).

875. A study of the reactions of harbour seal from cruise ships found that, if a cruise ship was less than 100m from a harbour seal haul-out site, individuals were 25 times more likely to flee into the water than if the cruise ship was at a distance of 500m from the haul-out site (Jansen *et al*., 2010). At distances of less than 100m, 89% of individuals would flee into the water, at 300m this would fall to 44% of individuals, and at 500m, only 6% of individuals would flee into the water (Jansen *et al*., 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

876. Therefore, it is considered that, 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.

877. Vessel movements to and from any port will be incorporated within existing vessel routes, which would be considerably further from either The Wash or Blakeney Point harbour seal haul-out sites than the 600m that is noted as being the distance at which harbour seal will react to vessel presence. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels, and the additional construction vessels using these existing vessel routes while transiting to port would not cause a significant increase in the potential for disturbance and / or interaction at harbour seal haul-out sites.

878. Therefore, there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance at seal haul-out sites during construction for SEP and / or DEP**.

8.4.4.1.7 Potential Effects of Any Disturbance of Foraging Harbour Seals at Sea

879. Foraging harbour seals have the potential to be disturbed due to underwater noise generating activities, and due to the increased presence of vessels at SEP and DEP and in the vicinity of the vessel transit route, from the construction port to SEP and DEP.

880. In 2012, 25 harbour seal from The Wash were tagged, as well as a further 10 from the Thames (Russell, 2016b), the results of which were used 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 of Norfolk, and at SEP and DEP (**Plate 8-1**; Russell, 2016b). Foraging activity was found to occur (in red) within a number of OWF sites, including SOW, DOW, and a relatively lower level of activity at Hornsea Projects One, Two, and Four, as well as Dogger Bank A. While the majority of these wind farm projects at the time of tagging (in 2012) had not commenced, SOW 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.

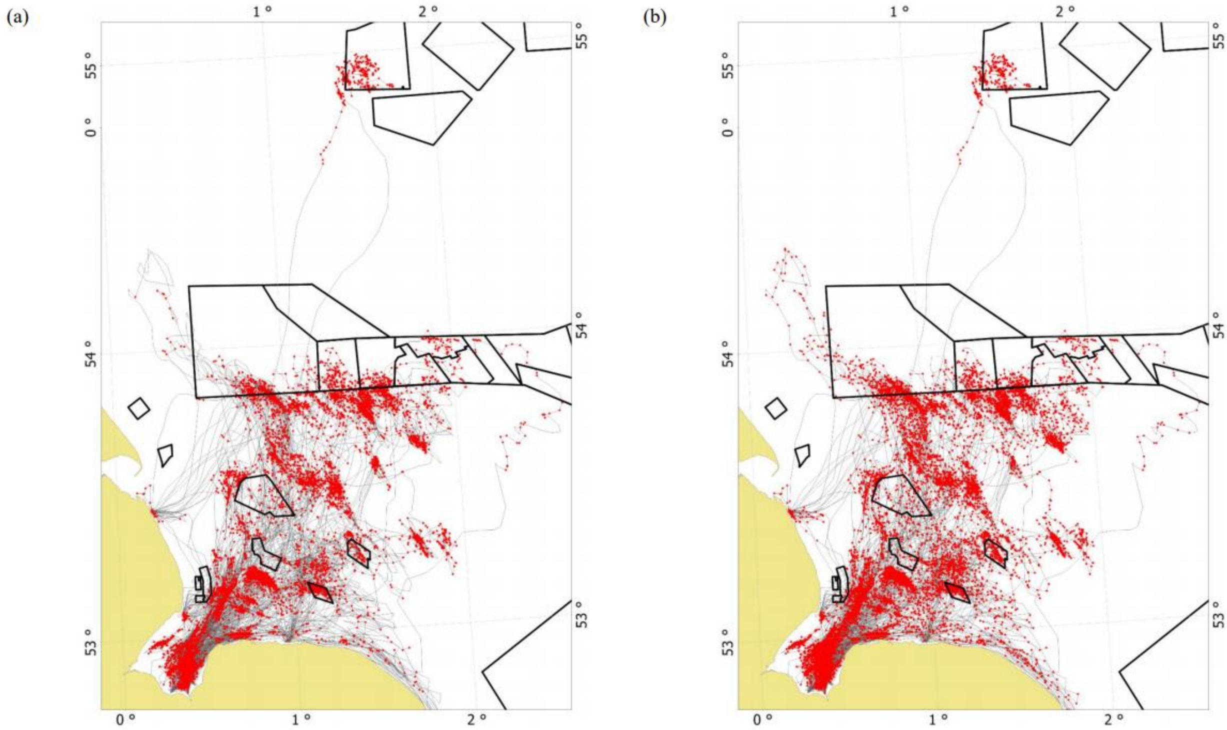

Plate 8-1: The Tracks (Grey) and Estimated Foraging Locations (Red) of Tagged Harbour Seals in Geo- (a) and Hydro- (b) Space (Russell, 2016b).

881. The potential for harbour seal to be disturbed from foraging at sea during construction relates to both the potential disturbance of harbour seal, and the potential for effect on fish (prey species). In total, the greatest area of effect for any disturbance of foraging harbour seal is up to 520km^2 for simultaneous piling at SEP and DEP (based on the maximum TTS impact area).

882. If it is assumed, as an unlikely and worst-case scenario, that all harbour seal within the total area would be disturbed, and that any disturbance could result in the cessation of foraging within that area, then a total of 98 harbour seal could potentially be disturbed from foraging during simultaneous piling at SEP and DEP. This effect could occur for up to 33 days, taking into account the durations of piling activities occurring at the same time.

883. For activities not including piling, which have the potential to take place over a longer time frame, of up to four years, less than one (0.06) harbour seal could be restricted from foraging throughout the entire construction period.

884. Therefore, between one and 98 harbour seal[13] (0.002-3.45% of SAC count; 0.0015-2.62%), could be temporarily disturbed from foraging at SEP and DEP, due to construction.

885. It is however unlikely that if harbour seal were disturbed that they would be restricted from foraging, as individuals would be able to forage in other areas, as they are generalist feeders. Taking this into account, the small number of harbour seal at risk of being temporarily disturbed from foraging, and the short-term nature of the potential effect, it is considered that there would be no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.

886. There is potential for SEP and DEP to affect between one and 104 harbour seal (2.7% of the SAC count; or 2.1% of the SE MU), however, as shown above it is unlikely that harbour seal would be disturbed from the entire area during construction. Therefore, there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance of foraging harbour seals at sea for SEP and / or DEP**.

8.4.4.1.8 Potential Effects of Any Changes to Water Quality

887. Sediment contamination levels across the offshore sites are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment (**Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Any potential changes to water quality during construction of SEP and DEP would be negligible.

888. Therefore, there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to any changes to water quality during construction for SEP and / or DEP**.

[13] Calculated from the density of harbour seal, and the total piling disturbance areas. If a total of 98 harbour seal could be disturbend from the area due to pilng, then they could also be disturbed from foraging within that area. This is highly precautionary, as it is unlikely that all grey seal present within those piling disturbance areas would be actively foraging at the time that the disturbing activity (i.e. piling) takes place.

8.4.4.1.9 Potential Effects of Any Changes in Prey Availability

889. The potential effects on prey species during construction can result from physical disturbance and loss of sea bed habitat; increased suspended sediment concentrations (SSC) and sediment re-deposition; and underwater noise. **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. 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 SEP and DEP would result in detectable changes to harbour seal populations

890. Harbour seal feed on a variety of prey species and are considered to be opportunistic feeders, feeding on a wide range of prey species and they have relatively large foraging ranges (see **ES Appendix 10.1 Marine Mammal Consultation Responses, Information and Survey Data** (document reference 6.3.10.1)).

891. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment on changes in prey availability are localised and short in duration and therefore there will be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to potential changes in prey availability (as a result of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment) during construction for SEP and / or DEP**.

892. The number of harbour seal that could be impacted as a result of any changes in prey availability due to underwater noise during piling, based on the worst-case for TTS SEL_{cum} for fish species with a swim bladder involved in hearing, is up to $330km^2$ at DEP and $210km^2$ at SEP, using the fleeing response model. This is the largest potential impact range for prey (fish) species, and has therefore been used to inform the below worst-case and precautionary assessment. This assessment assumes that all harbour seal within the largest impact area for fish (as noted above) would be at risk of a reduction in prey availability, due to the prey (fish) species themselves being potentially affected within that area.

893. As a worst-case, the number of harbour seal that could potentially be affected by any changes in prey availability is up to 84 individuals (2.95% of SAC count; 2.24% of SE MU) for SEP and DEP. This means that, under the precautionary assumptions of this assessment, up to 84 harbour seal could be at risk of a reduced (or removed) potential to forage within that area. More realistically, however, the reduction of prey (fish) species availability would not be for all fish within that area, and harbour seal would be able to forage within that area still, or, would be able to travel outside of that area to forage, with no reduction or impact to the overall population anticipated.

894. It is highly unlikely that there would be significant changes to prey over the entire area. It is more likely that effects would be restricted to an area around the working sites, and the potential areas for habitat loss. The temporary habitat disturbance footprint is up to 7.87km^2 for SEP and DEP, and the permanent footprint is 1.159km^2, which represents a very small proportion of the area available for harbour seal foraging from The Wash and North Norfolk Coast SAC; as noted above, harbour seal typically forage up to 80km from their haul-out sites, which equates to a significantly large total foraging area for the individuals associated with the site.

895. Mitigation to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species.

896. Therefore, there will be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to potential changes in prey availability (due to increased underwater noise) during construction for SEP and / or DEP**.

8.4.4.2 Potential Effects During Operation and Maintenance

8.4.4.2.1 Potential Effects of Underwater Noise from Operational Turbines

897. The underwater noise levels emitted during the operation of wind 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 turbine (Tougaard *et al*., 2009a; Sigray and Andersson, 2011).

898. Currently available data indicates that there is no lasting disturbance or exclusion of seals around wind farm sites during operation (Russell *et al*., 2014). Data collected suggests that any behavioural responses for seals may only occur up to a few hundred metres away (McConnell *et al*., 2012).

899. Monitoring studies at Nysted and Rødsand have also indicated that operational activities have had no impact on regional seal populations (Teilmann *et al*., 2006; McConnell *et al*., 2012). Tagged harbour seals have been recorded within two operational wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around wind turbine structures (Russell *et al*., 2014).

900. Furthermore, Russell *et al.* (2014) report that seals have been shown to forage within operational OWF sites, indicating no restriction to movements in operational OWF sites.

901. The results of the underwater noise modelling indicate that harbour seal would have to be less than 100m from the noise source (precautionary maximum range) for 24 hours in a 24 hour period, to be exposed to noise levels that could induce PTS or TTS / fleeing response based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

902. The maximum potential impact area for PTS or TTS for each operational turbine is less than 0.03km^2.

903. The potential effect for any TTS as a result of underwater noise from all operational wind turbines at each site (23 at SEP and 30 at DEP) has been assessed (**Table 8-83**).

904. The indicative separation distance between turbines (inter-row) and between turbines in rows (in-row) would be a minimum of 1.05km (maximum of 3.3km) therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine.

905. Taking into account the number of harbour seal potentially affected as a result of underwater noise from operational turbines (**Table 8-83**) there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS and TTS) from increased underwater noise from operational turbines for SEP and / or DEP**.

906. No additional mitigation is required or proposed.

Table 8-83: Maximum Number of Harbour Seal (and % of Reference Population) that Could be at Risk of TTS from Cumulative Exposure for All Operational Turbines at SEP and / or DEP

Species	Location	Operational Turbines Maximum number of individuals (% of SAC count and SE MU)	Potential adverse effect on site integrity
Harbour seal	SEP (up to 23 wind turbines; 0.69km^2)	0.19 (SEP density of 0.274/km^2) (0.0066% of SAC count; 0.005% of SE MU)	No
	DEP (up to 30 wind turbines; 0.90km^2)	0.07 (DEP density of 0.080/km^2) (0.0025% of SAC count; 0.002% of SE MU)	No
	SEP & DEP (up to 53 wind turbines; 1.59km^2)	0.26 (0.009% of SAC count; 0.0097% of SE MU)	No

8.4.4.2.2 Potential Effects of Underwater Noise during Operation and Maintenance Activities

907. The underwater noise from maintenance activities are considered to be the same or less than those assessed for underwater noise from other construction activities.

908. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS and TTS) from increased underwater noise during operation and maintenance activities for SEP and / or DEP.**

909. No additional mitigation is required or proposed for underwater noise during maintenance activities.

8.4.4.2.3 Potential Effects of Underwater Noise and Disturbance from Operation and Maintenance Vessels

910. The underwater noise from operation and maintenance vessels are considered to be less than those assessed for underwater noise from construction vessels.

911. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal from underwater noise from operation and maintenance vessels for SEP and / or DEP**.

912. No additional mitigation is required or proposed for underwater noise from operation and maintenance vessels.

8.4.4.2.4 Potential Barrier Effects from Underwater Noise during Operation and Maintenance

913. No barrier effects as a result of underwater noise during operation and maintenance are anticipated.

914. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal from barrier effects from underwater noise during operation and maintenance for SEP and / or DEP**.

915. No additional mitigation is required or proposed for barrier effects from underwater noise during operation and maintenance.

8.4.4.2.5 Potential Effects of Any Increased Collision Risk with Operation and Maintenance Vessels

916. 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 seven, which is considerably less than the 16 vessels that could be on site during construction. However, as a precautionary approach the assessment for construction has been used for the operational and maintenance assessment, as a worst-case scenario. The **Draft MMMP** (document reference 9.4) provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

917. The assessment of collision risk, as presented for the construction phase (**Section 8.4.4.1.5**), is based on the total project area, within which additional vessels may be present, and is not based on the number of vessels present within that area. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

918. In line with the construction assessment, there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to increased collision risk from operation and maintenance vessels for SEP and / or DEP.**

8.4.4.2.6 Potential for Disturbance at Harbour Seal Haul-Out Sites during Operation and Maintenance

919. Any potential disturbance at harbour seal haul-out sites during operation and maintenance would be less than those assessed for construction, as there are fewer vessels.

920. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to potential disturbance at seal haul-out sites for SEP and / or DEP.**

8.4.4.2.7 Potential for Disturbance of Foraging Harbour Seals at Sea during Operation and Maintenance

921. Any potential disturbance of foraging harbour seal during operation and maintenance would be less than that assessed during construction.

922. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to potential disturbance of foraging harbour seals at sea during the operation and maintenance phase for SEP and / or DEP.**

8.4.4.2.8 Potential Effects of Any Changes to Water Quality during Operation and Maintenance

923. Sediment contamination levels across the offshore sites are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment (**Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). Any changes in water quality during operation and maintenance would be negligible and less than during construction. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to changes in water quality during the operation and maintenance phase for SEP and / or DEP.**

8.4.4.2.9 Potential Effects of Any Changes in Prey Availability during Operation and Maintenance

924. The potential impacts of permanent loss or change of habitat, physical disturbance, temporary habitat loss, EMF, increased SSC, re-mobilisation of contaminated sediment and underwater noise on changes in prey availability are localised and, in some cases, short in duration. **ES Chapter 9 Fish and Shellfish Ecology** (document reference 6.1.9), provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms.

925. Therefore, there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to changes in prey availability during the operation and maintenance phase for SEP and / or DEP.**

8.4.4.3 Potential Effects During Decommissioning

926. Potential effects on harbour seal 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 the regulator prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

927. Decommissioning would most likely involve the removal of the accessible installed components comprising: all of the wind turbine components; part of the foundations (those above sea bed level); and the sections of the infield cables close to the offshore structures, as well as sections of the export cables. The process for removal of foundations is generally the reverse of the installation process. There would be no piling, and foundations may be cut to an appropriate level.

928. 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).

929. The potential effects on harbour seal during decommissioning would be the same or less than those assessed for construction for all the effects mentioned in **Sections 8.4.4.1** and **8.4.4.2.**

8.4.4.4 Potential In-Combination Effects

930. The in-combination assessment is based on both SEP and DEP being constructed, as the worst-case scenario. If SEP or DEP were to be developed in isolation, all potential in-combination effects would be less than as assessed.

931. The in-combination assessment considers plans or projects where the potential effects from SEP and DEP alone have the potential to interact with potential effects from the proposed construction, operation and maintenance or decommissioning of other projects.

932. The plans, projects and activities screened into the in-combination assessment for harbour seal are those that are located in the SE MU and wider North Sea area.

933. Full information on the screening of other projects and in-combination effects (including increased collision risk and changes to prey availability) is provided in **ES Appendix 10.3 Marine Mammal CIA Screening** (document reference 6.3.10.3). For harbour seal, all other potential effects, including PTS from underwater noise, TTS from underwater noise, changes to prey availability, increased collision risk with vessels and all operational effects have been screened out, with no potential in-combination effects.

934. The potential in-combination effect for foraging harbour seal from The Wash and North Norfolk Coast SAC screened in for assessment is:

- Disturbance from underwater noise.

935. See **Section 8.4.1.6** for further details on the approach to in-combination assessment.

936. For each project and activity the number of harbour seal that could be within the potential area of effect has been estimated, using the latest seal at sea usage maps to estimate densities (Carter *et al*., 2021). Densities were calculated based on the grid cells that overlap with the relevant project or area, and the most recent grey and harbour seal population estimates were used to convert the Carter *et al.* (2020) relative densities to absolute densities. See **Section 8.2.4.1** for more information. For the wider area, densities were calculated for the entire area of the English North Sea, approximately covering the SE England and NE England MUs.

937. The potential disturbance from piling activities has been estimated for each individual Project screened in for assessment, based on the maximum impact range and area for the worst-case modelled at DEP for TTS (weighted SEL_{cum}) of 9.7km from each piling location (220km^2 for each OWF). Piling at both SEP and DEP has been included in the in-combination assessment as a worst-case scenario.

938. There is little available information on the potential for disturbance from seismic surveys for harbour seal, however, observations of behavioural changes in other seal species have shown avoidance reactions up to 3.6km from the source (for a seismic survey of 1,600 cu. in.) (Harris *et al*., 2001). A more recent assessment of potential for disturbance to seal species, as a result of seismic surveys, shows potential disturbance ranges from 13.3km to 17.0km from source (BEIS, 2020). These ranges are based on modelled impact ranges, using the NMFS Level B harassment threshold of 160dB, for a noise source of 3,070 cubic inches, 4,240 cubic inches, or 8,000 cubic inches. A potential disturbance range of 17.0km (disturbance area of 907.9km^2) has therefore been used in the in-combination assessment for grey seal, due to a lack of species-specific information.

939. As a worst-case for geophysical surveys, it has been assumed that harbour seal within 1km (a total area of 3.1km^2), could be disturbed for each geophysical survey

940. The potential impact area during a high-order UXO detonation, based on the modelled worst-case impact range at SEP and DEP for TTS (unweighted SPL_{peak}) is 20km (1,256.6km^2).

941. The potential in-combination effects from all possible noise sources during piling at SEP and DEP is summarised in **Table 8-84**.

942. Based on the worst-case scenarios and precautionary approach, there is the potential for up to 224.3 harbour seal (0.73% of the reference population) to be disturbed (**Table 8-84**).

943. Taking into account mitigation for UXO and the SIP to reduce the significant disturbance of harbour porpoise from underwater noise in-combination effects, there would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal from SEP and DEP in-combination with other plans and projects**.

Table 8-84: Quantified In-Combination Assessment for the Potential Disturbance of Harbour Seal from All Possible Noise Sources during Piling at SEP and DEP

In-combination Effects	Area (km^2)	Density estimate/km^2	Number of harbour seal
Piling at OWFs			
SEP	220	0.274	60.3
DEP	220	0.080	17.6
Dogger Bank South	220	0.001	0.22
East Anglia ONE North	220	0.002	0.44
East Anglia TWO	220	0.0005	0.11
Five Estuaries	220	0.0002	0.04
Hornsea Project Four	220	0.001	0.22
North Falls	220	0.001	0.22
Outer Dowsing	220	0.044	9.7
Other OWF construction activities and vessels			
Norfolk Boreas	0.8	0.002	0.002
Norfolk Vanguard	0.8	0.005	0.004
Two geophysical surveys*	6.2	0.044	0.3
Two seismic surveys*	1,815.8	0.044	79.9
UXO clearance*	1,256.6	0.044	55.3
Total			**224.3**
% SAC count			**5.98%**
% wider reference population			**0.73%**

**Average density across the English North Sea area, approximately covering the combined SE and NE England MUs, calculated using the seal habitat preference map (Carter et al., 2020)*

8.4.4.5 Summary of Potential Effects on Site Integrity

944. The assessment of the potential effects for SEP and DEP has been summarised in relation to The Wash and North Norfolk Coast SAC conservation objectives for harbour seal (**Table 8-85**).

945. There would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to the effects mentioned in Sections 8.4.4.1 to 8.4.4.4 for SEP and DEP either alone or in-combination with other plans and projects**.

Table 8-85: Summary of the Potential Effects of SEP and DEP, Including In-Combination Effects on The Wash and North Norfolk Coast SAC in Relation to the Conservation Objectives for Harbour Seal

Conservation Objectives	SEP and DEP Effects			In-combination Effects
	Disturbance from underwater noise	Increased collision risk	Changes in prey availability	Disturbance from underwater noise during construction
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	×	×	×	×
The structure and function (including typical species) of qualifying natural habitats.	×	×	×	×
The structure and function of the habitats of qualifying species.	×	×	×	×
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	×	×	×	×
The populations of qualifying species.	×	×	×	×
The distribution of qualifying species within the site.	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives

9 Offshore Annex II Species (Ornithology)

946. The assessments for all of the SPAs in the following sections conclude no adverse effect on integrity except for in-combination effects on the following sites and features, for which an adverse effect on site integrity could not be ruled out:

- Collision risk and combined collision and displacement risk on the Sandwich tern feature of the Greater Wash SPA;
- Collision risk and combined collision and displacement risk on the Sandwich tern feature of the North Norfolk Coast SPA; and
- Collision risk on the kittiwake feature of the Flamborough and Filey Coast SPA.

947. The Applicant has therefore provided an HRA derogation case (see the **Habitats Regulations Derogation: Provision of Evidence** (document reference 5.5) which includes compensation proposals outlined in **Appendix 2 Sandwich Tern Compensation Document** (document reference 5.5.2) and **Appendix 3 Kittiwake Compensation Document** (document reference 5.5.3)) for these species.

948. Additionally, in response to feedback from consultation undertaken during the pre-application period (including on the draft Information for HRA provided as part of the section 42 consultation) and discussions with the offshore ornithology HRA compensation ETG, a derogation case has also been provided with respect to the gannet, guillemot and razorbill features of the Flamborough and Filey Coast SPA. However, the Applicant's assessment concludes no adverse effect on integrity for these features and therefore the HRA derogation case and associated compensatory measures are provided on a 'without prejudice' basis for these species. This approach is in accordance with the draft Overarching National Policy Statement for Energy (NPS EN-1), the draft National Policy Statement for Renewable Energy (NPS EN-3) and statements from the Secretary of State in the East Anglia ONE North and TWO, Hornsea Project Three and Norfolk Boreas and Vanguard decisions. **Appendix 4: Gannet, Guillemot and Razorbill Compensation Document** (document reference 5.5.4)) details the measures being proposed.

949. For each designated site screened into the Appropriate Assessment a site description is provided. Depending on the information available, this may include information taken from the citation for the site, its conservation objectives, supplementary advice on the conservation objectives, conservation advice, site condition monitoring or other baseline offshore ornithology information.

950. For each qualifying feature screened into the Appropriate Assessment, the following information is provided:

- The condition of the designated population, including any relevant data on population trends;
- A summary of the ecology of the species as relevant to the assessment, and a review of the key evidence in support of functional linkage between SEP and DEP, and the population;

- An assessment of the potential effects of SEP and DEP on the qualifying feature including a conclusion of adverse effect on integrity; and
- An assessment of potential effects on the qualifying feature when considering SEP and DEP in-combination with other relevant projects and including a conclusion of adverse effect on integrity.

951. Where predicted impacts (either in project alone or in-combination scenarios) equate to an increase of greater than 1% of baseline mortality of the relevant population, then an adverse effect on integrity cannot be ruled out, and further consideration is required e.g. through population modelling, to determine the significance of the mortality for the population in question. This is the approach recommended by Parker *et al*. (2022).

952. Quantitative information is available for OWFs in tiers 1 to 4, which have been included in the in-combination assessment. Whilst OWFs in tiers 5 and 6 are included in lists of projects to be considered (see **Chapter 5 EIA Methodology** (document reference 6.1.5)), they cannot be qualitatively considered with respect to the offshore ornithology assessment since no information at the required level of detail is publicly available (e.g. seabird densities, CRM results etc). The cut off for inclusion of other OWFs into the in-combination assessment was May 2022. This means that for projects in Examination at that point (i.e. Hornsea Project Four), and those submitted for Examination more recently (i.e. Awel Y Mor), updates to the assessment will be required during the Examination for SEP and DEP

9.1 Consultation

953. Consultation with regard to offshore ornithology has been undertaken in line with the general process described in **Section 4.2**. The key elements to date have included scoping, the ongoing EPP via the offshore ornithology ETG and offshore ornithology HRA compensation ETG, and the draft Information for HRA Report, which was published in April 2021.

954. The feedback received throughout this process has been considered in preparing the offshore ornithology sections of the RIAA. Stakeholder comments relevant to the RIAA are included within **Table 11-1** of **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). There is significant cross over between the two assessments with many of the stakeholder comments applying to both the ES and RIAA assessments. Therefore, the Applicant does not consider that it is appropriate to separate comments specific to each assessment given the complexity and duplication that would result from any such process.

955. A detailed description of the consultation process with respect to HRA compensation is provided within **Annex 1D: Record of HRA Derogation Consultation** (document reference 5.5.1.4) of **Appendix 1 Compensatory Measures Overview** (document reference 5.5.1) of the **HRA Derogation: Provision of Evidence** (document reference 5.7).

9.2 Worst-Case Scenario and Embedded Mitigation

9.2.1 Worst-Case Scenario

956. The final design of SEP and DEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach referred to as the Rochdale Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine: Rochdale Envelope (v3, 2018). The Rochdale Envelope for a project outlines the realistic worst-case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 5 EIA Methodology** (document reference 6.1.5).

957. In the response to the PEIR (**Table 11-1** of **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)), and draft guidance regarding evidence and data standards for OWF assessments (Natural England, 2021a), suggested templates for presenting worst case scenarios relevant to offshore ornithology in all project phases have been provided. These are presented in **Table 9-1** and are based on the project parameters described in **Chapter 4 Project Description**, which provides further details regarding specific activities and their durations.

958. In addition to the design parameters set out in **Table 9-1**, consideration is also given to:

- How SEP and DEP will be built out as described above for marine mammals in **Section 8.3.2.1** to **Section 8.3.2.3**. This accounts for the fact that whilst SEP and DEP are the subject of one DCO application, it is possible that only one Project could be built out (i.e. build SEP or DEP in isolation) or that both of the Projects could be developed. If both are developed, construction may be undertaken either concurrently or sequentially.
- A number of further development options which either depend on pre-investment or anticipatory investment, or that relate to the final design of the wind farms.
- Whether one OSP or two OSPs are required.
- The design option of whether to use all of the DEP North array area (DEP-N) and SEP South array area (DEP-S), or whether to use DEP-N only.

959. 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 4 Project Description** and the **Scenarios Statement** (document reference 9.28).

Table 9-1: Worst Case Scenario Information for SEP and DEP Presented in Format Requested by Natural England

Parameter	Values	
	DEP	SEP
Latitude (decimal degrees)	53.19	53.48
Area of OWF (km²)	103.53	92.53
Area of OWF + 2km buffer (km²)	286.89	207.54
Area of OWF + 4km buffer (km²)	504.30	347.06
Area of OWF + 10km buffer (km²)[1]	1,235.71	912.69
Maximum width of OWF (km)	10.18	9.62
Length of operational period (years)	40	40
Number of turbines	30	23
Number of blades	3	3
Maximum blade width (m)	7.50	7.50
Average blade pitch at mean predicted wind speed (degrees)[2]	0	0
Rotor radius (m)	117.50	117.50
Average rotation speed at mean predicted wind speed (rpm)[2]	5.66	5.66
Hub height relative to Highest Astronomical Tide (HAT) (m)	147.50	147.50
Tidal offset (m)	2.60	2.60

Notes
1. There is an overlap between the OWF + 10km buffer areas for SEP and DEP. The total combined area of both is 1,885.40km².
2. Uses mean annual wind speed predicted at 151m above mean sea level. Mean rotation speed during generic breeding season months April to August would be 5.20 rpm (12.3% decrease). This rotation speed was not used in the assessment, but would result in collision risk reducing by approximately 1.5% during these months.

9.2.2 Embedded Mitigation

960. **Table 9-2** describes the embedded mitigation relevant to the offshore ornithology assessment which has been incorporated into the design of SEP and DEP. The **Schedule of Mitigation and Mitigation Routemap** (document reference 6.5) details how and where these mitigation measures are secured within the **Draft DCO** (document reference 3.1).

Table 9-2 Embedded Mitigation Measures – Offshore Ornithology

Parameter	Mitigation measures embedded into project design
Site selection	Wind farm boundary site selection process: the shallow area to the northwest of the existing Dudgeon OWF was excluded from the DEP-N

Parameter	Mitigation measures embedded into project design
	boundary for technical reasons due to the shallow water depth and bathymetry, which were considered unsuitable for foundation and cable installation. In addition, Natural England advised (meeting held 29th January 2018) that this shallow area was believed to be important for feeding birds and that it would therefore be of benefit to exclude the area from development. Following the advice from Natural England and the bathymetry analysis, this area was removed from the southern boundary of DEP-N.
Air gap	The project designs of SEP and DEP assessed in the PEIR had an air gap of 26m at Highest Astronomical Tide (HAT). This was set at a value greater than the minimum of 22m to reduce the potential collision risk for offshore ornithology receptors. Between PEIR and the production of the ES, air gap has been further increased to 30m above HAT in response to consultation feedback, providing further reduction of potential collision risk for offshore ornithology receptors.
Best practice protocol for minimising disturbance to red-throated diver	Potential impacts on red-throated diver during operation and maintenance works will be mitigated through: • Avoiding and minimising maintenance vessel traffic, where possible, during the most sensitive time period in October to March (inclusive); • Restricting vessel movements where possible to existing navigation routes (where the densities of red-throated divers are typically relatively low); • As far as possible maintaining direct transit routes (to minimise transit distances through areas used by red-throated diver); • Where it is necessary to go outside of established navigational routes, avoid rafting birds either en-route to the wind farm sites from port and/or within the wind farm sites (dependent on location) and where possible avoid disturbance to areas with consistently high diver density; • Avoidance of over-revving of engines (to minimise noise disturbance); and • Briefing of vessel crew on the purpose and implications of these vessel management practices (through, for example, tool-box talks). The Project Team would make maintenance vessel operators aware of the importance of the species and the associated mitigation measures through tool box talks

9.3 Greater Wash SPA

961. The seaward boundary of the Greater Wash SPA is located approximately 7km from SEP at its nearest point, and 16km from DEP. However, the vast majority of the habitats contained within the SPA boundary are located substantially further away from both OWFs.

9.3.1 Description of Designation

962. The Greater Wash SPA is a marine SPA located in the southern North Sea. The SPA boundary encompasses offshore areas identified as containing high densities,

or encompassing breeding season foraging ranges of the qualifying bird species (Natural England and JNCC, 2016).

963. To the north, off the Holderness coast in Yorkshire, seabed habitats primarily comprise coarse sediments, with occasional areas of sand, mud and mixed sediments. Subtidal sandbanks occur at the mouth of the Humber Estuary, primarily comprising sand and coarse sediments. Offshore, soft sediments dominate, with extensive areas of subtidal sandbanks off The Wash as well as north and east Norfolk coasts. Closer inshore at The Wash and north Norfolk coast, sediments comprise a mosaic of sand, muddy sand, mixed sediments and coarse sediments, as well as occasional Annex I reefs. The area off the Suffolk coast continues the mosaic habitats mostly dominated by soft sediment.

964. The landward boundary of the SPA covers the coastline from Bridlington Bay in the north (at the village of Barmston), to the existing boundary of the Outer Thames Estuary SPA in the south. Across the mouth of the Humber Estuary, the boundary abuts the boundary of the Humber Estuary SPA, except where neither the little tern foraging zone or the red-throated diver Maximum Curvature Analysis (MCA) density threshold reaches the SPA. The landward boundary abuts the seaward boundary of The Wash SPA except where the former overlaps the latter to encompass habitats used by breeding Sandwich tern.

9.3.2 Conservation Objectives

965. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features.
- The structure and function of the habitats of the qualifying features.
- The supporting processes on which the habitats of the qualifying features rely.
- The populations of each of the qualifying features.
- The distribution of qualifying features within the site.

9.3.3 Appropriate Assessment

966. The qualifying features of this SPA and Ramsar site screened into the Appropriate Assessment are listed in **Table 5-2**. These are breeding Sandwich tern, breeding common tern, non-breeding little gull and non-breeding red-throated diver.

9.3.3.1 Sandwich Tern

9.3.3.1.1 Status

967. The Sandwich terns that make up the qualifying feature of this SPA breed within the North Norfolk Coast SPA and Ramsar site. Details on the status of these populations are provided in the Appropriate Assessment for that designated site in **Section 9.4.3**.

968. The citation for the Greater Wash SPA (Natural England, 2018a) states that the population of Sandwich terns associated with the SPA is 3,852 pairs (7,704 individuals), which was the peak mean count of birds present at the North Norfolk Coast SPA and Ramsar site between 2010 and 2014. More recent counts for the North Norfolk Coast SPA indicate that the population has increased. In the years during the collection of the majority of baseline data (2018 and 2019), the mean population was 9,443 individuals. The baseline annual mortality of this population, assuming an adult mortality rate of 10.2% (Horswill and Robinson, 2015), is 963 birds. This population and baseline mortality are used as the basis of the increase in mortality calculations presented in the following sections, to assess the potential impacts of SEP and DEP.

969. For population modelling, the mean count between 2010 and 2019 of 8,369 individuals was used as the starting population. The baseline annual mortality of the 2010 to 2019 mean population, assuming an adult mortality rate of 10.2% (Horswill and Robinson, 2015), is 854 birds.

970. No specific conservation advice was available for this qualifying feature.

9.3.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

971. The area within the Greater Wash SPA boundary contains habitats that are considered to represent important marine areas for Sandwich tern during the breeding season. It is acknowledged that birds also utilise habitats outside the SPA boundaries during the breeding season. Most recently, this has been demonstrated by GPS tracking of birds breeding at Scolt Head between 2016 and 2019 (Scragg *et al.*, 2016; Thaxter *et al.*, 2018; Green *et al.*, 2018, 2019). These birds remain qualifying features of the Greater Wash SPA when outside the boundary of the SPA.

972. The assessment therefore assumes that 100% of Sandwich terns present at SEP and DEP during the full breeding season (April to August; Furness (2015)) are breeding adults from the Greater Wash SPA population. Whilst this assumption is reasonable for purposes of assessment, it may be the case that this is a precautionary assumption. At around 50km, DEP is considerably beyond the mean maximum foraging range (34.3km (sd 23.2km)) (Woodward *et al.*, 2019), of birds from the Scolt Head colony. Whilst DEP is within the mean maximum foraging range plus one standard deviation, this measurement is considered to be a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony. It is therefore probable that a proportion of the birds using DEP will actually be non-breeding birds.

973. The Greater Wash SPA has been designated to protect important marine areas for the species whilst foraging during the breeding season. It is therefore considered that the designation does not protect birds that have dispersed from their colonies following the breeding season (April to August), or birds present prior to the breeding season. Therefore, Sandwich tern impacts outside the breeding season are not considered within the Appropriate Assessment for this site. They are however, considered within the Appropriate Assessment for the North Norfolk Coast SPA and Ramsar site (**Section 9.4.3**).

9.3.3.1.3 Potential Effects on the Qualifying Feature

974. The Sandwich tern qualifying feature of the Greater Wash SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.3.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.3.3.1.4.1 Operational Phase Displacement / Barrier Effects

975. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult Sandwich terns belonging to the Greater Wash SPA population, produced using design-based density estimates (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)) is presented in **Table 9-3** (DEP), **Table 9-4** (SEP), and **Table 9-5** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult Sandwich terns belonging to the Greater Wash SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The equivalent information produced using model-based density estimates (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)) is provided in **Table 9-6** (DEP), **Table 9-7** (SEP), and **Table 9-8** (SEP and DEP). The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

976. Displacement rates of 0.000 to 0.500 are considered to be appropriate for this species based on a review of available evidence (Cook *et al.*, 2014; Green *et al.*, 2019, 2018; Harwood *et al.*, 2018; Krijgsveld *et al.*, 2011; Scragg *et al.*, 2016; Thaxter *et al.*, 2018). A maximum mortality rate of 1% of displaced birds is considered to be appropriate, based on the existing mortality of adult birds of 0.102 (Horswill and Robinson, 2015), and low energy expenditure predictions of a closely related species (common tern) due to barrier effects by OWFs (Masden *et al.*, 2010).

Table 9-3: Predicted Operational Phase Displacement and Mortality of Greater Wash SPA Breeding Adult Sandwich Terns at DEP, Calculated Using Design-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	391 (breeding) 38 (autumn) 0 (spring) 429 (year round)	391 (breeding) 0 (autumn) 0 (spring) 391 (year round)	0 - 2	0.04 - 0.20
Mean	202 (breeding) 14 (autumn) 0 (spring) 216 (year round)	202 (breeding) 0 (autumn) 0 (spring) 202 (year round)	0 - 1	0.02 - 0.10
Lower 95% CI	79 (breeding) 0 (autumn)	79 (breeding) 0 (autumn)	0 - 0	0.01 - 0.04

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
	0 (spring) 79 (year round)	0 (spring) 79 (year round)		
Notes 1. For breeding season (Apr-Aug), assumes 100% of adult birds are Greater Wash SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-4: Predicted Operational Phase Displacement and Mortality of Greater Wash SPA Breeding Adult Sandwich Terns at SEP, Calculated using Design-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	127 (breeding) 8 (autumn) 0 (spring) 135 (year round)	139 (breeding) 0 (autumn) 0 (spring) 139 (year round)	0 - 1	0.01 - 0.07
Mean	71 (breeding) 3 (autumn) 0 (spring) 74 (year round)	71 (breeding) 0 (autumn) 0 (spring) 71 (year round)	0 - 0	0.01 - 0.04
Lower 95% CI	21 (breeding) 0 (autumn) 0 (spring) 21 (year round)	21 (breeding) 0 (autumn) 0 (spring) 21 (year round)	0 - 0	0.00 - 0.01
Notes 1. For breeding season (Apr-Aug), assumes 100% of adult birds are Greater Wash SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-5: Predicted Operational Phase Displacement and Mortality of Greater Wash SPA Breeding Adult Sandwich at SEP and DEP, Calculated using Design-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	518 (breeding) 46 (autumn) 0 (spring) 564 (year round)	518 (breeding) 0 (autumn) 0 (spring) 518 (year round)	0 - 3	0.05 - 0.27

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Mean	273 (breeding) 17 (autumn) 0 (spring) 290 (year round)	273 (breeding) 0 (autumn) 0 (spring) 273 (year round)	0 - 1	0.03 - 0.14
Lower 95% CI	100 (breeding) 0 (autumn) 0 (spring) 100 (year round)	100 (breeding) 0 (autumn) 0 (spring) 100 (year round)	0 - 0	0.01 - 0.05

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are Greater Wash SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

977. Based on the mean peak abundances calculated using design-based methods, the annual total of Sandwich terns from the Greater Wash SPA at risk of displacement from SEP and DEP together is 273 birds; 202 at DEP and 71 at SEP. At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 1.0 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0 to 0.4 birds due to displacement from SEP. The combined mortality of displacement from SEP and DEP would increase annual mortality within this population by 0% to 0.14% (**Table 9-5**).

Table 9-6: Predicted Operational Phase Displacement and Mortality of Greater Wash SPA Breeding Adult Sandwich Terns at DEP, Calculated using Model-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	327 (breeding) 41 (autumn) 0 (spring) 368 (year round)	327 (breeding) 0 (autumn) 0 (spring) 327 (year round)	0 - 2	0.03 - 0.17
Mean	202 (breeding) 17 (autumn) 0 (spring) 219 (year round)	202 (breeding) 0 (autumn) 0 (spring) 202 (year round)	0 - 1	0.02 - 0.10
Lower 95% CI	122 (breeding) 6 (autumn) 0 (spring) 128 (year round)	122 (breeding) 0 (autumn) 0 (spring) 122 (year round)	0 - 0	0.01 - 0.06

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are Greater Wash SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-7: Predicted Operational Phase Displacement and Mortality of Greater Wash SPA Breeding Adult Sandwich Terns at SEP, Calculated using Model-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	147 (breeding) 10 (autumn) 0 (spring) 157 (year round)	147 (breeding) 0 (autumn) 0 (spring) 147 (year round)	0 - 1	0.02 - 0.08
Mean	102 (breeding) 4 (autumn) 0 (spring) 106 (year round)	102 (breeding) 0 (autumn) 0 (spring) 102 (year round)	0 - 0	0.01 - 0.05
Lower 95% CI	81 (breeding) 1 (autumn) 0 (spring) 82 (year round)	81 (breeding) 0 (autumn) 0 (spring) 81 (year round)	0 - 0	0.01 - 0.04

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are Greater Wash SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-8: Predicted Operational Phase Displacement and Mortality of Greater Wash SPA Breeding Adult Sandwich Terns at SEP and DEP, Calculated using Model-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	474 (breeding) 51 (autumn) 0 (spring) 525 (year round)	474 (breeding) 0 (autumn) 0 (spring) 474 (year round)	0 - 2	0.05 - 0.25
Mean	304 (breeding) 21 (autumn) 0 (spring) 325 (year round)	304 (breeding) 0 (autumn) 0 (spring) 304 (year round)	0 - 1	0.03 - 0.16
Lower 95% CI	203 (breeding) 7 (autumn) 0 (spring) 210 (year round)	203 (breeding) 0 (autumn) 0 (spring) 203 (year round)	0 - 1	0.02 - 0.11

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are Greater Wash SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

978. Based on the mean peak abundances calculated using model-based methods, the annual total of Sandwich terns from the Greater Wash SPA at risk of displacement

from SEP and DEP together is 304 birds; 202 at DEP and 101 at SEP. At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 1.0 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0 to 0.5 birds due to displacement from SEP. The combined mortality of displacement from SEP and DEP would increase annual mortality within this population by 0.03% to 0.16% (**Table 9-5**).

979. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peak abundances are used as inputs to the assessment, since the maximum predicted mortality increase that could occur on this basis represents a 0.27% increase to baseline mortality.

980. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S (i.e. the northern and southern polygons of DEP), only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 22.1% higher at DEP-N than DEP as a whole. This compares to a value of 16.5% calculated from the model-based density estimates that were produced for these species, though the differences are unlikely to be statistically significant, based on assessment of data presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1). However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

981. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

982. The confidence in the assessment is high for several reasons. Firstly, despite not being available in large quantities, the evidence used to set the displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. The outcome of the assessment is the same regardless of whether design-based or model-based density estimates are used. The fact that both density estimation approaches produce similar population estimates provides additional confidence in the assessment. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.3.3.1.4.2 Collision Risk

983. Collision risk predictions for Greater Wash SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), calculated using design-based density estimates, are shown in **Table 9-9**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-10**. Outputs are based on Option 1 of the Band Model, avoidance rates of 0.980, the flight height distribution of Harwood (2021), and the flight speed of Fijn and Collier (2020). Nocturnal activity was set at 2% of daytime activity, based on an assessment of Sandwich tern tracking data from the Scolt Head population. These parameters are the same as the 'realistic worst case scenario' presented in **Chapter 11 Offshore Ornithology** (document reference 6.1.11) within the ES. Further information on this, detailed methodology and information on other input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

984. For DEP, the mean annual collision estimate (7.33) increases the annual baseline mortality by 0.76%. The predicted increase in the annual baseline mortality of Greater Wash SPA Sandwich terns is greater than 1% for the annual upper 95% CI output (21.41 collisions; 2.22%). For SEP, the mean annual collision estimate (1.84) increases the annual baseline mortality by 0.19%, and the upper 95% CI output (6.04) increases the baseline mortality by 0.63%. For SEP and DEP together, the upper 95% CI collision rate (27.46 collisions, or a 2.85% increase in existing mortality) results in predicted increases in the annual baseline mortality of Greater Wash SPA Sandwich terns of greater than 1%, but the mean annual collision rate (9.17) does not (0.95%). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

985. Some scenarios (DEP, and SEP and DEP together), involving the outputs of CRMs which used upper 95% CI density estimates as inputs also result in increases in the baseline mortality of Greater Wash SPA breeding adult Sandwich terns of more than 1%. PVAs have not been produced for these scenarios, since the probability of them occurring is extremely small. For example, the probability of the number of collisions predicted by the upper 95% CI CRM at DEP for a single month is 0.025. To obtain the annual collision rate presented in **Table 9-9** (21.41) would require this to happen five times (in April, May, June, July and August). The probability of this event occurring in a given year is one in 102,400,000 (one hundred and two million, four hundred thousand; 0.025 x 0.025 x 0.025 x 0.025 x 0.025). The probability of this occurring over multiple years is smaller still. Whilst the temporal limitations of the baseline data are acknowledged (which are very similar for all OWF assessments), it is still considered that the probability of these events actually occurring is too small to credibly refer to them as a realistic worst case scenario.

Table 9-9: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated Using Design-Based Density Estimates, Apportioned to Greater Wash SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	1.79	2.98	0.71	1.46	0.40	0.00	0.00	0.00	0.00	7.33
	Density	95% UCI	0.00	0.00	0.00	7.52	6.38	1.88	4.35	1.28	0.00	0.00	0.00	0.00	21.41
		95% LCI	0.00	0.00	0.00	0.00	0.80	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.90
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	-
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.02	0.62	0.39	0.72	0.09	0.00	0.00	0.00	0.00	1.84
	Density	95% UCI	0.00	0.00	0.00	0.16	1.33	0.93	3.29	0.33	0.00	0.00	0.00	0.00	6.04
		95% LCI	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	-
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP and DEP	Mean	-	0.00	0.00	0.00	1.81	3.59	1.09	2.18	0.49	0.00	0.00	0.00	0.00	9.17
	Density	95% UCI	0.00	0.00	0.00	7.68	7.72	2.81	7.64	1.61	0.00	0.00	0.00	0.00	27.46
		95% LCI	0.00	0.00	0.00	0.00	0.91	0.10	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	-
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]	J	F	M	A	M	J	J	A	S	O	N	D	Total

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

Table 9-10: Predicted Annual Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Design-Based Density Estimates and Apportioned to Greater Wash SPA, with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	7.33 (0.90 - 21.41)	0.76 (0.09 - 2.22)
SEP	1.84 (0.10 - 6.04)	0.19 (0.01 - 0.63)
SEP and DEP	9.17 (1.00 - 27.46)	0.95 (0.10 - 2.85)
Notes 1. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)		

986. Collision risk predictions for Greater Wash SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), calculated using model-based density estimates, are shown in **Table 9-11**. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), the use of model-based density estimates enables the consideration of smaller reporting regions than their design-based equivalents. Therefore, an additional scenario, SEP, and DEP-N has been considered. This is because it is possible that all of the turbines at DEP could be installed at DEP-N. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-12**. All other parameters are the same as the models which used design-based density estimates, as described above.

987. For DEP, the mean annual collision estimate (8.30) increases the annual baseline mortality by 0.86%, which is a slightly greater predicted collision rate than the equivalent value derived from CRMs run using design-based density estimates. The predicted increase in the annual baseline mortality of Greater Wash SPA Sandwich terns is greater than 1% for the annual upper 95% CI output (14.04 collisions; 1.46% annual mortality increase), though is substantially less than the equivalent value derived from CRMs run using design-based density estimates. For SEP, the mean annual collision estimate (2.72) increases the annual baseline mortality by 0.28%. The upper 95% CI output (4.98) increases the baseline mortality by 0.52%. As with DEP, the mean collision rate using model-based density estimates results in a higher mean than the equivalent value derived from CRMs run using design-based density estimates, but a lower upper 95% CI value. For SEP and DEP together, the mean and upper 95% CI collision rates (11.01 and 19.03) both result in predicted increases in the annual baseline mortality of Greater Wash SPA Sandwich terns of greater than 1% (1.14% and 1.98% respectively). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

Table 9-11: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Model-Based Density Estimates, Apportioned to Greater Wash SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	2.04	2.62	1.18	2.20	0.26	0.00	0.00	0.00	0.00	8.30
	Density	95% UCI	0.00	0.00	0.00	4.01	4.02	2.16	3.24	0.61	0.00	0.00	0.00	0.00	14.04
		95% LCI	0.00	0.00	0.00	0.90	1.63	0.58	1.48	0.10	0.00	0.00	0.00	0.00	4.69
DEP-N	Mean	-	0.00	0.00	0.00	2.63	3.12	1.67	2.99	0.18	0.00	0.00	0.00	0.00	10.59
	Density	95% UCI	0.00	0.00	0.00	5.22	4.82	3.04	4.36	0.51	0.00	0.00	0.00	0.00	17.94
		95% LCI	0.00	0.00	0.00	1.15	1.93	0.83	2.04	0.05	0.00	0.00	0.00	0.00	6.00
SEP	Mean	-	0.00	0.00	0.00	0.05	0.67	0.72	1.18	0.10	0.00	0.00	0.00	0.00	2.72
	Density	95% UCI	0.00	0.00	0.00	0.18	1.16	1.60	1.73	0.31	0.00	0.00	0.00	0.00	4.98
		95% LCI	0.00	0.00	0.00	0.01	0.37	0.28	0.84	0.03	0.00	0.00	0.00	0.00	1.53
SEP and DEP	Mean	-	0.00	0.00	0.00	2.08	3.28	1.90	3.38	0.37	0.00	0.00	0.00	0.00	11.01
	Density	95% UCI	0.00	0.00	0.00	4.20	5.18	3.76	4.97	0.92	0.00	0.00	0.00	0.00	19.03
		95% LCI	0.00	0.00	0.00	0.91	2.00	0.86	2.31	0.13	0.00	0.00	0.00	0.00	6.21
SEP and DEP-N	Mean	-	0.00	0.00	0.00	2.68	3.79	2.39	4.17	0.28	0.00	0.00	0.00	0.00	13.31
	Density	95% UCI	0.00	0.00	0.00	5.40	5.98	4.64	6.09	0.82	0.00	0.00	0.00	0.00	22.92
		95% LCI	0.00	0.00	0.00	1.16	2.30	1.11	2.88	0.08	0.00	0.00	0.00	0.00	7.53

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

Table 9-12: Predicted Annual Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Model-Based Density Estimates and Apportioned to Greater Wash SPA, with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	8.30 (4.69 - 14.04)	0.86 (0.49 - 1.46)
DEP-N	10.59 (6.00 - 17.94)	1.10 (0.62 - 1.86)
SEP	2.72 (1.53 - 4.98)	0.28 (0.16 - 0.52)
SEP and DEP	11.01 (6.21 - 19.03)	1.14 (0.64 - 1.98)
SEP and DEP-N	13.31 (7.53 - 22.92)	1.38 (0.78 - 2.38)
Notes 1. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)		

988. The avoidance rate used for the assessment (0.980), which is recommended for use by Natural England, does not include a correction for birds displaced by OWFs. Whilst there is uncertainty around the level of macro-avoidance (i.e. displacement) that will actually occur, evidence indicates that this will be greater than zero. The avoidance rate of 0.980 is substantially lower than avoidance rate used in the DECC (2012) HRA for this species (0.9883). Separately, Harwood *et al.* (2018) calculated an avoidance rate of 0.993 for Sandwich terns at SOW. Both of these avoidance rates describe behavioural avoidance only, and do not account for model error in the CRM (Cook *et al.*, 2014). These avoidance rates are presented for comparison, and are not utilised by the assessment to draw conclusions. Further discussion on these rates is provided in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1). Nonetheless, these avoidance rates derive from data on Sandwich terns at operational wind farms, whereas the value of 0.980 is a generic, and likely precautionary default value applied to in the absence of sufficient species-specific data. The effect of accounting for plausible macro-avoidance corrections and the alternative avoidance rates on the annual collision rates predicted for breeding adult Sandwich terns of the Greater Wash SPA is presented in **Table 9-13** for CRMs produced using design-based density estimates, and **Table 9-14** for CRMs produced using model-based density estimates.

989. The incorporation of displacement rates of 0.250 or greater reduces the mean collision rate from CRMs using design-based density estimates of SEP and DEP further below 1% of the existing annual mortality of Greater Wash SPA breeding adult Sandwich terns. The same effect also occurs if the alternative avoidance rates of 0.993 (Harwood *et al.*, 2018) and 0.9883 (DECC, 2012) are used in CRM. Using the outputs of CRMs derived from model-based density estimates, only macro-avoidance rates of 0% in conjunction with an avoidance rate of 0.980 produces a collision rate which increases the existing mortality rate of Greater Wash SPA Sandwich terns by more than 1%. Such a scenario is considered unlikely based on observed macro-avoidance behaviour around OWFs by this species, and behavioural avoidance rates previously calculated for Sandwich tern.

Table 9-13: Effect of Macro-Avoidance Corrections and Different Avoidance Rates on Greater Wash SPA Sandwich Tern Collision Rates (Mean and 95% CIs, Based on 95% CI of Design-Based Densities) at SEP, DEP and SEP and DEP, Calculated using Design-Based Density Estimates

Site	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
DEP	7.33 (0.90 - 21.41)	5.49 (0.67 - 16.06)	3.66 (0.45 - 10.71)	4.29 (0.53 - 12.53)	2.56 (0.31 - 7.50)
SEP	1.84 (0.10 - 6.04)	1.38 (0.08 - 4.53)	0.92 (0.05 - 3.02)	1.08 (0.06 - 3.53)	0.65 (0.04 - 2.11)
SEP and DEP	9.17 (1.00 - 27.46)	6.88 (0.75 - 20.59)	4.59 (0.50 - 13.73)	5.36 (0.59 - 16.06)	3.21 (0.35 - 9.61)

Table 9-14: Effect of Macro-Avoidance Corrections and Different Avoidance Rates on Greater Wash SPA Sandwich Tern Collision Rates (Mean and 95% CIs, Based on 95% CI of Design-Based Densities) at SEP, DEP and SEP and DEP, Calculated using Model-Based Density Estimates

Site	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
DEP	8.30 (4.69 - 14.04)	6.23 (3.52 - 10.53)	4.15 (2.35 - 7.02)	4.86 (2.74 - 8.21)	2.91 (1.64 - 4.91)
DEP-N	10.59 (6.00 - 17.94)	7.94 (4.50 - 13.46)	5.30 (3.00 - 8.97)	6.20 (3.51 - 10.49)	3.71 (2.10 - 6.28)
SEP	2.72 (1.53 - 4.98)	2.04 (1.15 - 3.74)	1.36 (0.77 - 2.49)	1.59 (0.90 - 2.91)	0.95 (0.54 - 1.74)
SEP and DEP	11.01 (6.21 - 19.03)	8.26 (4.66 - 14.27)	5.51 (3.11 - 9.52)	6.44 (3.63 - 11.13)	3.85 (2.17 - 6.66)
SEP and DEP-N	13.31 (7.53 - 22.92)	9.98 (5.65 - 17.19)	6.66 (3.77 - 11.46)	7.79 (4.41 - 13.41)	4.66 (2.64 - 8.02)

990. When a level of macro-avoidance (either 0.250 or 0.500) is assumed, the mean Sandwich tern collision rates predicted at SEP and DEP using an avoidance rate of 0.980 do not produce impacts of a sufficient magnitude to lead to a detectable impact at the population level (i.e. greater than 1%). The installation of all of DEP's turbines in DEP-N, combined with the impacts at SEP, could result in mean mortality rates of just over 1% at macro-avoidance rates of 0.250 (1.04%), but given the highly dynamic nature of Sandwich tern population trends (**Section 9.4.3.1.1**), it seems

unlikely that an impact of this magnitude would result in an adverse effect on the integrity of the qualifying feature.

991. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

992. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters, and the avoidance rate, the selected parameters are considered to be sufficiently precautionary based on expert opinion and information drawn from the literature to provide confidence that collision rates are not underestimated, and may in fact be overestimated.

9.3.3.1.4.3 Combined Displacement / Barrier Effects and Collision Risk

993. The mean combined displacement and collision rates for breeding adult Sandwich tern from the Greater Wash SPA for SEP and in isolation and together, calculated using design-based density estimates as inputs, are presented in **Table 9-15** (assuming a displacement rate of 0.000), **Table 9-16** (assuming a displacement rate of 0.250) and **Table 9-17** (assuming a displacement rate of 0.500). Mortality rates of displaced birds are assumed to be 1% for all scenarios. The collision rates were calculated using an avoidance rate of 0.980, with the corresponding displacement rate also applied to account for macro-avoidance. The corresponding outputs calculated using model-based density estimates are presented in **Table 9-18**, **Table 9-19**, and **Table 9-20**.

Table 9-15: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Greater Wash SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.000, Calculated using Design-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0	7.33 (0.90 - 21.41)	7.33 (0.90 - 21.41)	0.76 (0.09 - 2.22)
SEP	0	1.84 (0.10 - 6.04)	1.84 (0.10 - 6.04)	0.19 (0.01 - 0.63)
SEP and DEP	0	9.17 (1.00 - 27.46)	9.17 (1.00 - 27.46)	0.95 (0.10 - 2.85)
Notes 1. Assumes displacement rate of 0.000 2. Assumes avoidance rate of 0.980, with 0.000 displacement rate 3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-16: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Greater Wash SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.250, Calculated using Design-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0.51 (0.20 - 0.98)	5.49 (0.67 - 16.06)	6.00 (0.87 - 17.04)	0.62 (0.09 - 1.77)
SEP	0.18 (0.05 - 0.32)	1.38 (0.08 - 4.53)	1.57 (0.13 - 4.85)	0.16 (0.01 - 0.50)
SEP and DEP	0.69 (0.25 - 1.30)	6.88 (0.75 - 20.99)	7.56 (1.00 - 21.89)	0.78 (0.10 - 2.27)

Notes
1. Assumes displacement rate of 0.250 and mortality rate of 1% of displaced birds
2. Assumes avoidance rate of 0.980, with 0.250 displacement rate
3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-17: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Greater Wash SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.500, Calculated using Design-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	1.01 (0.40 - 1.96)	3.66 (0.45 - 11.33)	4.67 (0.85 - 13.29)	0.48 (0.09 - 1.38)
SEP	0.36 (0.11 - 0.64)	0.92 (0.05 - 3.02)	1.28 (0.16 - 3.66)	0.13 (0.02 - 0.38)
SEP and DEP	1.37 (0.51 - 2.60)	4.59 (0.50 - 14.35)	5.95 (1.01 - 16.95)	0.62 (0.10 - 1.76)

Notes
1. Assumes displacement rate of 0.500 and mortality rate of 1% of displaced birds
2. Assumes avoidance rate of 0.980, with 0.500 displacement rate
3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-18: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Greater Wash SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.000, Calculated using Model-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0	8.30 (4.69 - 14.04)	8.30 (4.69 - 14.04)	0.86 (0.49 - 1.46)
SEP	0	2.72 (1.53 - 4.98)	2.72 (1.53 - 4.98)	0.28 (0.16 - 0.52)

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
SEP and DEP	0	11.01 (6.21 - 19.03)	11.01 (6.21 - 19.03)	1.14 (0.64 - 1.98)
Notes 1. Assumes displacement rate of 0.000 2. Assumes avoidance rate of 0.980, with 0.000 displacement rate 3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-19: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Greater Wash SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.250, Calculated using Model-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0.50 (0.30 - 0.82)	6.23 (3.51 - 10.53)	6.73 (3.81 - 11.35)	0.70 (0.40 - 1.18)
SEP	0.26 (0.20 - 0.37)	2.04 (1.15 - 3.73)	2.30 (1.35 - 4.10)	0.24 (0.14 - 0.43)
SEP and DEP	0.76 (0.50 - 1.19)	8.26 (4.66 - 14.26)	9.02 (5.16 - 15.45)	0.94 (0.54 - 1.60)
Notes 1. Assumes displacement rate of 0.250 and mortality rate of 1% of displaced birds 2. Assumes avoidance rate of 0.980, with 0.250 displacement rate 3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-20: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Greater Wash SPA Breeding Adult Sandwich tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance rate of 0.500, Calculated using Model-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	1.01 (0.61 - 1.64)	4.15 (2.34 - 7.02)	5.16 (2.95 - 8.66)	0.54 (0.31 - 0.90)
SEP	0.51 (0.40 - 0.74)	1.36 (0.76 - 2.49)	1.87 (1.16 - 3.23)	0.19 (0.12 - 0.34)
SEP and DEP	1.52 (1.01 - 2.38)	5.51 (3.10 - 9.51)	7.03 (4.11 - 11.89)	0.73 (0.43 - 1.23)
Notes 1. Assumes displacement rate of 0.500 and mortality rate of 1% of displaced birds 2. Assumes avoidance rate of 0.980, with 0.500 displacement rate 3. Background population is Greater Wash SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

994. Of the scenarios presented, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur). The conclusions for collision impacts alone (**Section 9.3.3.1.4.2**) covers this scenario. The conclusions for all other scenarios presented in the above tables result in very similar, but slightly smaller impacts being predicted. This also applies to any scenario where all the turbines at DEP are all placed in DEP-N.

995. **It is concluded that predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

996. The confidence in the assessment is high, for the reasons provided in the individual displacement (**Section 9.3.3.1.4.1**) and collision (**Section 9.3.3.1.4.2**) assessments.

9.3.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.3.3.1.5.1 Operational Phase Displacement / Barrier Effects

997. Operational displacement impacts on Greater Wash SPA Sandwich tern have not previously been considered by other OWFs. A quantitative assessment for other OWFs within foraging range of this population of Sandwich terns was therefore undertaken, using the same input parameters and assumptions described in **Section 9.3.3.1.4.1**.

998. For other OWFs, only flying bird densities were available. However, published literature suggests that Sandwich terns spend the overwhelming majority of their time at sea in flight (Garthe and Hüppop, 2004; Perrow *et al.*, 2017). This is supported by the fact that of the 1,710 Sandwich tern observations made during the SEP and DEP baseline surveys, 1,676 (98%) were of birds in flight. As a result, the lack of “all birds” data for other OWFs is not considered to materially affect the assessment.

999. The annual total of Sandwich terns from the Greater Wash SPA at risk of displacement from OWFs in the wider Wash area (including SEP and DEP) is 496 birds when design-based density estimates are used for SEP and DEP, and 527 birds when model-based density estimates are used for SEP and DEP (**Table 9-21**). At displacement rates of 0.000 to 0.500 and a mortality rate of 1% for displaced birds (**Section 9.3.3.1.4.1**), 0 to 2.48 (using design-based density estimates for SEP and DEP), or 0 to 2.64 (using model-based density estimates for SEP and DEP) SPA breeding adults would be predicted to die each year due to displacement from these OWFs. This would increase annual mortality within this population by 0% to 0.26% (using design-based density estimates for SEP and DEP), or 0% to 0.27% (using model-based density estimates for SEP and DEP). The displacement matrices for both sets of in-combination displacement figures are presented in **Table 9-22** and **Table 9-23**.

1000. The predicted increases in baseline mortality of breeding adult Sandwich tern due to in-combination operational phase displacement is low. This is particularly true of the lower range of mortality predictions. These lower predictions for displacement mortality are considered to represent more realistic values for this species based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together, in-combination with other OWFs, would not adversely affect the integrity of the Greater Wash SPA.**

Table 9-21: Breeding Season Population Estimates of Sandwich Terns Apportioned to the Greater Wash SPA at SEP, DEP and Other OWFs Included in the In-Combination Assessment

Tier	OWF	Sandwich terns at risk of displacement	Predicted displacement[1]	Predicted mortality[2]
1	DOW	58	0 - 29	0 - 0.29
1	Race Bank	130	0 - 65	0 - 0.65
1	SOW	12	0 - 6	0 - 0.06
2	Triton Knoll	23	0 - 11	0 - 0.11
TOTAL (excluding SEP and DEP)		223	0 - 111	0 - 1.11
5	DEP (design-based density estimates)	202	0 - 101	0 - 1.01
5	SEP (design-based density estimates)	71	0 - 36	0 - 0.36
5	DEP (model-based density estimates)	202	0 -101	0 - 1.01
5	SEP (model-based density estimates)	102	0 - 51	0 - 0.51
TOTAL (including SEP and DEP, design-based density estimates)		496	0 - 248	0 - 2.48
TOTAL (including SEP and DEP, model-based density estimates)		527	0 - 264	0 - 2.64
Notes 1. Based on 0.000 to 0.500 displacement rates 2. Based on 1% mortality of displaced birds				

Table 9-22: In-Combination Displacement Matrix for Sandwich Tern from Greater Wash SPA from OWFs in the UK North Sea (SEP and DEP Contributions Calculated from Design-

Based Density Estimates), with the Ranges of Displacement and Mortality Considered by the Assessment shown in Red

	Mortality (%)										
Displacement (%)	1	2	3	4	5	10	20	30	50	80	100
10	0	1	1	2	2	5	10	15	25	40	50
20	1	2	3	4	5	10	20	30	50	79	99
30	1	3	4	6	7	15	30	45	74	119	149
40	2	4	6	8	10	20	40	60	99	159	198
50	2	5	7	10	12	25	50	74	124	198	248
60	3	6	9	12	15	30	60	89	149	238	298
70	3	7	10	14	17	35	69	104	174	278	347
80	4	8	12	16	20	40	79	119	198	317	397
90	4	9	13	18	22	45	89	134	223	357	446
100	5	10	15	20	25	50	99	149	248	397	496

Table 9-23: In-Combination Displacement Matrix for Sandwich Tern from Greater Wash SPA from OWFs in the UK North Sea (SEP and DEP Contributions Calculated from Model-Based Density Estimates), with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

	Mortality (%)										
Displacement (%)	1	2	3	4	5	10	20	30	50	80	100
10	1	1	2	2	3	5	11	16	26	42	53
20	1	2	3	4	5	11	21	32	53	84	105
30	2	3	5	6	8	16	32	47	79	126	158
40	2	4	6	8	11	21	42	63	105	169	211
50	3	5	8	11	13	26	53	79	132	211	264
60	3	6	9	13	16	32	63	95	158	253	316
70	4	7	11	15	18	37	74	111	184	295	369
80	4	8	13	17	21	42	84	126	211	337	422
90	5	9	14	19	24	47	95	142	237	379	474
100	5	11	16	21	26	53	105	158	264	422	527

9.3.3.1.5.2 Collision Risk

1001. Collision risk for Greater Wash SPA Sandwich tern was previously calculated for other OWFs using models not recommended for use in OWF assessment by Natural England. Revised CRM for other OWFs was therefore undertaken. This amounts to investigations which go substantially beyond those typically carried out for an OWF assessment. Detailed methodology and input parameters for CRM, including the consented and as-built designs of existing OWFs, are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1002. The annual in-combination predicted collision mortality for the Greater Wash SPA breeding adult Sandwich tern population is presented in the following tables. CRM results obtained using consented OWF parameters (Scenario A) are presented in **Table 9-24** and as-built parameters (Scenario B) in **Table 9-25**.

1003. Whilst the CRM for the as-built scenario provides the most realistic outputs, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, albeit extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, two further sets of CRM outputs for hypothetical OWF designs have been produced. The first (**Table 9-26**) assumes that any unbuilt capacity at the consented OWFs is built out using turbines of the same specification as the consented design (Scenario C). The second (**Table 9-27**) assumes that any unbuilt capacity at the consented OWFs is built out using turbines of the same specification as those actually used at the OWF (Scenario D). The final set of CRM outputs (Scenario E) (**Table 9-28**) is the same as Scenario D but with the assumption that the as-built layout of DOW is legally secured through a mechanism within the DCO (**Section 3.3.2**). Further details describing the mechanism for securing the as-built layout of DOW are provided in **ES Chapter 4 Project Description** (document reference 6.1.4). The avoidance rates (with and without macro-avoidance) are as per those considered in **Section 9.3.3.1.4.2**.

Table 9-24: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the Greater Wash SPA using Consented OWF Parameters (Scenario A)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	40.1	30.1	20.0	23.5	14.0
1	Race Bank	89.1	66.8	44.5	52.1	31.2
1	SOW	16.7	12.6	8.4	9.8	5.9
2	Triton Knoll	17.8	13.4	8.9	10.4	6.2
TOTAL (excluding SEP and DEP)		163.8	122.8	81.9	95.8	57.3
5	DEP (design-based density estimates)	7.3	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.8	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.3 (10.6)	6.2 (7.9)	4.1 (5.3)	4.9 (6.2)	2.9 (3.7)
5	SEP (model-based density estimates)	2.7	2.0	1.4	1.6	1.0

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
TOTAL (including SEP and DEP, design-based density estimates)		172.9	129.7	86.5	101.2	60.5
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		174.8 (177.1)	131.1 (132.7)	87.4 (88.6)	102.2 (103.6)	61.2 (62.0)

Table 9-25: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the Greater Wash SPA using As-Built OWF Parameters (Scenario B)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	33.3	25.0	16.6	19.5	11.7
1	Race Bank	30.1	22.6	15.1	17.6	10.5
1	SOW	16.7	12.6	8.4	9.8	5.9
2	Triton Knoll	6.1	4.5	3.0	3.5	2.1
TOTAL (excluding SEP and DEP)		86.2	64.7	43.1	50.4	30.2
5	DEP (design-based density estimates)	7.3	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.8	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.3 (10.6)	6.2 (7.9)	4.1 (5.3)	4.9 (6.2)	2.9 (3.7)
5	SEP (model-based density estimates)	2.7	2.0	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		95.4	71.6	47.7	55.8	33.4
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		97.2 (99.5)	72.9 (74.6)	48.6 (49.8)	56.9 (58.2)	34.0 (34.9)

Table 9-26: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the Greater Wash SPA using As-Built OWF Parameters, with Additional Unbuilt Capacity Built Out using Consented Design Turbines (Scenario C)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	44.5	33.4	22.3	26.0	15.6
1	Race Bank	31.0	23.3	15.5	18.1	10.9
1	SOW	16.7	12.6	8.4	9.8	5.9
2	Triton Knoll	11.2	8.4	5.6	6.6	3.9
TOTAL (excluding SEP and DEP)		103.5	77.6	51.8	60.6	36.2
5	DEP (design-based density estimates)	7.3	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.8	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.3 (10.6)	6.2 (7.9)	4.1 (5.3)	4.9 (6.2)	2.9 (3.7)
5	SEP (model-based density estimates)	2.7	2.0	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		112.7	84.5	56.3	65.9	39.4
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		114.5 (116.8)	85.9 (87.5)	57.3 (58.5)	67.0 (68.4)	40.1 (40.9)

Table 9-27: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the Greater Wash SPA using As-Built OWF Parameters, with Additional Unbuilt Capacity Built Out using As-Built Design Turbines (Scenario D)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	42.6	32.0	21.3	24.9	14.9
1	Race Bank	30.4	22.8	15.2	17.8	10.7
1	SOW	16.7	12.6	8.4	9.8	5.9
2	Triton Knoll	7.8	5.9	3.9	4.6	2.7
TOTAL (excluding SEP and DEP)		97.6	73.2	48.8	57.1	34.2

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
5	DEP (design-based density estimates)	7.3	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.8	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.3 (10.6)	6.2 (7.9)	4.1 (5.3)	4.9 (6.2)	2.9 (3.7)
5	SEP (model-based density estimates)	2.7	2.0	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		106.8	80.1	53.4	62.5	37.4
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		108.6 (110.9)	81.5 (83.1)	54.3 (55.5)	63.5 (64.9)	38.0 (38.9)

Table 9-28: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the Greater Wash SPA using As-Built OWF Parameters, with Additional Unbuilt Capacity Built Out using As-Built Design Turbines Except for DOW, for Which the As-Built Design is Assumed to be Legally Secured (Scenario E)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	33.3	25.0	16.6	19.5	11.7
1	Race Bank	30.4	22.8	15.2	17.8	10.7
1	SOW	16.7	12.6	8.4	9.8	5.9
2	Triton Knoll	7.8	5.9	3.9	4.6	2.7
TOTAL (excluding SEP and DEP)		88.3	66.2	44.1	51.6	30.9
5	DEP (design-based density estimates)	7.3	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.8	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates;	8.3 (10.6)	6.2 (7.9)	4.1 (5.3)	4.9 (6.2)	2.9 (3.7)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
	values in parentheses assumes all turbines installed in DEP-N)					
5	SEP (model-based density estimates)	2.7	2.0	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		97.5	73.1	48.7	57.0	34.1
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		99.3 (101.6)	74.5 (76.1)	49.6 (50.8)	58.1 (59.4)	34.8 (35.6)

1004. Using the consented OWF designs (Scenario A), along with the recommended avoidance rate (0.980), either 172.9 or 174.8 (0.000 macro-avoidance), 129.7 or 131.1 (0.250 macro-avoidance), or 86.5 or 87.4 (0.500 macro-avoidance) breeding adult Greater Wash SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-24**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.1% and 4.2% of this total respectively (5.3% together) when CRMs calculated using design-based density estimates are used, or 4.7% and 1.6% of this total respectively (6.3% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual Greater Wash SPA breeding adult Sandwich tern mortality rate of 18.0% or 18.1% (0.000 macro-avoidance), 13.5% or 13.6% (0.250 macro-avoidance), or 9.0% or 9.1% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used, and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 18.4%, 13.8% or 9.2% depending on the macro-avoidance rate selected. Only three values were calculated for this scenario as only model-based density estimates could be used to assess Sandwich tern density, and therefore collision risk, at DEP-N.

1005. These mortality rates are considered to be unrealistically high, since the OWF designs used as CRM input parameters do not exist. For this situation to actually occur, the as-built DOW, Race Bank, SOW and Triton Knoll OWFs would need to be decommissioned and replaced by the consented designs. These designs included turbines that have been superseded by more modern designs. It is not clear how or why this situation would ever arise in reality and it is not considered to be a plausible scenario, though it is recognised that this is the current “legally secured” scenario.

1006. Using the as-built OWF designs (Scenario B), along with the recommended avoidance rate (0.980), either 95.4 or 97.2 (0.000 macro-avoidance), 71.6 or 72.9 (0.250 macro-avoidance), or 47.7 or 48.6 (0.500 macro-avoidance) breeding adult Greater Wash SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-25**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.9% and 7.7% of this total respectively (9.6% together) when CRMs calculated using design-based density estimates are used, or 8.5% and 2.8% of this total respectively (11.3% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual Greater Wash SPA breeding adult Sandwich tern mortality rate of 9.9% or 10.1% (0.000 macro-avoidance), 7.4% or 7.6% (0.250 macro-avoidance), or 5.0% or 5.0% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP’s turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 10.3%, 7.7% or 5.2% depending on the macro-avoidance rate selected.

1007. Whilst this situation is probably the most realistic in terms of OWF design, it does not account for the fact that the as-built designs are not legally secured.

1008. Using the as-built OWF designs with additional unbuilt capacity built out using consented design turbines (Scenario C), along with the recommended avoidance rate (0.980), either 112.7 or 114.5 (0.000 macro-avoidance), 84.5 or 85.9 (0.250 macro-avoidance), or 56.3 or 57.3 (0.500 macro-avoidance) breeding adult Greater Wash SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-26**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.6% and 6.5% of this total respectively (8.1% together) when CRMs calculated using design-based density estimates are used, or 7.2% and 2.4% of this total respectively (9.6% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual Greater Wash SPA breeding adult Sandwich tern mortality rate of 11.7% or 11.9% (0.000 macro-avoidance), 8.8% or 8.9% (0.250 macro-avoidance), or 5.8% and 5.9% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP’s turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 12.1%, 9.1% or 6.1% depending on the macro-avoidance rate selected.

1009. This situation represents a worst case scenario for the building out of as yet unbuilt capacity at the existing OWFs. However, this is not a highly likely scenario, because it requires any further build-out of existing OWFs to use turbine designs that have been superseded by more modern alternatives. Whilst possible, this does not seem like a realistic scenario.

1010. Using the as-built OWF designs with additional unbuilt capacity built out using as-built design turbines (Scenario D), along with the recommended avoidance rate (0.980), either 106.8 or 108.6 (0.000 macro-avoidance), 80.1 or 81.5 (0.250 macro-avoidance), or 53.4 or 54.3 (0.500 macro-avoidance) breeding adult Greater Wash SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-27**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.7% and 6.9% of this total respectively (8.6% together) when CRMs calculated using design-based density estimates are used, or 7.6% and 2.5% of this total respectively (10.1% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual Greater Wash SPA breeding adult Sandwich tern mortality rate of 11.1% or 11.3% (0.000 macro-avoidance), 8.3% or 8.5% (0.250 macro-avoidance), or 5.5% or 5.6% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 11.5%, 8.6% or 5.8% depending on the macro-avoidance rate selected.

1011. This situation represents the most realistic scenario for the building out of as yet unbuilt capacity at the existing OWFs of the two presented, though is still considered to be relatively unlikely to actually occur.

1012. Using the as-built OWF designs with additional unbuilt capacity built out using as-built design turbines, but with the assumption that the DOW as-built design is legally secured (Scenario E), along with the recommended avoidance rate (0.980), either 97.5 or 99.3 (0.000 macro-avoidance), 73.1 or 74.5 (0.250 macro-avoidance), or 48.7 or 49.6 (0.500 macro-avoidance) breeding adult Greater Wash SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-28**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.9% and 7.5% of this total respectively (9.4% together) when CRMs calculated using design-based density estimates are used, or 8.4% and 2.7% of this total respectively (11.1% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual Greater Wash SPA breeding adult Sandwich tern mortality rate of 10.1% or 10.3% (0.000 macro-avoidance), 7.6% or 7.7% (0.250 macro-avoidance), or 5.1% or 5.2% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used and the density estimation method at SEP and

DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 10.5%, 7.9% or 5.3% depending on the macro-avoidance rate selected.

1013. This situation represents the most realistic scenario for the building out of as yet unbuilt capacity at the existing OWFs of the two presented, in addition to DOW being legally secured in its as-built form as is being provided for through a mechanism within the DCO (see **Section 3.3.2**).

1014. It is clear from this assessment that the contribution of SEP and DEP to the overall collision risk of Greater Wash SPA Sandwich tern is relatively modest, and that the bulk of impacts seem to result from the operation of existing OWFs. Based on the increases in annual mortality of the breeding adult Sandwich tern population of the Greater Wash SPA, there is potential for significant effects to occur at the population level due to this impact pathway. The PVAs produced for the Sandwich tern population of the North Norfolk Coast SPA, whilst slightly larger in terms of absolute mortalities per year due to the inclusion of passage season impacts, are relevant to this assessment (**Table 9-71**, **Table 9-72** and **Table 9-73**).

1015. The discussion regarding the impact magnitudes and interpretation of the PVA counterfactuals presented for collision impacts on the North Norfolk Coast SPA Sandwich tern population (**Section 9.4.3.1.5.2**) remains relevant for collision impacts on the Greater Wash SPA Sandwich tern population.

1016. In conclusion, it seems reasonable to assume that since the potential changes at the population level could be larger than the changes that have occurred at the colony over the last four decades, the annual mortalities considered in the PVAs summarised in **Table 9-71**, **Table 9-72** and **Table 9-73** may already be at, or close to, a level where an adverse effect on the integrity of the Greater Wash SPA might be expected.

1017. **It is concluded that an adverse effect on the integrity of the Greater Wash SPA cannot be ruled out as a result of predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.3.3.1.5.3 Combined Displacement / Barrier Effects and Collision Risk

1018. The predicted annual in-combination breeding adult Greater Wash SPA Sandwich tern mortality from collision and displacement for OWFs in the Greater Wash area under different OWF design scenarios and macro-avoidance rates is shown in **Table 9-29** (displacement rate of 0.000, which will result in the same impacts as collision alone), **Table 9-30** (displacement rate of 0.250) and **Table 9-31** (displacement rate of 0.500). These scenarios use the avoidance rate recommended by Natural England (0.980), and incorporate a level of macro-avoidance which is close to many of the previously observed values for this effect in other studies (**ES Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). It should be noted that this section of the assessment focuses on the scenario that all turbines that are installed at DEP will be installed across DEP as a whole, not just DEP-N, since the former is the worst case scenario when displacement impacts are included.

Table 9-29: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Sandwich Tern of the Greater Wash SPA Under Different OWF Designs, Assuming no Macro-Avoidance

OWF	Consented (Scenario A)	As built (Scenario B)	As-built, built out to consented capacity with consented turbines Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
Existing OWFs[1]	163.8 (17.0%)	86.2 (9.0%)	103.5 (10.7%)	97.6 (10.1%)	88.3 (9.2%)
DEP (design-based density estimates)	7.3	7.3	7.3	7.3	7.3
SEP (design-based density estimates)	1.8	1.8	1.8	1.8	1.8
DEP (model-based density estimates)	8.3	8.3	8.3	8.3	8.3
SEP (model-based density estimates)	2.7	2.7	2.7	2.7	2.7
TOTAL (including SEP and DEP, design-based density estimates) [1]	172.9 (18.0%)	95.4 (9.9%)	112.7 (11.7%)	106.8 (11.1%)	97.5 (10.1%)
TOTAL (including SEP and DEP, model-based density estimates) [1]	174.8 (18.1%)	97.2 (10.1%)	114.5 (11.9%)	108.6 (11.3%)	99.3 (10.3%)
Notes Assumes displacement rate of 0.000 for displacement assessment, and avoidance rate of 0.980, with 0.000 displacement rate for collision assessment 1. Values in parentheses are predicted increases in annual mortality of Greater Wash SPA breeding adult Sandwich terns, assuming population size of 9,443 individuals and adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)					

Table 9-30: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Sandwich Tern of the Greater Wash SPA under Different OWF Designs, Assuming 0.250 Macro-Avoidance

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
Existing OWFs[1]	123.4 (12.8%)	65.2 (6.8%)	78.2 (8.1%)	73.8 (7.7%)	66.8 (6.9%)
DEP (design-based density estimates)	6.0	6.0	6.0	6.0	6.0
SEP (design-based density estimates)	1.6	1.6	1.6	1.6	1.6
DEP (model-based density estimates)	6.7	6.7	6.7	6.7	6.7
SEP (model-based density estimates)	2.3	2.3	2.3	2.3	2.3
TOTAL (including SEP and DEP, design-based density estimates)[1]	130.9 (13.6%)	72.8 (7.6%)	85.8 (8.9%)	81.3 (8.4%)	74.3 (7.7%)
TOTAL (including SEP and DEP, model-based density estimates) [1]	132.4 (13.7%)	74.2 (7.7%)	87.2 (9.1%)	82.8 (8.6%)	75.8 (7.9%)

Notes
Assumes displacement rate of 0.250 and mortality rate of 1% of displaced birds for displacement assessment, avoidance rate of 0.980, with 0.250 displacement rate for collision assessment
1. Values in parentheses are predicted increases in annual mortality of Greater Wash SPA breeding adult Sandwich terns, assuming population size of 9,443 individuals and adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-31: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Sandwich Tern of the Greater Wash SPA under Different OWF Designs, Assuming 0.500 Macro-Avoidance

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
Existing OWFs[1]	83.0 (8.6%)	44.2 (4.6%)	52.9 (5.5%)	49.9 (5.2%)	45.3 (4.7%)
DEP (design-based density estimates)	4.7	4.7	4.7	4.7	4.7
SEP (design-based density estimates)	1.3	1.3	1.3	1.3	1.3
DEP (model-based density estimates)	5.2	5.2	5.2	5.2	5.2
SEP (model-based density estimates)	1.9	1.9	1.9	1.9	1.9
TOTAL (including SEP and DEP, design-based density estimates) [1]	88.9 (9.2%)	50.2 (5.2%)	58.8 (6.1%)	55.9 (5.8%)	51.2 (5.3%)
TOTAL (including SEP and DEP, model-based density estimates)[1]	90.0 (9.3%)	51.3 (5.3%)	59.9 (6.2%)	56.9 (5.9%)	52.3 (5.4%)
Notes Assumes displacement rate of 0.500 and mortality rate of 1% of displaced birds for displacement assessment, avoidance rate of 0.980, with 0.500 displacement rate for collision assessment 1. Values in parentheses are predicted increases in annual mortality of Greater Wash SPA breeding adult Sandwich terns, assuming population size of 9,443 individuals and adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)					

1019. As with the project alone scenarios examined, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Table 9-29**). The conclusions for all other scenarios presented in the above tables result in very similar, but slightly smaller impacts being predicted.

1020. It is clear from this assessment that the contribution of SEP and DEP to the overall collision risk of Greater Wash SPA Sandwich tern is relatively modest, and that the bulk of impacts seem to result from the operation of existing OWFs. Based on the increases in annual mortality of the breeding adult Sandwich tern population of the Greater Wash SPA, there is potential for significant effects to occur at the population level due to this impact pathway. The PVAs produced for the Sandwich tern population of the North Norfolk Coast SPA, whilst slightly larger in terms of absolute mortalities per year due to the inclusion of passage season impacts, are relevant to this assessment (**Table 9-77** and **Table 9-78**).

1021. The discussion regarding the impact magnitudes and interpretation of the PVA counterfactuals presented for combined displacement and collision impacts on the North Norfolk Coast SPA Sandwich tern population (**Section 9.4.3.1.5.3**) remains relevant for combined displacement and collision impacts on the Greater Wash SPA Sandwich tern population.

1022. In conclusion, it seems reasonable to assume that since the potential changes at the population level could be larger than the changes that have occurred at the colony over the last four decades, the annual mortalities considered in the PVAs summarised in **Table 9-77** and **Table 9-78** may already be at, or close to, a level where an adverse effect on the integrity of the Greater Wash SPA might be expected.

1023. **It is concluded that an adverse effect on the integrity of the Greater Wash SPA cannot be ruled out as a result of predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.3.3.2 Common Tern

9.3.3.2.1 Status

1024. The common terns that make up the qualifying feature of this SPA breed within the North Norfolk Coast SPA and Ramsar site, for which a separate Appropriate Assessment has been carried out in **Section 9.4.3.2**.

1025. The citation for the Greater Wash SPA (Natural England, 2018a) states that the population of common terns associated with the SPA is 510 pairs (1,020 individuals), which was the peak mean count of birds present at the North Norfolk Coast SPA and Ramsar site between 2010 and 2014. The most recent count for that site is 289 pairs, or 578 breeding adults, in 2020 (JNCC, 2022). At Breydon Water SPA and Ramsar site, which also contributes to the Greater Wash SPA common tern population, 27 pairs (54 individuals) were present in 2020. In total therefore, the Greater Wash SPA population is 632 individual breeding adult common terns. This is used as the reference population for the assessment. The baseline annual mortality of this population, assuming an adult mortality rate of 11.7% (Horswill and Robinson, 2015), is 74 birds.

1026. No specific conservation advice was available for this qualifying feature.

9.3.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1027. The area within the Greater Wash SPA boundary contains habitats that are considered to represent important marine areas for common tern during the breeding season. It is acknowledged that birds may also utilise habitats outside the SPA boundaries during the breeding season.

1028. The assessment assumes that 100% of common terns present at SEP and DEP during the full breeding season (May to August; Furness (2015)) are breeding adults from the Greater Wash SPA population. It seems, however, as though this may be an unrealistically precautionary assumption. DEP is considerably beyond the mean maximum foraging range (18.0km (sd 8.9km)) (Woodward *et al.*, 2019), of birds from both the Scolt Head (51km) and Blakeney Point (38km) colonies, which is where the majority of birds that make up the Greater Wash SPA population breed. SEP is closer, but still beyond the mean maximum foraging range of both Scolt Head (33km) and Blakeney Point (22km). Breydon Water is considerably further away from SEP and DEP. Whilst SEP is within the mean maximum foraging range plus one standard deviation from Blakeney Point, this measurement is considered to be a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony. It is therefore probable that a proportion of the birds using SEP, and as many as all of the birds using DEP are not breeding adult birds from any of the colonies which contribute birds to the Greater Wash SPA population.

1029. The Greater Wash SPA has been designated to protect important marine areas for the species whilst foraging during the breeding season. It is therefore considered that the designation does not protect birds that have dispersed from their colonies following the breeding season (May to August), or birds present prior to the breeding season. Therefore, common tern impacts outside the breeding season are not considered within the Appropriate Assessment for this site. They are however, considered within the Appropriate Assessment for the North Norfolk Coast SPA and Ramsar site (**Section 9.4.3.2**).

9.3.3.2.3 Potential Effects on the Qualifying Feature

1030. The common tern qualifying feature of the Greater Wash SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.3.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.3.3.2.4.1 Collision Risk

1031. Collision risk predictions for Greater Wash SPA common terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-32**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-33**. Outputs are based on Option 2 of the Band Model and avoidance rates of

0.980, as recommended by the statutory guidance (UK SNCBs, 2014). The methodology and input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1032. For DEP, the mean annual collision estimate (0.36) increases the annual baseline mortality by 0.49%. The predicted increase in the annual baseline mortality of Greater Wash SPA Sandwich terns is greater than 1% for the annual upper 95% CI output (1.61 collisions per year; 2.17%). For SEP, the mean annual collision estimate (0.36) increases the annual baseline mortality by 0.49%, and the upper 95% CI output (1.64) increases the baseline mortality by 2.22%. For SEP and DEP together, the mean collision rate (0.73) represents a less than 1% increase in the existing mortality of the population (0.98%). The upper 95% CI collision rate (4.39%) results in predicted increases in the annual baseline mortality of Greater Wash SPA common terns of greater than 1%. These values all assume an extremely precautionary 100% of birds present at SEP and DEP belonging to the Greater Wash SPA population.

Table 9-32: Predicted Monthly Breeding Season Collision Mortality for Common Tern at SEP and DEP Apportioned to Greater Wash SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.19	0.05	0.00	0.13	0.00	0.00	0.00	0.00	0.36
	Density	95% UCI	0.00	0.00	0.00	0.00	0.77	0.34	0.00	0.50	0.00	0.00	0.00	0.00	1.61
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.30	0.08	0.00	0.21	0.00	0.00	0.00	0.00	0.59
		95% LCI	0.00	0.00	0.00	0.00	0.09	0.02	0.00	0.06	0.00	0.00	0.00	0.00	0.17
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.10	0.15	0.00	0.10	0.00	0.00	0.00	0.00	0.36
	Density	95% UCI	0.00	0.00	0.00	0.00	0.75	0.28	0.00	0.61	0.00	0.00	0.00	0.00	1.64
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.17	0.25	0.00	0.17	0.00	0.00	0.00	0.00	0.59
		95% LCI	0.00	0.00	0.00	0.00	0.05	0.07	0.00	0.05	0.00	0.00	0.00	0.00	0.16
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
	Mean	-	0.00	0.00	0.00	0.00	0.29	0.20	0.00	0.23	0.00	0.00	0.00	0.00	0.73

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
SEP and DEP	Density	95% UCI	0.00	0.00	0.00	0.00	1.52	0.62	0.00	1.11	0.00	0.00	0.00	0.00	3.25
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.47	0.32	0.00	0.38	0.00	0.00	0.00	0.00	1.17
		95% LCI	0.00	0.00	0.00	0.00	0.13	0.09	0.00	0.11	0.00	0.00	0.00	0.00	0.33
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out.

Table 9-33: Predicted Annual Breeding Season Collision Mortality for Common Tern at SEP and DEP Apportioned to Greater Wash SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	0.36 (0.00 - 1.61)	0.49 (0.00 - 2.17)
SEP	0.36 (0.00 - 1.64)	0.49 (0.00 - 2.22)
SEP and DEP	0.73 (0.00 - 3.25)	0.98 (0.00 - 4.39)
Notes 1. Background population is Greater Wash SPA breeding adults (632 individuals), adult age class annual mortality rate of 11.7% (Horswill and Robinson, 2015)		

1033. In summary, the mean common tern collision rates predicted at SEP and DEP using an avoidance rate of 0.980 do not produce impacts of a sufficient magnitude to lead to an adverse effect on integrity of the Greater Wash SPA. Predicted increases in mortality using the mean collision outputs are close to, but below, the 1% threshold in existing mortality increase, beyond which impacts may be detectable.

1034. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 36 flying birds were observed across DEP (of which 29 were within DEP-N, and seven within DEP-S). When corrected for the different survey transect lengths in both regions of DEP this means that encounter rate was 32.2% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude could lead to increases in mortality of greater than 1% being predicted. However, since the difference in encounter rate between DEP-N and DEP-S is unlikely to be statistically significant, it is still considered that effects will likely be undetectable within the context of natural variation.

1035. Furthermore, it is likely that the proportion of birds present at SEP and DEP that are actually associated with the SPA is substantially overestimated, and subsequently so are the predicted impacts. Both OWFs lie a considerable distance from the breeding colonies from which the Greater Wash SPA population originates relative to the published mean maximum foraging range. In addition, approximately 90% of the annual collision risk at SEP and DEP occurred in May and August. Whilst these months are part of the full breeding season, they are also in the spring and autumn passage periods respectively for this species (Furness, 2015). Therefore, the majority of collisions predicted are likely to involve birds from other colonies on passage, and not breeding adults associated with the Greater Wash SPA.

1036. **It is concluded that predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

1037. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore**

Ornithology Technical Report (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters, and the avoidance rate, the selected parameters are considered to be sufficiently precautionary based on expert opinion and information drawn from the literature to provide confidence that collision rates are not underestimated, and may in fact be overestimated.

9.3.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.3.3.2.5.1 Collision Risk

1038. Of the other OWFs within the Greater Wash area for which assessments were consulted (i.e. SOW, DOW, Race Bank OWF and Triton Knoll), common tern collisions were predicted at SOW only. Three collisions per year were estimated, at an avoidance rate of 0.980 (SCIRA Offshore Energy Ltd, 2006). SOW is located approximately 32km from Scolt Head, and 19km from Blakeney Point at its nearest point. It therefore lies outside the mean maximum foraging range (18.0km (sd 8.9km)) (Woodward *et al.*, 2019) of both breeding locations from which Greater Wash SPA common terns originate, but within the mean maximum foraging range plus one standard deviation of Blakeney Point. However, this measurement is considered to be poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. Furthermore, approximately 80% of the annual collision risk at SOW occurred in August, with the remainder in May. Whilst these months are part of the full breeding season, they are also in the autumn and spring passage periods respectively for this species (Furness, 2015). Therefore, the majority of collisions predicted at SOW are likely to involve birds from other colonies on passage, and not breeding adults associated with the Greater Wash SPA. The same arguments apply to the predicted impacts of SEP and DEP.

1039. Outside the breeding season, there is potential for other OWFs to impact this qualifying feature during the spring and autumn migration seasons. However, a review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. As approximately just 0.2% of migration season impacts on this species would be apportioned to this SPA population (Furness, 2015), it is considered unlikely that in-combination effects on this qualifying feature will occur to the level where an adverse effect on the integrity of the site would be possible.

1040. **It is concluded that an adverse effect on the integrity of the Greater Wash SPA can be ruled out as a result of predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.3.3.3 Little Gull

9.3.3.3.1 Status

1041. Little gull is a species about which very little is known. The non-breeding little gull qualifying feature of the Greater Wash SPA is not well characterised, and no national population estimate exists. However, during the designation process of the Greater Wash SPA, it was recognised that it supports one of the largest non-breeding marine populations of this species in the UK (Lawson *et al*., 2016; Natural England and JNCC, 2016). Numbers in UK waters peak during spring and autumn migration (Brown and Grice, 2005). Skov *et al*. (2007) estimated that 5,400 birds winter in the North Sea although this represents only a small fraction of the numbers passing though on migration. The North Sea flyway population has previously been estimated to consist of 75,000 individuals (Stienen *et al*., 2007).

1042. The citation for the Greater Wash SPA (Natural England, 2018a) states that the population of little gulls associated with the SPA is 1,255 individuals, which was the peak mean count of birds present within the area designated as the SPA. The population estimate was based on distance-corrected visual aerial survey data collected between 2004 and 2006. It was recognised during the designation process that visual aerial surveys may underestimate numbers of little gull, and that the numbers recorded in the area of search may have in fact been around 50% of those actually present (Natural England and JNCC, 2016). This would mean that over 4,300 birds were present in the area of search (an area substantially larger than what was eventually designated as the SPA) during the surveys. Furthermore, the surveys occurred in October and November, which may have missed peak numbers of little gull in September and early October. It has previously been suggested that numbers could be up to five times greater at peak times than were recorded in the 2004 to 2006 surveys (MacArthur Green and Royal HaskoningDHV, 2019), and around to 10,000 to 20,000 birds therefore pass through the Greater Wash area of search each year. However, this figure could realistically be substantially greater, based on the North Sea flyway population on 75,000 birds (Stienen *et al*., 2007). It is considered likely that 1,255 individuals is a substantial underestimate of the Greater Wash SPA population.

1043. The published adult mortality rate for this species is 20.0% (Horswill and Robinson, 2015), with no age class-specific survival rates available. Given the uncertainty around the population size to be included in the assessment, several are used. They are set out in **Table 9-34**.

Table 9-34: Population and Annual Mortality Estimates of Little Gull used in the Appropriate Assessment

Population estimate source and justification	Population estimate (individuals)	Annual mortality[1] (individuals)
Greater Wash SPA citation (Natural England, 2018a)	1,255	251

Population estimate source and justification	Population estimate (individuals)	Annual mortality[1] (individuals)
Considered to underestimate population by up to fivefold due to peak passage period not being surveyed, and up to 50% due to survey method		
Number of birds passing through Greater Wash SPA during autumn passage (MacArthur Green and Royal HaskoningDHV, 2019) Corrected population estimate based on known sources of underestimation of cited Greater Wash SPA population	10,000 to 20,000	2,000 to 4,000
North Sea flyway population	75,000	15,000
Notes 1. Assumes adult age class annual mortality rate of 20.0% (Horswill and Robinson, 2015)		

1044. No specific conservation advice was available for this qualifying feature.

9.3.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1045. The area within the Greater Wash SPA boundary contains habitats that are considered to represent important marine areas for little gull during the breeding season. It is acknowledged that birds also utilise habitats outside the SPA boundaries during the non-breeding season (Lawson *et al*., 2016), and that birds remain qualifying features of the Greater Wash SPA when outside the boundary of the SPA.

1046. The assessment therefore assumes that 100% of little gulls present at SEP and DEP belong to the Greater Wash SPA population.

9.3.3.3.3 Potential Effects on the Qualifying Feature

1047. The little gull qualifying feature of the Greater Wash SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.3.3.3.4 Potential Effects of SEP and DEP In Isolation and Together

9.3.3.3.4.1 Collision Risk

1048. Collision risk predictions for little gull at SEP, DEP, and SEP and DEP together, (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-35**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate across the various population estimates under consideration is presented in **Table 9-36**. Outputs are based on Option 2 of the Band Model, avoidance rates of 0.992 and generic flight height distributions ("Corrigendum," 2014; Johnston *et al.*, 2014). Nocturnal activity was set at 25% of daytime activity. These parameters were selected based on Natural England's advice provided during the Norfolk Vanguard OWF DCO Examination (Natural England, 2019a). Further information on this, detailed methodology and information on other input parameters for Collision Risk Modelling (CRM) are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1049. For SEP and DEP respectively, the mean annual collision estimate for little gull was 0.43 and 1.89. The Greater Wash SPA population at citation represents 1.7% to 13.0% of the number of birds passing through the Greater Wash area of search (i.e. 10,000 to 75,000). On this basis, 0.03 to 0.25 collisions per year at DEP would be attributable to the Greater Wash SPA population of little gull, and 0.01 to 0.06 at SEP, giving a total of 0.04 to 0.30 collisions per year for Greater Wash SPA little gull at SEP and DEP together. The increase in existing mortality levels due to these predicted impacts is 0.02% to 0.12%. Applying the same calculations to the 95% upper CI collision rates results in 0.13 to 1.03 collisions per year being attributed to the Greater Wash SPA little gull population, representing a 0.05% to 0.41% increase in existing mortality. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

1050. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. The small sample size of flying birds recorded across DEP as a whole (25 birds) means that any differences in encounter rate between DEP and DEP-N are highly unlikely to be statistically significant for this species. Therefore, the collision rates presented here are a reasonable representation of the worst case scenario for DEP.

Table 9-35: Predicted Monthly Breeding Season Collision Mortality for Little Gull at SEP and DEP

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.89	0.00	0.00	1.89
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.47	0.00	0.00	6.47
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.13	0.00	0.00	4.13
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.51
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.33	0.00	0.43
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.33	0.95	0.00	1.44
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.15	0.72	0.00	0.94
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.09	0.00	0.11
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	1.95	0.33	0.00	2.31
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	6.80	0.95	0.00	7.91
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	4.28	0.72	0.00	5.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.52	0.09	0.00	0.62
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]	J	F	M	A	M	J	J	A	S	O	N	D	Total
Notes 1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 25% of daytime activity.														

Table 9-36: Predicted Annual Collision Mortality for Little Gull at SEP and DEP Relevant Background Populations with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% annual mortality increase		
		Birds passing through GW area of search, lower estimate[1]	Birds passing through GW area of search, upper estimate[2]	North Sea flyway[3]
DEP	1.89 (0.00 - 6.47)	0.09 (0.00 - 0.32)	0.05 (0.00 - 0.16)	0.01 (0.00 - 0.04)
SEP	0.43 (0.00 - 1.44)	0.02 (0.00 - 0.07)	0.01 (0.00 - 0.04)	0.00 (0.00 - 0.01)
SEP and DEP	2.31 (0.00 - 7.91)	0.12 (0.00 - 0.40)	0.06 (0.00 - 0.20)	0.02 (0.00 - 0.05)

Notes
1. Background population of 10,000 individuals, adult age class annual mortality rate of 20.0% (Horswill and Robinson, 2015)
2. Background population of 20,000 individuals, adult age class annual mortality rate of 20.0% (Horswill and Robinson, 2015)
3. Background population of 75,000 individuals, adult age class annual mortality rate of 20.0% (Horswill and Robinson, 2015)

1051. **It is concluded that predicted little gull mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

1052. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.3.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.3.3.3.5.1 Collision Risk

1053. Seasonal and annual in-combination totals of estimated collision mortality of little gull that pass through the Greater Wash area of search at all OWFs included in the in-combination assessment are presented in **Table 9-37**. This information was largely taken from the Norfolk Boreas HRA (MacArthur Green and Royal HaskoningDHV, 2019). The Hornsea Project Four ES Chapter (APEM, 2021) has been published since the publication of the above document, and the number of collisions for little gull presented incorporated into this assessment.

1054. The collision rates presented in **Table 9-37** are based on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than suggested by their consents. These as-built designs will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

Table 9-37: In-Combination Collision Risk for Little Gull Passing Through the Greater Wash Area of Search using Consented OWF Parameters

Tier	OWF	Predicted collisions
1	Hornsea Project One	4
1	Race Bank	21
1	SOW	3
2	Triton Knoll	26
3	Hornsea Project Three	0.5
3	Hornsea Project Two	0.5
3	Norfolk Boreas	3.9
3	Norfolk Vanguard	8.3
4	Hornsea Project Four	0.1
TOTAL (excluding SEP and DEP)		67.3
5	DEP	1.9
5	SEP	0.4
TOTAL (including SEP and DEP)		69.6

1055. The total predicted annual collision mortality for little gull from the Greater Wash SPA is 69.6 individuals (**Table 9-37**). Between them, SEP and DEP contribute 2.3 birds to this total, or 3.3%. The predicted in-combination mortality would increase the baseline adult mortality rate of the Greater Wash area of search population of little gull (i.e. 10,000 to 20,000 birds) by 1.7% to 3.5%, and that of the North Sea flyway population by 0.5%.

1056. The Greater Wash SPA population at citation represents 1.7% to 13.0% of the number of birds passing through the Greater Wash area of search (i.e. 10,000 to 75,000). On this basis, 1.18 to 9.05 collisions per year would be attributable to the Greater Wash SPA population of little gull. The increase in existing mortality levels due to these predicted impacts is 0.47% to 3.60% (or 1.80% assuming a background population of 20,000 individuals). Accounting for the difference between consented and as-built OWF designs (i.e. 40% reduction in predicted collisions), mortality increases of 0.19% to 1.44% (or 0.72% assuming a background population of 20,000 individuals) within the Greater Wash SPA population are possible.

1057. The larger (and probably more realistic) little gull reference populations result in predicted mortality increases of less than 1%. This, combined with the conclusion of no adverse effect on integrity reached for the non-material change application for Triton Knoll OWF (BEIS, 2018), where seven little gulls from the Greater Wash SPA were predicted to die annually through collision, suggest that the same conclusion applies here.

1058. **It is concluded that an adverse effect on the integrity of the Greater Wash SPA can be ruled out as a result of predicted little gull mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.3.3.4 Red-Throated Diver

9.3.3.4.1 Status

1059. At citation, the population of red-throated diver was 1,511 non-breeding individuals (Natural England, 2018a). This was calculated using a five year peak mean population estimate derived from distance-corrected visual aerial surveys of the Greater Wash in 2002/03, 2004/05, 2005/06, 2006/07 and 2007/08.

1060. The annual baseline mortality of this population, assuming that the published all age class mortality rate of 22.8% applies (Horswill and Robinson 2015), is 345 birds.

1061. No specific conservation advice was available for this qualifying feature.

9.3.3.4.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1062. The Greater Wash SPA boundary was selected to include important marine areas for this qualifying feature (Natural England and JNCC, 2016). All red-throated divers within the SPA belong to its population. Birds situated outside the SPA boundary are not associated with the SPA.

1063. The export cable corridor that serves both SEP and DEP crosses the Greater Wash SPA. Any impacts on red-throated divers in this section of the export cable corridor during the construction phase will be from the Greater Wash SPA population.

1064. The Greater Wash SPA is located approximately 6km from SEP at its nearest point, and 16km from DEP. The vast majority of the habitats contained within the SPA boundary are located substantially further away from both OWFs. Operational displacement effects on red-throated diver can occur at considerable distances from OWFs (Dorsch *et al.*, 2020; Hi Def Aerial Surveying, 2017; Mendel *et al.*, 2019; Vilela *et al.*, 2020). As a result, Natural England have advised that OWFs within 10km of a designated site for red-throated diver require consideration with respect to impacts on red-throated divers within that SPA (UK SNCBs, 2022). Therefore, SEP is considered in further detail by the Appropriate Assessment. The distance between the DEP wind farm site and the Greater Wash SPA is too great for adverse effects to occur on the designated site, l*et al*one an effect that could be considered likely to be significant (and therefore require an Appropriate Assessment).

9.3.3.4.3 Potential Effects on the Qualifying Feature

1065. The red-throated diver qualifying feature of the Greater Wash SPA has been screened into the Appropriate Assessment due to the potential risk of disturbance and displacement during the construction and operational phases of SEP, and within the export cable corridor shared by SEP and DEP which crosses the SPA, during the construction phase.

1066. During construction, the installation of the export cable within the Greater Wash SPA could result in the direct displacement and mortality of the qualifying feature. Construction and operational phase displacement effects within the SEP wind farm site could impact the qualifying feature either directly (displacing birds from habitats within the SPA boundary), or indirectly due to construction and operational phase displacement from SEP and DEP (displacing birds into the SPA, which can have knock on effects on birds already within it). However, indirect effects are not considered to represent a sufficiently large impact that adverse effect on the integrity of the site could result. This is because the numbers of birds displaced from SEP and DEP, and their immediate surroundings would be relatively small, and of the birds displaced, those displaced into the Greater Wash SPA are highly unlikely to occur in sufficient numbers to cause substantial, if any, mortality within the SPA population (**ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). DEP is therefore not considered further by the assessment. In addition, the presence of an operational OWF within 10km of an SPA can result in an area of potential displacement within an SPA. This potential impact is also investigated in the case of SEP. Finally, the potential for operation and maintenance vessels to cause impacts during the operational phase is considered.

9.3.3.4.4 Potential Effects of SEP and DEP in Isolation and Together

9.3.3.4.4.1 Construction Phase Displacement / Barrier Effects

1067. The aerial survey study area from which baseline survey data were collected did not include any of the Greater Wash SPA, as it is situated greater than 4km from both SEP and DEP. As is standard practice for baseline surveys of OWFs, the export cable corridor was not covered by the surveys. The Appropriate Assessment therefore utilises data from Lawson *et al.* (2016) to evaluate the magnitude of potential construction phase disturbance and displacement effects on the Greater Wash SPA population of red-throated diver. This dataset was selected in preference to the dataset of Bradbury *et al.* (2014) since it was used to estimate the SPA population at citation, allowing potential displacement to be directly expressed as a percentage of the SPA population. Digital aerial surveys were conducted in early 2022 to estimate the number of red-throated divers present in the Greater Wash

SPA, and their distribution. However, this dataset was not available during the preparation of this assessment.

1068. It has been assumed that 100% displacement of red-throated diver will occur within 2km of the cable laying vessel when it is present within the Greater Wash SPA, wherever in the export cable corridor it is situated at any given time. Literature indicates that the majority of red-throated divers present will flush from approaching vessels at a distance of 1km or less (Bellebaum *et al.*, 2006; Jarrett *et al.*, 2018; Topping and Petersen, 2011). Fliessbach *et al.* (2019) stated that 95% of red-throated divers observed during their study elicited an escape response when approached by a vessel, with a mean escape distance of 750m (standard deviation 437m) and a maximum escape distance of 1,700m. Unidentified diver species were recorded flushing at distances of 2km from the survey vessel. On the balance of this information, 100% displacement at 2km from cable laying activities is considered to be appropriately precautionary.

1069. The available evidence regarding red-throated diver displacement by operational OWFs suggests that there will be little or no impact on adult survival as a result of displacement, and that any impact would probably be undetectable at the population level. No evidence has been identified which supports the upper range of mortality effects for displaced birds currently advised by Natural England (i.e. up to 10%), and a review of the available evidence indicates that a mortality rate of 1% is considered to appropriately precautionary (MacArthur Green, 2019a). It is assumed that these conclusions can also be applied to birds displaced by the cable laying vessel in the export cable corridor that overlaps with the Greater Wash SPA.

1070. To estimate potential displacement within the section of export cable corridor that crosses the Greater Wash SPA, modelled red-throated diver density estimates for this area, plus a 2km buffer, have been extracted from Lawson *et al.* (2016). The mean density estimate, with 95% CIs was 0.274 birds/km^2 (0.118 to 0.432 birds/km^2).

1071. Within 2km of the cable laying vessel, this means that 3.4 birds would be displaced if the mean density is assumed (1.5 to 5.4 if the lower and upper 95% CIs are considered). The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1). Assuming a mortality rate of 1% to 10% amongst displaced birds, 0.0 to 0.3 red-throated divers (assuming mean density values) could be expected to be lost to the population as a result of this activity (0.0 to 0.5 birds if the 95% CIs are considered). These impacts would increase the existing annual mortality within the Greater Wash SPA population by 0.0% to 0.1% in the case of the mean modelled red-throated diver within the export cable corridor, or 0.0% to 0.2% if the 95% CIs of density are used. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

1072. **It is concluded that predicted red-throated diver mortality due to construction phase displacement within the export cable corridor of SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

1073. The confidence in the assessment is medium. Firstly, the evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. The conclusion of the assessment is the same irrespective of whether the mean, 95% upper CI or maximum densities are used to calculate potential mortality and increases in the baseline mortality rate of the background population. However, the data on which the assessment is based, despite being the best available, is not considered to be up to date.

9.3.3.4.4.2 Operational Phase Displacement / Barrier Effects

1074. Mean modelled densities from Lawson *et al.* (2016) indicate that there are approximately 22 birds (95% CIs 8 to 40) within the Greater Wash SPA using habitats that are within 6km to 12km of SEP, which is the maximum displacement distance considered by the “straight line” method of potential displacement estimation used during the East Anglia ONE North and TWO DCO Examination (ScottishPower Renewables, 2022). Red-throated diver displacement by operational OWFs occurs on a gradient (as demonstrated by many studies). This means that at greater distances from the OWF, less birds within a given area will be displaced than in an area nearer to it. Since the Greater Wash SPA is situated at least 6km from SEP, displacement rates are extremely unlikely to be as high as is assumed to be the case within 2km of OWFs (100% by Natural England, and 90% by recent literature review (MacArthur Green, 2019a)). Displacement rates as suggested by the “straight line” method used during the East Anglia ONE North and TWO DCO Examination (ScottishPower Renewables, 2022) indicate that between 6km and 12km from an OWF, between 0% and 46% of birds may be displaced. These rates have been used to estimate the potential level of operational phase displacement of red-throated diver within the Greater Wash SPA by SEP (**Table 9-38**). A displacement matrix has not been produced for these calculations, since the displacement rate varies depending on the distance from the OWF.

Table 9-38: Potential Operational Phase Displacement of Red-Throated Divers within the Greater Wash SPA due to SEP

OWF or buffer area[1]	% displacement[1]	Red-throated diver abundance[2]	Red-throated diver displacement	Predicted mortality[4]	
				1%	10%
6-7km	46	0.0[3]	0.0	0.0	0.0
7-8km	37	0.6	0.2	0.0	0.0
8-9km	28	2.1	0.6	0.0	0.1
9-10km	19	4.4	0.8	0.0	0.1
10-11km	10	6.6	0.7	0.0	0.1
11-12km	0	8.7	0.0	0.0	0.0
Total		22.3	2.3	0.02	0.23

OWF or buffer area[1]	% displacement[1]	Red-throated diver abundance[2]	Red-throated diver displacement	Predicted mortality[4]	
				1%	10%
% increase to existing mortality[5]				0.01%	0.07%

Notes
1. Appropriate displacement distances and rates were set on basis of advice given by Natural England during the DCO Examination for East Anglia One North and TWO OWFs
2. Calculated from mean modelled density estimates from Lawson *et al.* (2016)
3. No density estimates occurred within this region due to its extremely small size. A mean of the two adjacent density estimates was therefore used as a surrogate.
4. Mortality rates of displaced birds as previously advised by Natural England
5. Background population of 1,511 individuals, adult age class annual mortality rate of 22.8% (Horswill and Robinson, 2015)

1075. The 22.3 birds within areas of the Greater Wash SPA that are within 6km to 12km of SEP represents 1.5% of the SPA population. Of these birds, 2.3 could be impacted by operational displacement as a result of SEP when displacement rates suggested by Natural England are assumed. Assuming mortality rates of 1% to 10% of displaced birds, 0.02 to 0.23 birds could die annually due to operational phase displacement from SEP (95% CI of 0.00 to 0.18). This would increase the existing annual mortality of the Greater Wash SPA red-throated diver population by 0.0% to 0.1%.

1076. The numbers of displaced birds presented in **Table 9-38** are an overestimate due to existing impacts from other operational OWFs. The vast majority (approximately 80%) of habitat within the Greater Wash SPA that is within 6km to 12km of SEP is also within 12km of either SOW or Race Bank OWF, both of which are already operational. A proportion of the birds occupying areas impacted by the existing OWFs will therefore have been displaced already, and would therefore not be displaced for a second time by the operation of SEP. The actual number of birds displaced by SEP would therefore be lower than indicated in **Table 9-38**. Calculations that include only habitats within 12km of SEP that are not within 12km of another OWF are presented in **Table 9-39**. These are an underestimate of the total amount of displacement that will occur, since birds will remain in some areas already impacted by SOW and Race Bank OWF, which could therefore be displaced by SEP.

1077. The true magnitude of the impact is likely to lie between the predictions in **Table 9-38** and **Table 9-39**.

Table 9-39: Predicted Operational Phase Displacement of Red-Throated Divers within the Greater Wash SPA That are not Already Impacted by Other OWFs, due to SEP

OWF or buffer area[1]	% displacement[1]	Red-throated diver abundance[2]	Red-throated diver displacement	Predicted mortality[3]	
				1%	10%
9-10km	19	0.3	0.1	0.0	0.0
10-11km	10	1.5	0.1	0.0	0.0
11-12km	0	3.3	0.0	0.0	0.0
Total		5.2	0.3	0.00	0.02

OWF or buffer area[1]	% displacement[1]	Red-throated diver abundance[2]	Red-throated diver displacement	Predicted mortality[3]	
				1%	10%
% increase to existing mortality[4]				0.00%	0.01%

Notes
1. Appropriate displacement distances and rates were set on basis of advice given by Natural England during the DCO Examination for East Anglia One North and TWO OWFs
2. Calculated from mean modelled density estimates from Lawson *et al.* (2016)
3. Mortality rates of displaced birds as previously advised by Natural England
4. Background population of 1,511 individuals, adult age class annual mortality rate of 22.8% (Horswill and Robinson, 2015)

1078. The effective area over which displacement could occur within the Greater Wash SPA has also been examined. The 0km to 12km buffer zone of SEP was split into 1km increments, and the area overlapping the Greater Wash SPA measured. For each 1km buffer region, a percentage displacement rate was applied. These rates were taken from the "straight line" method used during the East Anglia ONE North and TWO DCO Examination (ScottishPower Renewables, 2022). The 147.1km^2 of Greater Wash SPA habitat within 12km of SEP represents 4.2% of the total habitat within the SPA. Using the displacement rates taken from the "straight line" method, the resulting effective area of the SEP buffer zones within which displacement could occur that are within the Greater Wash SPA is 16.86km^2 (**Table 9-40**). This represents 0.48% of the Greater Wash SPA.

1079. This value is likely to be an overestimate. The location of SEP relative to existing OWFs means that much of the area of its 0km to 12km buffers which overlap the Greater Wash SPA also overlap with corresponding buffers from two OWFs, SOW and Race Bank, which are already in operation. Areas of habitat that are already affected by this impact pathway cannot be affected twice, though the magnitude of impact in particular areas could increase due to the combined impact of multiple OWFs. If areas from which red-throated divers may have been displaced by existing OWFs are accounted for, the resulting effective area within which displacement could occur within the Greater Wash SPA due to SEP is 4.69km^2 (**Table 9-40**). This represents 0.13% of the Greater Wash SPA. This number is an underestimate, since it does not account for the increased magnitude of impact that could occur in already impacted areas within the Greater Wash SPA. The true potential magnitude of this impact therefore lies between 0.13% and 0.48%.

Table 9-40: Effective Area Over which Displacement of Red-Throated Diver could Occur within the Greater Wash SPA due to SEP Buffer Zones

OWF or buffer area	% displacement	SEP overlap with SPA, including areas overlapping other OWF buffers		SEP overlap with SPA, excluding areas overlapping other OWF buffers	
		Area of buffer overlapping SPA (km^2)	Effective area over which displacement could occur (km^2)	Area of buffer overlapping SPA (km^2)	Effective area over which displacement could occur (km^2)
OWF	100	0	0	0	0

OWF or buffer area	% displacement	SEP overlap with SPA, including areas overlapping other OWF buffers		SEP overlap with SPA, excluding areas overlapping other OWF buffers	
		Area of buffer overlapping SPA (km^2)	Effective area over which displacement could occur (km^2)	Area of buffer overlapping SPA (km^2)	Effective area over which displacement could occur (km^2)
0-1km	100	0	0	0	0
1-2km	91	0	0	0	0
2-3km	82	0	0	0	0
3-4km	73	0	0	0	0
4-5km	64	0	0	0	0
5-6km	55	0	0	0	0
6-7km	46	0.20	0.09	0	0
7-8km	37	3.67	1.36	0.76	0.28
8-9km	28	18.09	4.88	8.40	2.35
9-10km	19	33.09	6.29	8.21	1.56
10-11km	10	42.34	4.23	4.96	0.50
11-12km	0	49.66	0.00	3.45	0
Total		147.05	16.86	25.78	4.69
As % of Greater Wash SPA (3,535.78km^2)		4.16%	0.48%	0.73%	0.13%

1080. The effective areas over which displacement of red-throated diver could occur within the Greater Wash SPA due to operational phase displacement impacts from SEP are small relative to the overall amount of habitat available (**Table 9-40**), and concerns small areas of habitat at one edge of the SPA. Parts of the potentially impacted areas were included in the SPA citation for species other than red-throated diver (Natural England and JNCC, 2016). This means that birds were probably not present in these areas in substantial numbers prior to the operation of SOW. This is reflected in the relatively low numbers of birds predicted to be present in areas of impacted habitat (Lawson *et al.*, 2016), and the predicted impact by operational phase displacement due to SEP presented in **Table 9-38** and **Table 9-39**.

1081. **It is concluded that predicted red-throated diver mortality and changes to distribution due to operational phase displacement of SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

1082. The confidence in the assessment is medium. The evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. However, the data on which the assessment is based, despite being the best available, is not considered to be up to date.

9.3.3.4.4.3 Operational Phase Displacement / Barrier Effects due to Operation and Maintenance Vessel Activity

1083. The aerial survey study area from which baseline survey data were collected did not include any of the Greater Wash SPA, as it is situated greater than 4km from both SEP and DEP. The Appropriate Assessment therefore utilises data from Lawson *et al.* (2016) to evaluate the magnitude of potential operational phase disturbance and displacement effects on the Greater Wash SPA population of red-throated diver due to the presence of vessels within the SPA. It should be noted that a digital aerial survey programme of the Greater Wash SPA commissioned by Natural England was carried out in early 2022. This dataset was not made available to be included in the assessment, so this aspect of the assessment may require updating once the most recent data are made available.

1084. The operation and maintenance vessels that will be used during the operational phase of SEP and DEP will transit from the operation and maintenance base located in Great Yarmouth across the Greater Wash SPA, for a distance of around 38km. The operation and maintenance base is already used by vessels servicing the operational OWFs SOW and DOW, as is the transit route across the SPA. At present, approximately 660 vessel movements take place in the transit corridor within the SPA annually due to these activities, which has been the case since 2021. Prior to that, an unknown number of vessel transits occurred elsewhere within the SPA, which were associated with operation and maintenance vessels of DOW only. Prior to 2021, the operations and maintenance vessels associated with SOW were based separately at Wells-next-the-Sea (approximately 28km from the south west tip of SEP i.e. its closest point). The route that is used by the SOW and DOW operation and maintenance vessels is also relatively frequently used by other vessels according to a review of vessel tracking data (ABP Marine Environmental Research, 2014). This suggests that the red-throated diver population along the proposed SEP and DEP operation and maintenance vessel transit corridor may already be subject to displacement by other vessels.

1085. In the best case scenario, SEP and DEP will not add to the existing total of vessel movements, since daughter craft from a larger vessel which transits from Great Yarmouth will be used for operation and maintenance activities at SEP and DEP, as well as SOW and DOW. These craft will only depart the larger vessel once it has arrived at the relevant OWF, and will rejoin the vessel before it departs for the return journey to Great Yarmouth. In the worst case, an additional 1,200 vessel movements per year through the Greater Wash SPA could occur as a result of operation and maintenance activities associated with SEP and DEP. These additional movements would use the same general route that is currently used by the operation and maintenance vessels associated with SOW and DOW. Additionally, as noted below (**paragraph 1094**), a best practice protocol for minimising disturbance to red-throated divers as secured through the **Outline PEMP** (document reference 9.10) would be adhered to by SEP and/or DEP operation and maintenance vessels.

1086. Literature indicates that the majority of red-throated divers present will flush from approaching vessels at a distance of 1km or less (Bellebaum *et al.*, 2006; Jarrett *et al.*, 2018; Topping and Petersen, 2011). Fliessbach *et al.* (2019) stated that 95% of red-throated divers observed during their study elicited an escape response when approached by a vessel, with a mean escape distance of 750m (standard deviation 437m) and a maximum escape distance of 1,700m. Unidentified diver species were recorded flushing at distances of 2km from the survey vessel. On the balance of this information, 100% displacement at 2km from operation and maintenance vessels is considered to be a highly precautionary assumption.

1087. Information on the repopulation of areas by red-throated diver following displacement by vessels was identified from a single source (Burger *et al*., 2019). This suggested that birds may partially return into areas a vessel has passed through after around seven hours, though the displacement effect may be greater where faster vessels are concerned. Increasing the number of vessel transits through the transit corridor may result in birds being more frequently displaced, which potentially could have energetic consequences. That being said, it is clear that red-throated divers avoid shipping lanes within the Outer Thames SPA (Irwin *et al.*, 2019), so it seems reasonable to assume that an increase in the number of vessel movements in the Greater Wash SPA might cause birds to avoid the transit corridor altogether. The fact that these areas may already subject to moderate levels of vessel traffic (ABP Marine Environmental Research, 2014) indicates relatively low numbers of birds may be present.

1088. The available evidence regarding red-throated diver displacement by operational OWFs suggests that there will be little or no impact on adult survival as a result of displacement, and that any impact would probably be undetectable at the population level. No evidence has been identified which supports the upper range of mortality effects for displaced birds currently advised by Natural England for displacement by operational OWFs (i.e. up to 10%), and a review of the available evidence indicates that a mortality rate of 1% is considered to appropriately precautionary (MacArthur Green, 2019a). It is assumed that these conclusions can also be applied to birds displaced by operation and maintenance vessels in the transit corridor between SEP and DEP and the Great Yarmouth base that overlaps with the Greater Wash SPA.

1089. Including a 2km buffer, the transit corridor used by the SOW and DOW operation and maintenance vessels occupies 152.48km2 of the Greater Wash SPA, or approximately 4.3% of the total habitat within the SPA boundary. The mean and 95% CI abundance of birds within the transit corridor (calculated from mean modelled density estimates from Lawson *et al.* (2016) was 91 birds (95% CIs 21 to 231). This represents 6.0% (95% CIs 1.4% to 15.3%) of the red-throated diver population of the Greater Wash SPA at citation.

1090. Assuming a mortality rate of 1% of displaced birds within the transit corridor, 0.91 (95% CIs 0.21 to 2.31) birds could be lost annually to the population based on the available survey data, which could represent an increase in existing mortality within the Greater Wash SPA population of 0.26% (95% CIs 0.06% to 0.67%). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

1091. It could also be argued that since this impact might already be occurring due to the activities of vessels associated with SOW and DOW (and impacts are probably smaller than suggested above due to the ongoing effects of other vessels within the transit corridor), the actual impact that results from operation and maintenance activities of vessels associated with SEP and DEP in the Greater Wash SPA is very low.

1092. **It is concluded that predicted red-throated diver mortality due to operational phase displacement within the operation and maintenance vessel transit corridor of SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Greater Wash SPA.**

1093. The confidence in the assessment is high. The evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. The conclusion of the assessment is the same irrespective of whether the mean, 95% upper CI or maximum densities are used to calculate potential mortality and increases in the baseline mortality rate of the background population. In addition, the data on which the assessment is based, are the best available and are considered to be up to date.

1094. A number of best practice measures will be implemented regarding the operation and maintenance of SEP and DEP. These measures will minimise the potential impacts of vessels on red-throated diver. These measures are secured through the **Outline PEMP** (document reference 9.10) and include:

- Avoiding and minimising maintenance vessel traffic, where possible, during the most sensitive time period in October to March (inclusive);
- Restricting vessel movements where possible to existing navigation routes (where the densities of red-throated divers are typically relatively low);
- As far as possible maintaining direct transit routes (to minimise transit distances through areas used by red-throated diver), where it is necessary to go outside of established navigational routes, avoid rafting birds either en-route to the wind farm sites from port and/or within the wind farm sites (dependent on location) and where possible avoid disturbance to areas with consistently high diver density;
- Avoidance of over-revving of engines (to minimise noise disturbance); and
- Briefing of vessel crew on the importance of the species and the associated mitigation measure through tool box talks.

9.3.3.4.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.3.3.4.5.1 Construction Phase Displacement / Barrier Effects

1095. Vessel activity is likely to already impact the distribution of red-throated divers within the Greater Wash SPA. This represents an established situation following many decades of different types of vessel activity in the area. However, any increase in shipping activity will constitute an in-combination effect on red-throated divers belonging to the Greater Wash SPA.

1096. The displacement impacts on red-throated diver that will occur due to the installation of the SEP and DEP export cable within the Greater Wash SPA are temporary and reversible, and low number of birds and a small amount of habitat are predicted to be impacted at any one time (**Section 9.3.3.4.4.1**). The magnitude and duration of these impacts indicates that the likelihood of an in-combination disturbance effect is extremely small. It should also be noted that whilst some displacement of red-throated divers in the export cable corridor crossing the Greater Wash SPA will occur during the construction phase, the relocation of the SOW operations and maintenance base from Wells-next-the-Sea to Great Yarmouth in 2021 has likely reduced the existing levels of vessel activity within the Greater Wash SPA. This means that in practice, it is expected that increases in vessel activity within the Greater Wash SPA beyond the existing level are not anticipated (compared to pre-2021 levels) as a result of activities during the construction phase of SEP.

1097. **It is concluded that predicted red-throated diver mortality due to construction phase displacement within the export cable corridor of SEP, DEP and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Greater Wash SPA.**

9.3.3.4.5.2 Operational Phase Displacement / Barrier Effects

1098. Mean modelled red-throated diver densities from Lawson *et al.* (2016) have been used to estimate the number of birds at risk of displacement within the Greater Wash SPA due to operational displacement by OWFs. Along with SEP, all OWFs in any stage of development situated less than 12km from any boundary of the Greater Wash SPA at the nearest point were included in the assessment. These were (from north to south) Westermost Rough, Humber Gateway, Triton Knoll, Race Bank, Lincs, Inner Dowsing, SOW, Lynn and Scroby Sands. The abundance of birds in OWFs and 1km buffers up to 12km from OWFs according to Lawson *et al.* (2016) was estimated, and displacement rates applied to each 1km buffer based on the "straight line" approach employed during the East Anglia ONE North and TWO DCO Examination (ScottishPower Renewables, 2022). The potential effects of in-combination operational OWF displacement on the red-throated diver qualifying feature of the Greater Wash SPA is presented in **Table 9-41**.

Table 9-41: Potential In-Combination Operational Phase Displacement of Red-Throated Divers within the Greater Wash SPA

OWF or buffer area[1]	% displacement[1]	Red-throated diver abundance[2]	Red-throated diver displacement	Predicted mortality[3]	
				1%	10%
OWF	100	7.2	7.2	0.1	0.7
0-1km	100	29.6	29.6	0.3	3.0
1-2km	91	39.5	35.9	0.4	3.6
2-3km	82	45.7	37.5	0.4	3.7
3-4km	73	49.6	36.2	0.4	3.6
4-5km	64	53.9	34.5	0.3	3.5
5-6km	55	55.9	30.8	0.3	3.1
6-7km	46	61.6	28.3	0.3	2.8
7-8km	37	72.0	26.6	0.3	2.7
8-9km	28	64.9	18.2	0.2	1.8
9-10km	19	67.2	12.8	0.1	1.3
10-11km	10	61.9	6.2	0.1	0.6
11-12km	0	62.5	0.0	0.0	0.0
Total		671.5	303.8	3.0	30.4
% increase to existing mortality[4]				0.9%	8.8%

Notes
1. Appropriate displacement distances and rates were set on basis of advice given by Natural England during the DCO Examination for East Anglia One North and TWO OWFs
2. Calculated from mean modelled density estimates from Lawson *et al.* (2016)
3. Mortality rates of displaced birds as previously advised by Natural England
4. 3. Background population of 1,511 individuals, adult age class annual mortality rate of 22.8% (Horswill and Robinson, 2015)

1099. In total, the mean modelled densities presented by Lawson *et al.* (2016) indicate that 671.5 red-throated divers use habitats within 12km of operational OWFs within the Greater Wash SPA. This represents 44.4% of the Greater Wash SPA population. Of these birds, 303.8 (or 20.1% of the SPA population) could be displaced due to in-combination operational phase OWF displacement, when displacement rates taken from the “straight line” approach are used (ScottishPower Renewables, 2022). Assuming mortality rates of 1% to 10% of displaced birds, 3.0 to 30.4 birds could die annually due to in-combination operational phase OWF displacement. This would increase the existing annual mortality of the Greater Wash SPA red-throated diver population by 0.9% to 8.8%.

1100. In addition to the numbers of red-throated divers that could be displaced and/or die due to operational phase displacement from SEP in-combination with other projects, the effective area over which displacement could occur within the Greater Wash SPA has also been examined. The combined 0km to 12km buffer zone of the OWFs listed above was split into 1km increments, and the area overlapping the Greater Wash SPA calculated.

1101. For each 1km buffer region, a percentage displacement rate was applied. These rates were advised by Natural England during the East Anglia ONE North and TWO DCO Examination. The resulting effective area over which displacement could occur within the Greater Wash SPA when habitat potentially impacted by SEP is excluded from calculations, is 806.42km^2 (**Table 9-42**). This represents 22.81% of the Greater Wash SPA. The addition of SEP to these calculations revises the area potentially impacted to 811.11km^2 (**Table 9-42**), an increase of 0.58%. This represents 22.94% of the Greater Wash SPA.

Table 9-42: Effective Area Over which Red-Throated Diver Displacement could Occur within the Greater Wash SPA due to Existing OWF and SEP Buffer Zones

OWF or buffer area	% displacement	Existing OWF overlap with SPA		Existing OWF plus SEP overlap with SPA	
		Area of buffer overlapping SPA (km^2)	Effective area over which displacement could occur (km^2)	Area of buffer overlapping SPA (km^2)	Effective area over which displacement could occur (km^2)
OWF	100	28.11	28.11	28.11	28.11
0-1km	100	65.07	65.07	65.07	65.07
1-2km	91	88.13	80.20	88.13	80.20
2-3km	82	108.73	89.16	108.73	89.16
3-4km	73	129.35	94.42	129.35	94.42
4-5km	64	147.79	94.58	147.79	94.58
5-6km	55	159.74	87.86	159.74	87.86
6-7km	46	183.16	84.26	183.16	84.26
7-8km	37	197.77	73.18	198.53	73.46
8-9km	28	192.85	54.00	201.25	56.35
9-10km	19	195.35	37.12	203.56	38.68
10-11km	10	184.77	18.48	189.73	18.97
11-12km	0	178.11	0.00	181.56	0.00
Total		1,858.93	806.42	1884.71	811.11
As % of Greater Wash SPA (3,535.78km^2)		52.57%	22.81%	53.30%	22.94%

1102. In summary, the assessment presented uses the displacement rates suggested by the "straight line" approach used to estimate potential red-throated diver displacement impacts during the East Anglia One North and Two DCO Examination (ScottishPower Renewables, 2022), in conjunction with a precautionary evidence-based mortality rate of 1% (MacArthur Green, 2019a). The predicted annual mortality of Greater Wash SPA red-throated divers is 3.0 individuals. This increases the baseline annual mortality of the Greater Wash SPA population by 0.9%. Increases in mortality of less than 1% are not expected to be distinguishable from natural variation.

1103. Changes in the distribution of red-throated diver within the Greater Wash SPA are likely to have occurred due to the operation of existing OWFs. Just over half of the habitats within the SPA boundary are within 12km of an OWF, and around 23% of habitats within the SPA are predicted to have been affected by this impact pathway if displacement rates suggested by Natural England during the East Anglia One

North and Two DCO Examination are used to calculate impacts. The contribution of SEP to these distribution changes is very small (less than 1%).

1104. **It is concluded that predicted red-throated diver mortality and changes to distribution due to operational phase displacement of SEP, DEP and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Greater Wash SPA.**

1105. The confidence in the assessment is medium. The evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. Finally, the conclusion of the assessment is the same irrespective of whether the mean, 95% upper CI or maximum densities are used to calculate potential mortality and increases in the baseline mortality rate of the background population. However, the data on which the assessment is based, despite being the best available, is not considered to be up to date.

9.3.3.4.5.3 Operational Phase Displacement / Barrier Effects due to Operation and Maintenance Vessel Activity

1106. The operation and maintenance bases for the majority of OWFs located in the wider Wash area (i.e. Humber Gateway, Inner Dowsing, Lincs, Lynn, Race Bank, Triton Knoll and Westermost Rough) are located in the port of Grimsby. The navigational approach to the port overlaps with the Greater Wash SPA. Therefore, operation and maintenance vessels associated with these OWFs will pass through the northern section of the Greater Wash SPA to some extent on their inbound and outbound trips to their respective OWFs. As the vessels pass through the Greater Wash SPA, red-throated divers which are part of the SPA qualifying feature are likely to be disturbed and displaced.

1107. The available data on red-throated diver distribution with the Greater Wash SPA (Lawson *et al*., 2016) suggests that the navigational approach to Grimsby (and other ports within the Humber Estuary) that crosses the Greater Wash SPA supports relatively low densities of red-throated divers. This is likely due at least in part to the high amount of existing vessel traffic in this area (ABP Marine Environmental Research, 2014). It is presumed that the operation and maintenance vessels of these OWFs utilise existing shipping routes where feasible, and that the routes to and from the port to each OWF are relatively consistent. It is also presumed that vessels will avoid areas of shallower water, which are generally where red-throated divers are present in higher density.

1108. The location of Humber Gateway, Race Bank, Triton Knoll and Westermost Rough OWFs mean that it is reasonable to assume that other than the navigational approach to the port of Grimsby and the other ports within the Humber Estuary, where very few red-throated divers were recorded, boats will not enter the Greater Wash SPA during their routine activities. It is likely that based on the geographical location of the Lincs, Lynn and Inner Dowsing OWFs, operation and maintenance vessels associated with these OWFs will cross the Greater Wash SPA for a greater distance.

1109. The available evidence regarding red-throated diver displacement by operational OWFs suggests that there will be little or no impact on adult survival as a result of displacement, and that any impact would probably be undetectable at the population level. No evidence has been identified which supports the upper range of mortality effects for displaced birds currently advised by Natural England for displacement by operational OWFs (i.e. up to 10%), and a review of the available evidence indicates that a mortality rate of 1% is considered to appropriately precautionary (MacArthur Green, 2019a). It is assumed that these conclusions can also be applied to birds displaced by operation and maintenance vessels in the transit corridors that overlap with the Greater Wash SPA.

1110. Since the transit routes used by operation and maintenance vessels associated with other OWFs are unknown, it is not possible to quantitatively assess the potential in-combination impact of operation and maintenance vessels on Greater Wash SPA red-throated diver. However, given that it is predicted that the mortality rate of displaced birds is predicted to be very low due to operation and maintenance activities, it is considered that impacts will be small, and insufficient to represent an adverse effect on the integrity of the SPA.

1111. It could also be argued that since this impact might already be occurring due to the activities of vessels associated with SOW and DOW (and impacts are probably smaller than suggested above due to the ongoing effects of other vessels within the transit corridor), the actual impact that results from a potential increase in operation and maintenance activities of vessels associated with SEP and DEP in the Greater Wash SPA is very low, and that SEP and DEP do not contribute materially to the impact.

1112. **It is concluded that predicted red-throated diver mortality due to operational phase displacement within the operation and maintenance vessel transit corridor of SEP, DEP and SEP and DEP together, in-combination with similar activities associated with other OWFs, would not adversely affect the integrity of the Greater Wash SPA.**

1113. The confidence in the assessment is medium. The evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. However, the data on which the assessment is based, whilst the best available, are not considered to be up to date.

1114. A number of best practice measures will be implemented regarding the operation and maintenance of SEP and DEP. These measures will minimise the potential impacts of vessels on red-throated diver. These are secured through the **Outline PEMP** (document reference 9.10) and include:

- Avoiding and minimising maintenance vessel traffic, where possible, during the most sensitive time period in October to March (inclusive)
- Restricting vessel movements where possible to existing navigation routes (where the densities of red-throated divers are typically relatively low)
- As far as possible maintaining direct transit routes (to minimise transit distances through areas used by red-throated diver), where it is necessary to go outside of established navigational routes, avoid rafting birds either en-route to the wind farm sites from port and/or within the wind farm sites (dependent on location) and where possible avoid disturbance to areas with consistently high diver density
- Avoidance of over-revving of engines (to minimise noise disturbance), and
- Briefing of vessel crew on the importance of the species and the associated mitigation measure through tool box talks.

9.4 North Norfolk Coast SPA and Ramsar Site

9.4.1 Description of Designation

1115. The North Norfolk Coast SPA and Ramsar site is located east of The Wash on the northern coastline of Norfolk. It covers an area of nearly 8,000 hectares, extending approximately 40km from Holme to Weybourne. The SPA was originally designated in January 1989 (English Nature, 1996a). A variety of coastal habitats occur within the designated site, including intertidal mudflats and sandflats, coastal waters, saltmarshes, shingle, sand dunes, freshwater grazing marshes and reedbeds. The site is important within Europe as one of the largest areas of undeveloped coastal habitat of its type, and at designation was the fourth most important wetland site for waterfowl in Britain.

1116. The coastal waters of North Norfolk are shallow and follow the complex series of harbours and inlets along the coast. Large populations of small fish including sandeel and sprat are present, which provide vital food for breeding tern populations that occur within the site. The SPA citation states that the site qualifies under Article 4.1 of the Birds Directive by supporting up to 4,500 pairs of Sandwich terns, up to 1,000 pairs of common terns, and up to 400 pairs of little terns.

1117. The site also qualifies under Article 4.1 of the Birds Directive by supporting nationally important numbers of bittern, marsh harrier, Montagu's harrier, and avocet. Smaller proportions of the national breeding populations of Arctic tern, kingfisher and short-eared owl, all of which are listed on Annex 1 of the Birds Directive are also supported.

1118. The site qualifies under Article 4.2 of the Birds Directive as an internationally important wetland, regularly supporting, in winter, over 10,000 wildfowl (over 20,000 on average) and internationally important numbers of the following waterfowl species: 9,000 dark-bellied brent geese, 6,000 pink-footed-geese, 6,000 knot and 5,600 wigeon.

1119. Whilst not qualifying features, nationally important wintering numbers of other species are also supported. These are 270 European white-fronted geese, 450 pintails (this species is a qualifying feature of the Ramsar site, which lists the population as 991 birds), 2,600 shelducks, 500 grey plovers, 400 ringed plovers, 5,000 oystercatchers and 800 redshanks. In addition, many of the huge wader flocks which feed in The Wash regularly use the western parts of the designated site as a high water roost.

1120. The site supports also nationally important breeding populations of gadwall, shoveler, garganey, black-tailed godwit, bearded tit and parrot crossbill.

1121. A similar species assemblage is described by the Ramsar site citation (JNCC, 2008a).

9.4.2 Conservation Objectives

1122. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features.
- The structure and function of the habitats of the qualifying features.
- The supporting processes on which the habitats of the qualifying features rely.
- The populations of each of the qualifying features.
- The distribution of qualifying features within the site.

1123. The qualifying features of this SPA and Ramsar site screened into the Appropriate Assessment are listed in **Table 5-2**. These are Sandwich tern and common tern, in addition to the non-breeding waterbird features pink-footed goose, dark-bellied brent goose, pintail, wigeon, knot, and a non-breeding waterbird assemblage.

9.4.3 Appropriate Assessment

9.4.3.1 Sandwich Tern

9.4.3.1.1 Status

1124. The biogeographic population of Sandwich tern was estimated at 74,000 pairs, of which 11,000 pairs breed in Great Britain (Mitchell *et al*., 2004). Sandwich tern breeding numbers in the UK increased from the 1920s to the mid-1980s, after major reductions caused by human exploitation and hunting. National surveys showed an increase in the UK population of 33% from 1969 to 1986, but a decrease of 15% from 1986 to 2000 (JNCC, 2020).

1125. Stroud *et al.* (2016) identified that the SPA suite with breeding Sandwich tern as a designated feature has 13 qualifying sites in Great Britain, three in Scotland, nine in England and one in Wales. The SPAs in Great Britain were estimated to hold 72% of the Great Britain breeding population of Sandwich terns present in 2000 (Stroud *et al*., 2016). The North Norfolk Coast SPA and Ramsar site held 3,700 pairs of Sandwich terns at designation, the largest breeding population of the species in the UK SPA network. Numbers have decreased at many of the SPA sites, but have increased at some, including the North Norfolk Coast SPA and Ramsar site, such that the overall population change since designation is small. The JNCC seabird monitoring index for Sandwich tern suggests that current numbers in England (in 2020) are very similar to numbers present in 1986; the index in 2020 being essentially the same as in 1986 despite periods in the mid-1990s and early 2010s when the index fell below 100 (JNCC, 2020). The data indicate that whilst numbers of Sandwich terns are relatively stable overall within the SPA suite, birds have concentrated at a smaller number of larger colonies. The North Norfolk Coast SPA and Ramsar site breeding colonies are examples of such colonies, which underlines their importance to the UK SPA network.

1126. Within the boundary of the North Norfolk Coast SPA and Ramsar site, Sandwich tern breed at two principal colonies; Blakeney Point and Scolt Head (JNCC, 2022; Perrow *et al.*, 2017). Alternative breeding locations within the SPA, such as Holkham, have been unused since 2004 (JNCC, 2022).

1127. Long-term and short-term trends in the North Norfolk Coast SPA and Ramsar site Sandwich tern population are described in the data presented in **Plate 9-1** and **Plate 9-2**, whilst **Table 9-43** presents population and productivity data since 2004. Though population size has at times fluctuated since 1989, the recent trend is an increasing one. The most recent published count estimated the population to be 13,170 breeding adults in 2020 (JNCC, 2022). The large increase in population size between 2019 and 2020 (almost 4,000 birds) was due to an influx of birds from a failed Dutch colony that moved to the North Norfolk area later in the spring. This has been evidenced via unpublished ringing and colour ringing observations.

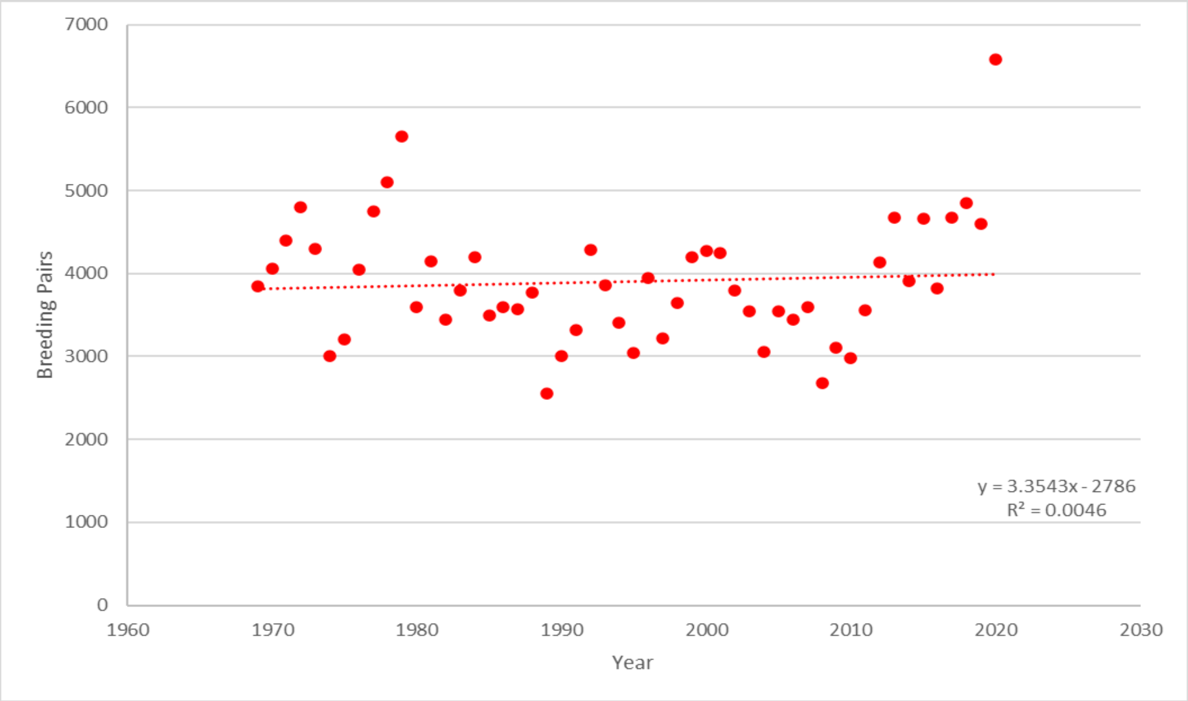

Plate 9-1: Number of Pairs of Sandwich Terns Recorded at North Norfolk Coast SPA between 1969 and 2020, with Linear Trend Line (Data from JNCC SMP Database)

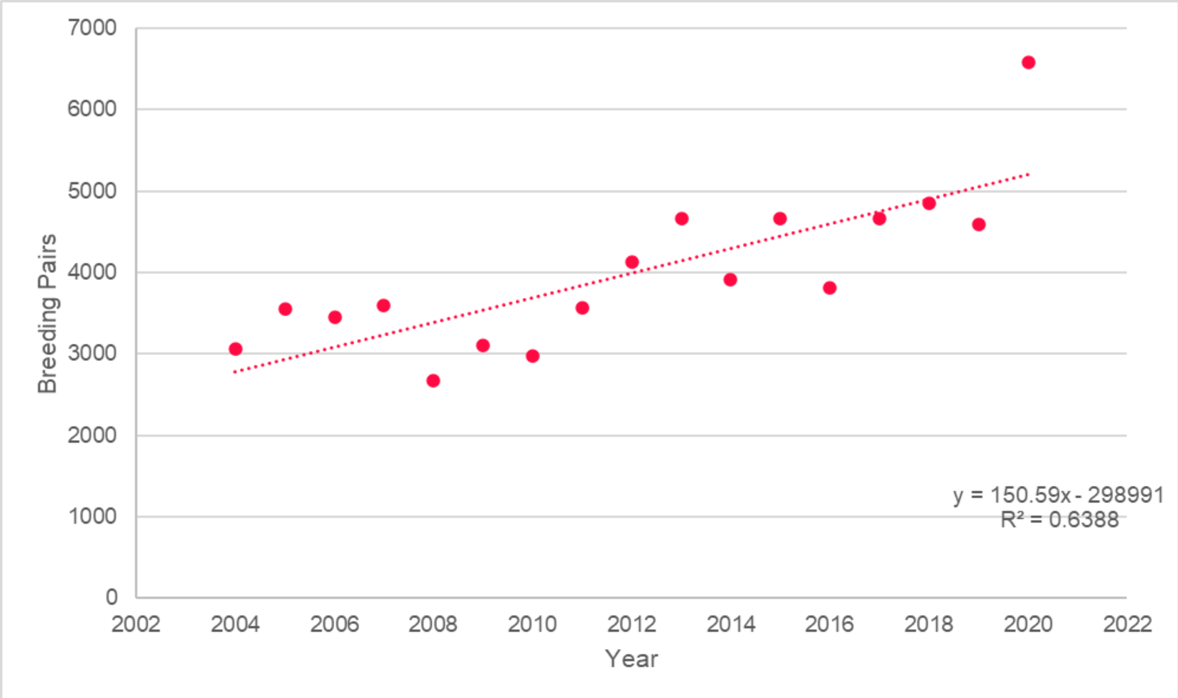

Plate 9-2: Number of Pairs of Sandwich Tern Recorded at North Norfolk Coast SPA from 2004 to 2020, with Linear Trend Line (Data from JNCC SMP Database)

Table 9-43: Annual Sandwich Tern Population Estimation and Breeding Success at the North Norfolk Coast SPA and Ramsar Site by Breeding Colony Since 2004 (JNCC, 2022)

Year	Scolt Head		Blakeney Point		Total Adults
	Nests	Success	Nests	Success	
2004	1,800	0.34	1,260	0.34	6,120
2005	1,900	0.87	1,650	0.55	7,100
2006	2,500	0.80	950	0.86	6,900
2007	1,800	0	1,800	0.78	7,200
2008	280	0.01	2,400	0.64	5,360
2009	No data	-	3,100	0.42	6,200
2010	480	0	2,500	0.36	5,960
2011	0	-	3,562	0.52	7,124
2012	400	0	3,735	0.59	8,270
2013	550	0	4,120	0.44	9,340
2014	1,050	0.60	2,859	0.19	7,818
2015	3,550	0.90	1,113	0.01	9,326
2016	3,365	0.80	451	0.39	7,632
2017	4,665	0.94	3	0	9,336
2018	4,685	0.85	165	0.12	9,700
2019	3,805	No data	788	0.51	9,186
2020	4,160	0.72	2,425	0.45	13,170

1128. Since 2015, the majority of Sandwich terns breeding in the North Norfolk Coast SPA and Ramsar site have been located at Scolt Head. Another breeding site at Blakeney Point was the location with the most breeding activity from 1979 to 2015, but held very few birds prior to 1976 (JNCC, 2022). In 2019, 2020 and 2021, numbers of birds breeding at Blakeney Point have increased (JNCC, 2022).

1129. The selection of a preferred breeding location generally shifts every few years, and is thought to be due to a number of reasons. These include the presence of black-headed (positive factor) and large gulls (negative factor) at the start of the breeding season, the presence of non-avian predators (e.g. rats and foxes), and the state of vegetation.

1130. Sandwich terns are highly vulnerable to mammal predators and declines at colonies are most often related to an increase in predator access, especially to foxes, but also rats, stoats and American mink. Predators can cause complete abandonment of a colony, or periodic breeding failure (Mitchell *et al*., 2004). Predation by gulls can also influence breeding success but tends to be less of a problem than predation by mammals.

1131. Sandwich tern nesting habitat is dynamic, with influences of coastal erosion and flooding potentially leading to habitat loss, and of plant succession potentially leading to habitat becoming overgrown and unsuitable for this species (Mitchell *et al*., 2004). Sandwich terns have been affected by chemical pollution, with very large decreases in breeding numbers in the Netherlands in the 1960s (Mitchell *et al*., 2004) but that pressure has been reduced.

1132. Breeding success can be strongly affected by forage fish abundance such as sandeel, sprat and juvenile herring. Overwinter survival may be influenced by fisheries off West Africa affecting abundance of forage fish in that region (Mitchell *et al*., 2004), and deliberate trapping of birds at the West African coast for sport and food has been identified as affecting survival, especially of immature birds.

1133. In the years during the collection of the majority of baseline data (2018 and 2019), the mean Sandwich tern population of the North Norfolk Coast SPA was 9,443 individuals. The baseline annual mortality of this population, assuming an adult mortality rate of 10.2% (Horswill and Robinson, 2015), is 963 birds. This population and baseline mortality are used as the basis of the increase in mortality calculations presented in the following sections, to assess the potential impacts of SEP and DEP.

1134. For population modelling, the mean count between 2010 and 2019 of 8,369 individuals was used as the starting population. The baseline annual mortality of the 2010 to 2019 mean population, assuming an adult mortality rate of 10.2% (Horswill and Robinson, 2015), is 854 birds.

1135. Supplementary advice on these conservation objectives were added for qualifying features in 2019 (Natural England, 2019b). For Sandwich tern, these are:

- Restore the size of the breeding population to a level which is above 4,500 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.
- Maintain safe passage of birds moving between nesting and feeding areas.
- Reduce the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.
- Restrict predation and disturbance caused by native and non-native predators.
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).
- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.
- Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at levels described in site specific supporting notes.
- Maintain the distribution, abundance and availability of key food and prey items (e.g. sandeel, sprat) at preferred sizes. The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population.

- Maintain the availability of shallow sloping nesting sites, grading to <30cm above water level, restricting the probability that they will flood.
- Maintain vegetation cover which should be <10% throughout areas used for nesting, providing sufficient bare ground for the colony as a whole.
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels.
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels.
- Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels.
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.4.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1136. Scolt Head is located 51km from DEP and 33km from SEP, and Blakeney Point is located 38km from DEP and 22km from SEP (**Table 9-44**). The mean maximum foraging range of Sandwich tern is 34.3km (±23.2km), and the maximum foraging range is 54km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Sandwich tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 49km (±7.1km) based on data from two sites. The updated review of Woodward *et al.* (2019), based on five sites, gives a smaller mean maximum foraging range. However, it was noted by the recent review that clear differences in data collected using different methods (i.e. boat tracking versus tagged birds) means that the confidence level in the data was changed from “high” to “moderate”.

Table 9-44: Approximate Distances between North Norfolk Coast SPA and Ramsar site, Commonly used Sandwich Tern Breeding Locations at SEP and DEP

Location	Distance from DEP (km)	Distance from SEP (km)
Nearest SPA boundary	37	21
Scolt Head	51	33
Blakeney Point	38	22

1137. SEP is within the mean maximum foraging range of Sandwich terns from the North Norfolk Coast SPA breeding at both Scolt Head and Blakeney Point. DEP, however, is outside the mean maximum foraging range of birds at both colonies, but within mean maximum foraging range plus one standard deviation, and the maximum foraging range. The latter two measurements are considered to be poor indicators of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity.

1138. It has been recently demonstrated by GPS tracking of birds breeding at Scolt Head between 2016 and 2019 (Scragg *et al.*, 2016; Thaxter *et al.*, 2018; Green *et al.*, 2018, 2019) that birds from Scolt Head do make trips to SEP, DEP and the habitats surrounding them. This provides clear evidence of connectivity between the North Norfolk Coast SPA.

1139. Given the distance between the breeding sites and DEP in particular, it is possible that not all Sandwich terns present in these areas during the breeding season are breeding adults from the North Norfolk Coast SPA. Some birds may be non-breeding birds from either the North Norfolk Coast SPA, or other colonies, both in the UK and elsewhere. Despite this, the assessment takes the view that 100% of Sandwich terns present at SEP and DEP during the full breeding season (April to August; Furness (2015)) are breeding adults from the North Norfolk Coast SPA. Whilst this assumption is reasonable for purposes of assessment, it may be the case that this is a precautionary assumption.

1140. Outside the breeding season breeding Sandwich terns are assumed to range widely and to mix with birds of all ages from breeding colonies in the UK and further afield. The relevant background population is considered to be the UK North Sea and Channel BDMPS, consisting of 38,051 individuals during autumn migration (July to September), and spring migration (March to May) (Furness, 2015).

1141. Estimates of the proportion of Sandwich terns present at SEP and DEP during the autumn and spring migration seasons which originate from the North Norfolk Coast SPA and Ramsar site are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS (Furness 2015). During both autumn and spring migration seasons, breeding adult Sandwich terns from the North Norfolk Coast SPA and Ramsar site make up 21.8% of the total BDMPS population. The same percentage of impacts are therefore attributable to birds from this SPA during these times of year.

9.4.3.1.3 Potential Effects on the Qualifying Feature

1142. The Sandwich tern qualifying feature of the North Norfolk Coast SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.4.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.4.3.1.4.1 Operational Phase Displacement/Barrier Effects

1143. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult Sandwich terns belonging to the North Norfolk Coast SPA population, produced using design-based density estimates (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)) is presented in **Table 9-45** (DEP), **Table 9-46** (SEP) and **Table 9-47** (SEP and DEP together). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult Sandwich terns belonging to the North Norfolk Coast SPA population by season. An estimated annual mortality for the population is provided, along with the increase of existing mortality within the breeding adult SPA population that would occur due to such an impact. The equivalent information produced using model-based density estimates (**Appendix 11.1 Offshore Ornithology Technical Report**) is provided in **Table 9-48** (DEP), **Table 9-49** (SEP), and **Table 9-50** (SEP and DEP). The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1144. Displacement rates of 0.000 to 0.500 are considered to be appropriate for this species based on a review of available evidence (Cook *et al.*, 2014; Green *et al.*, 2019, 2018; Harwood *et al.*, 2018; Krijgsveld *et al.*, 2011; Scragg *et al.*, 2016; Thaxter *et al.*, 2018). A maximum mortality rate of 1% of displaced birds is considered to be appropriate, based on the existing mortality of adult birds of 0.102 (Horswill and Robinson, 2015), and low energy expenditure predictions of a closely related species (common tern) due to barrier effects by OWFs (Masden *et al.*, 2010). The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-45: Predicted Operational Phase Displacement and Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Terns at DEP, Calculated using Design-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	391 (breeding) 38 (autumn) 0 (spring) 429 (year round)	391 (breeding) 8 (autumn) 0 (spring) 399 (year round)	0 - 2	0.04 - 0.21
Mean	202 (breeding) 14 (autumn) 0 (spring) 216 (year round)	202 (breeding) 3 (autumn) 0 (spring) 205 (year round)	0 - 1	0.02 - 0.11
Lower 95% CI	79 (breeding) 0 (autumn) 0 (spring) 79 (year round)	79 (breeding) 0 (autumn) 0 (spring) 79 (year round)	0 - 0	0.01 - 0.04

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are North Norfolk Coast SPA breeders. For autumn and spring migration seasons (September and March), assumes 21.7% of adult birds are North Norfolk Coast SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-46: Predicted Operational Phase Displacement and Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Terns at SEP, Calculated using Design-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	127 (breeding) 8 (autumn) 0 (spring) 135 (year round)	127 (breeding) 2 (autumn) 0 (spring) 129 (year round)	0 - 1	0.01 - 0.07
Mean	71 (breeding) 3 (autumn) 0 (spring) 74 (year round)	71 (breeding) 1 (autumn) 0 (spring) 72 (breeding)	0 - 0	0.01 - 0.04
Lower 95% CI	21 (breeding) 0 (autumn) 0 (spring) 21 (year round)	21 (breeding) 0 (autumn) 0 (spring) 21 (year round)	0 - 0	0.00 - 0.01

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are North Norfolk Coast SPA breeders. For autumn and spring migration seasons (September and March), assumes 21.7% of adult birds are North Norfolk Coast SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-47: Predicted Operational Phase Displacement and Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Terns at SEP and DEP, Calculated using Design-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	518 (breeding) 132 (autumn) 0 (spring) 617 (year round)	518 (breeding) 10 (autumn) 0 (spring) 528 (year round)	1 - 3	0.05 - 0.27
Mean	273 (breeding) 45 (autumn) 0 (spring) 300 (year round)	273 (breeding) 4 (autumn) 0 (spring) 277 (year round)	0 - 1	0.03 - 0.14
Lower 95% CI	100 (breeding) 0 (autumn) 0 (spring) 86 (year round)	100 (breeding) 0 (autumn) 0 (spring) 100 (year round)	0 - 0	0.01 - 0.05

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are North Norfolk Coast SPA breeders. For autumn and spring migration seasons (September and March), assumes 21.7% of adult birds are North Norfolk Coast SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

1145. Based on the mean peak abundances calculated from design-based density estimates, the annual total of Sandwich terns from the North Norfolk Coast SPA at risk of displacement from SEP and DEP together is 277 birds; 205 at DEP and 72 at SEP (**Table 9-47**). At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 1.0 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0 to 0.4 birds due to displacement from SEP. The combined displacement mortality from SEP and DEP would increase annual mortality within this population by 0% to 0.14%.

Table 9-48: Predicted Operational Phase Displacement and Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Terns at DEP, Calculated using Model-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	327 (breeding) 41 (autumn) 0 (spring) 368 (year round)	327 (breeding) 9 (autumn) 0 (spring) 336 (year round)	0 - 2	0.03 - 0.17
Mean	202 (breeding) 17 (autumn) 0 (spring) 219 (year round)	202 (breeding) 4 (autumn) 0 (spring) 206 (year round)	0 - 1	0.02 - 0.11
Lower 95% CI	122 (breeding) 6 (autumn) 0 (spring) 128 (year round)	122 (breeding) 1 (autumn) 0 (spring) 123 (year round)	0 - 1	0.01 - 0.06
Notes 1. For breeding season (Apr-Aug), assumes 100% of adult birds are North Norfolk Coast SPA breeders. For autumn and spring migration seasons (September and March), assumes 21.7% of adult birds are North Norfolk Coast SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-49: Predicted Operational Phase Displacement and Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Terns at SEP, Calculated using Model-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	147 (breeding) 10 (autumn) 0 (spring) 157 (year round)	147 (breeding) 2 (autumn) 0 (spring) 149 (year round)	0 - 1	0.02 - 0.08
Mean	102 (breeding) 4 (autumn) 0 (spring) 106 (year round)	102 (breeding) 1 (autumn) 0 (spring) 103 (year round)	0 - 1	0.01 - 0.05
Lower 95% CI	81 (breeding) 1 (autumn) 0 (spring) 82 (year round)	81 (breeding) 0 (autumn) 0 (spring) 81 (year round)	0 - 0	0.01 - 0.04

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are North Norfolk Coast SPA breeders. For autumn and spring migration seasons (September and March), assumes 21.7% of adult birds are North Norfolk Coast SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-50: Predicted Operational Phase Displacement and Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Terns at SEP and DEP, Calculated using Model-Based Density Estimates

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	474 (breeding) 51 (autumn) 0 (spring) 525 (year round)	474 (breeding) 11 (autumn) 0 (spring) 485 (year round)	0 - 2	0.05 - 0.25
Mean	304 (breeding) 21 (autumn) 0 (spring) 325 (year round)	304 (breeding) 5 (autumn) 0 (spring) 309 (year round)	0 - 2	0.03 - 0.16
Lower 95% CI	203 (breeding) 7 (autumn) 0 (spring) 210 (year round)	203 (breeding) 2 (autumn) 0 (spring) 204 (year round)	0 - 1	0.02 - 0.11

Notes
1. For breeding season (Apr-Aug), assumes 100% of adult birds are North Norfolk Coast SPA breeders. For autumn and spring migration seasons (September and March), assumes 21.7% of adult birds are North Norfolk Coast SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

1146. Based on the mean peak abundances calculated using model-based methods, the annual total of Sandwich terns from the North Norfolk Coast SPA at risk of displacement from SEP and DEP together is 309 birds; 206 at DEP and 103 at SEP (**Table 9-50**). At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 1.0 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0 to 0.5 birds due to displacement from SEP. The combined mortality of displacement from SEP and DEP would increase annual mortality within this population by 0.03% to 0.16%.

1147. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peak abundances are used as inputs to the assessment, since the maximum predicted mortality increase that could occur on this basis represents a 0.25% increase to baseline mortality (**Table 9-47**).

1148. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 22.1% higher at DEP-N than DEP as a whole. This compares to a value of 16.5% calculated from the model-based density estimates that were produced for these species, though the differences are unlikely to be statistically significant, based on assessment of data presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1). However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1149. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the North Norfolk Coast SPA.**

1150. The confidence in the assessment is high for several reasons. Firstly, despite not being available in large quantities, the evidence used to set the displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. The outcome of the assessment is the same regardless of whether design-based or model-based density estimates are used. The fact that both density estimation approaches produce similar population estimates, which provides additional confidence in the assessment. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.4.3.1.4.2 Collision Risk

1151. Collision risk predictions for North Norfolk Coast SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-51**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-52**. Outputs are based on Option 1 of the Band Model, avoidance rates of 0.980, the flight height distribution of Harwood (2021), and the flight speed of Fijn and Collier (2020). Nocturnal activity was set at 2% of daytime activity, based on an assessment of Sandwich tern tracking data from the Scolt Head population. These parameters are the same as the “realistic worst case scenario” presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). Further information on this, detailed methodology and information on other input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1152. For DEP, the mean annual collision estimate increases the annual baseline mortality by 0.77%. The predicted increase in the annual baseline mortality of North Norfolk Coast SPA Sandwich terns is greater than 1% for the annual upper 95% CI output (2.25%). For SEP, the mean annual collision estimate increases the annual baseline mortality by 0.19%, and the upper 95% CI output increases the baseline mortality by 0.63%. For SEP and DEP together, the mean collision rate represents an annual mortality increase of 0.96%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

1153. Some scenarios (DEP, and SEP and DEP together) involving the outputs of CRMs which used upper 95% CI density estimates as inputs also result in increases in the baseline mortality of North Norfolk Coast SPA breeding adult Sandwich terns of more than 1%. The probability of these scenarios occurring is extremely small. For example, the probability of the number of collisions predicted by the upper 95% CI CRM at DEP for a single month is 0.025. To obtain the annual collision rate presented in **Table 9-51** (21.69) would require this to happen six times (in April, May, June, July, August and September). The probability of this event occurring in a given year is over one in four billion (one hundred and two million, four hundred thousand; 0.025 x 0.025 x 0.025 x 0.025 x 0.025). The probability of this occurring over multiple years is smaller still. Whilst the temporal limitations of the baseline data are acknowledged (which are very similar for all OWF assessments), it is still considered that the probability of these events actually occurring is too small to credibly refer to them as a realistic worst case scenario.

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Table 9-51: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Design-Based Density Estimates, Apportioned to North Norfolk Coast SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	1.79	2.98	0.71	1.46	0.40	0.06	0.00	0.00	0.00	7.38
	Density	95% UCI	0.00	0.00	0.00	7.52	6.38	1.88	4.35	1.28	0.27	0.00	0.00	0.00	21.69
		95% LCI	0.00	0.00	0.00	0.00	0.80	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.90
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	-
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.02	0.62	0.39	0.72	0.09	0.01	0.00	0.00	0.00	1.85
	Density	95% UCI	0.00	0.00	0.00	0.16	1.33	0.93	3.29	0.33	0.05	0.00	0.00	0.00	6.09
		95% LCI	0.00	0.00	0.00	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	-
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP and DEP	Mean	-	0.00	0.00	0.00	1.81	3.59	1.09	2.18	0.49	0.06	0.00	0.00	0.00	9.23
	Density	95% UCI	0.00	0.00	0.00	7.68	7.72	2.81	7.64	1.61	0.32	0.00	0.00	0.00	27.77
		95% LCI	0.00	0.00	0.00	0.00	0.91	0.10	0.00	0.00	0.00	0.00	0.00	0.00	1.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	-
		-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-

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Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
	Avoidance Rate	+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

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Table 9-52: Predicted Annual Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Design-Based Density Estimates and Apportioned to North Norfolk Coast SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	7.38 (0.90 - 21.69)	0.77 (0.09 - 2.25)
SEP	1.85 (0.10 - 6.09)	0.19 (0.01 - 0.63)
SEP and DEP	9.23 (1.00 - 27.77)	0.96 (0.10 - 2.88)
Notes 1. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)		

1154. Collision risk predictions for North Norfolk Coast SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), calculated using model-based density estimates, are shown in **Table 9-53**. Collision estimates are presented by month. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), the use of model-based density estimates enables the consideration of smaller reporting regions than their design-based equivalents. Therefore, an additional scenario, SEP, and DEP-N has been considered. This is because it is possible that all of the turbines at DEP could be installed at DEP-N. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-54**. All other parameters are the same as the models which used design-based density estimates, as described above.

1155. For DEP, the mean annual collision estimate (8.30) increases the annual baseline mortality by 0.86%, which is a slightly greater predicted collision rate than the equivalent value derived from CRMs run using design-based density estimates (7.38). The predicted increase in the annual baseline mortality of North Norfolk Coast SPA Sandwich terns is greater than 1% for the annual upper 95% CI output (14.04 collisions; 1.46% annual mortality increase), though is substantially less than the equivalent value derived from CRMs run using design-based density estimates (21.69 collisions; 2.25% annual mortality increase). For SEP, the mean annual collision estimate (2.72) increases the annual baseline mortality by 0.28%. The upper 95% CI output (4.98) increases the baseline mortality by 0.52%. As with DEP, the mean collision rate using model-based density estimates results in a higher mean than the equivalent value derived from CRMs run using design-based density estimates, but a lower upper 95% CI value. For SEP and DEP together, the mean and upper 95% CI collision rates (11.01 and 19.03) both result in predicted increases in the annual baseline mortality of North Norfolk Coast SPA Sandwich terns of greater than 1% (1.14% and 1.98% respectively). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

Table 9-53: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Model-Based Density Estimates, Apportioned to North Norfolk Coast SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	2.04	2.62	1.18	2.20	0.26	0.14	0.00	0.00	0.00	8.44
	Density	95% UCI	0.00	0.00	0.00	4.01	4.02	2.16	3.24	0.61	0.33	0.00	0.00	0.00	14.37
		95% LCI	0.00	0.00	0.00	0.90	1.63	0.58	1.48	0.10	0.05	0.00	0.00	0.00	4.74
DEP-N	Mean	-	0.00	0.00	0.00	2.63	3.12	1.67	2.99	0.18	0.20	0.00	0.00	0.00	10.79
	Density	95% UCI	0.00	0.00	0.00	5.22	4.82	3.04	4.36	0.51	0.47	0.00	0.00	0.00	18.42
		95% LCI	0.00	0.00	0.00	1.15	1.93	0.83	2.04	0.05	0.07	0.00	0.00	0.00	6.07
SEP	Mean	-	0.00	0.00	0.00	0.05	0.67	0.72	1.18	0.10	0.02	0.00	0.00	0.00	2.74
	Density	95% UCI	0.00	0.00	0.00	0.18	1.16	1.60	1.73	0.31	0.06	0.00	0.00	0.00	5.04
		95% LCI	0.00	0.00	0.00	0.01	0.37	0.28	0.84	0.03	0.01	0.00	0.00	0.00	1.54
SEP and DEP	Mean	-	0.00	0.00	0.00	2.08	3.28	1.90	3.38	0.37	0.16	0.00	0.00	0.00	11.17
	Density	95% UCI	0.00	0.00	0.00	4.20	5.18	3.76	4.97	0.92	0.39	0.00	0.00	0.00	19.42
		95% LCI	0.00	0.00	0.00	0.91	2.00	0.86	2.31	0.13	0.06	0.00	0.00	0.00	6.27
SEP and DEP-N	Mean	-	0.00	0.00	0.00	2.68	3.79	2.39	4.17	0.28	0.22	0.00	0.00	0.00	13.53
	Density	95% UCI	0.00	0.00	0.00	5.40	5.98	4.64	6.09	0.82	0.53	0.00	0.00	0.00	23.46
		95% LCI	0.00	0.00	0.00	1.16	2.30	1.11	2.88	0.08	0.08	0.00	0.00	0.00	7.61

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

Table 9-54: Predicted Annual Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP, Calculated using Model-Based Density Estimates and Apportioned to North Norfolk Coast SPA, with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	8.44 (4.74 - 14.37)	0.88 (0.49 - 1.49)
DEP-N	10.79 (6.07 - 18.42)	1.12 (0.63 - 1.91)
SEP	2.74 (1.54 - 5.04)	0.28 (0.16 - 0.52)
SEP and DEP	11.17 (6.27 - 19.42)	1.16 (0.65 - 2.02)
SEP and DEP-N	13.53 (7.61 - 23.46)	1.40 (0.79 - 2.44)
Notes 1. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)		

1156. The avoidance rate used for the assessment (0.980), which is recommended for use by Natural England does not include a correction for birds displaced by OWFs. Whilst there is uncertainty around the level of macro-avoidance (i.e. displacement) that will actually occur, evidence indicates that this will be greater than zero. The avoidance rate of 0.980 is substantially lower than avoidance rate used in the DECC (2012) HRA for this species (0.9883). Separately, Harwood *et al.* (2018) calculated an avoidance rate of 0.993 for Sandwich terns at SOW. Both of these avoidance rates describe behavioural avoidance only, and do not account for model error in the CRM (Cook *et al.*, 2014). These avoidance rates are presented for comparison, and are not utilised by the assessment to draw conclusions. Further discussion on these rates is provided in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1). Nonetheless, these avoidance rates derive from data on Sandwich terns at operational wind farms, whereas the value of 0.980 is a generic, and likely precautionary default value applied to in the absence of sufficient species-specific data. The effect of accounting for plausible macro-avoidance corrections and the alternative avoidance rates on the annual collision rates predicted for breeding adult Sandwich terns of the North Norfolk Coast SPA is presented in **Table 9-55** for CRMs produced using design-based density estimates, and **Table 9-56** for CRMs produced using model-based density estimates..

1157. The incorporation of displacement rates of 0.250 or greater reduces the mean collision rate of SEP and DEP below 1% of the existing annual mortality of North Norfolk Coast SPA breeding adult Sandwich terns. The same effect also occurs if the alternative avoidance rates of 0.993 (Harwood *et al.*, 2018) and 0.9883 (DECC, 2012) are used in CRM. These avoidance rates are presented for comparison, and are not utilised by the assessment to draw conclusions. Further discussion on these rates is provided in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-55: Effect of Macro-Avoidance Corrections and Different Avoidance Rates on North Norfolk Coast SPA Sandwich Tern Collision Rates (Mean and 95% CIs, Based on 95% CI of Design-Based Densities) at SEP, DEP and SEP and DEP, Calculated using Design-Based Density Estimates

Site	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
DEP	7.38 (0.90 - 21.69)	5.54 (0.67 - 16.26)	3.69 (0.45 - 10.84)	4.32 (0.53 - 12.69)	2.58 (0.31 - 7.59)
SEP	1.85 (0.10 - 6.09)	1.39 (0.08 - 4.57)	0.93 (0.05 - 3.04)	1.08 (0.06 - 3.56)	0.65 (0.04 - 2.11)
SEP and DEP	9.23 (1.00 - 27.77)	6.92 (0.75 - 20.83)	4.62 (0.50 - 13.89)	5.40 (0.59 - 16.25)	4.71 (0.35 - 9.72)

Table 9-56: Effect of macro-avoidance corrections and different avoidance rates on North Norfolk Coast SPA Sandwich tern collision rates (mean and 95% CIs, based on 95% CI of design-based densities) at SEP, DEP and SEP and DEP together, calculated using model-based density estimates

Site	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
DEP	8.44 (4.74 - 14.37)	6.33 (3.56 - 10.78)	4.22 (2.37 - 7.19)	4.94 (2.77 - 8.41)	2.95 (1.66 - 5.03)
DEP-N	10.79 (6.07 - 18.42)	8.09 (4.55 - 13.82)	5.40 (3.04 - 9.21)	6.31 (3.55 - 10.78)	3.78 (2.12 - 6.45)
SEP	2.74 (1.54 - 5.04)	2.06 (1.16 - 3.78)	1.37 (0.77 - 2.52)	1.60 (0.90 - 2.95)	0.96 (0.54 - 1.76)
SEP and DEP	11.17 (6.27 - 19.42)	8.38 (4.70 - 14.57)	5.59 (3.14 - 9.79)	6.53 (3.67 - 11.36)	3.91 (2.19 - 6.80)
SEP and DEP-N	13.53 (7.61 - 23.46)	10.15 (5.71 - 17.60)	6.77 (3.81 - 11.73)	7.92 (4.45 - 13.72)	4.74 (2.66 - 8.21)

1158. In summary, the mean Sandwich tern collision rates predicted at SEP and DEP using an avoidance rate of 0.980 (as recommended by Natural England), and either model or design-based densities, do not produce impacts of a sufficient magnitude to lead to an adverse effect on integrity of the North Norfolk Coast SPA.

1159. When a level of macro-avoidance (either 0.250 or 0.500) is assumed, the mean Sandwich tern collision rates predicted at SEP and DEP using an avoidance rate of 0.980 do not produce impacts of a sufficient magnitude to lead to a detectable impact at the population level (i.e. greater than 1%). The installation of all of DEP's turbines in DEP-N, combined with the impacts at SEP, could result in mean mortality rates of just over 1% at macro-avoidance rates of 0.250 (1.05%), but given the highly dynamic nature of Sandwich tern population trends (**Section 9.4.3.1.1**), it seems unlikely that an impact of this magnitude would result in an adverse effect on the integrity of the qualifying feature.

1160. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the North Norfolk Coast SPA.**

1161. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters, and the avoidance rate, the selected parameters are considered to be sufficiently precautionary based on expert opinion and information drawn from the literature to provide confidence that collision rates are not underestimated, and may in fact be overestimated.

9.4.3.1.4.3 Combined Displacement/Barrier Effects and Collision Risk

1162. The mean combined displacement and collision rates for breeding adult Sandwich tern from the North Norfolk Coast SPA for SEP and DEP in isolation and together, calculated using design-based density estimates as inputs, are presented in **Table 9-57** (assuming a displacement rate of 0.000), **Table 9-58** (assuming a displacement rate of 0.250) and **Table 9-59** (assuming a displacement rate of 0.500). Mortality rates of displaced birds are assumed to be 1% for all scenarios. The collision rates were calculated using an avoidance rate of 0.980, with the corresponding displacement rate also applied to account for macro-avoidance. The corresponding outputs calculated using model-based density estimates are presented in **Table 9-60**, **Table 9-61**, and **Table 9-62**.

Table 9-57: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.000, Calculated using Design-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0	7.38 (0.90 - 21.69)	7.38 (0.90 - 21.69)	0.77 (0.09 - 2.25)
SEP	0	1.85 (0.10 - 6.09)	1.85 (0.10 - 6.09)	0.19 (0.01 - 0.63)
SEP and DEP	0	9.23 (1.00 - 27.77)	9.23 (1.00 - 27.77)	0.96 (0.10 - 2.88)
Notes 1. Assumes displacement rate of 0.000 2. Assumes avoidance rate of 0.980, with 0.000 displacement rate				

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-58: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.250, Calculated using Design-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0.51 (0.20 - 1.00)	5.54 (0.68 - 16.27)	6.05 (0.88 - 17.27)	0.63 (0.09 - 1.79)
SEP	0.18 (0.05 - 0.32)	1.39 (0.08 - 4.57)	1.58 (0.13 - 4.89)	0.16 (0.01 - 0.51)
SEP and DEP	0.69 (0.25 - 1.32)	6.92 (0.75 - 20.83)	7.61 (1.00 - 22.15)	0.79 (0.10 - 2.30)
Notes 1. Assumes displacement rate of 0.250 and mortality rate of 1% of displaced birds 2. Assumes avoidance rate of 0.980, with 0.250 displacement rate 3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-59: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.500, Calculated using Design-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	1.03 (0.40 - 2.00)	3.69 (0.45 - 10.85)	4.72 (0.85-12.85)	0.49 (0.09 - 1.33)
SEP	0.36 (0.11 - 0.64)	0.93 (0.05 - 3.05)	1.29 (0.16-3.69)	0.13 (0.02 - 0.38)
SEP and DEP	1.38 (0.50 - 2.64)	4.62 (0.50 - 13.89)	6.00 (1.00-16.53)	0.62 (0.10 - 1.72)
Notes 1. Assumes displacement rate of 0.500 and mortality rate of 1% of displaced birds 2. Assumes avoidance rate of 0.980, with 0.500 displacement rate 3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-60: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.000, Calculated using Model-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0	8.44 (4.74 - 14.37)	8.44 (4.74 - 14.37)	0.88 (0.49 - 1.49)
SEP	0	2.74 (1.54 - 5.04)	2.74 (1.54 - 5.04)	0.28 (0.16 - 0.52)
SEP and DEP	0	11.17 (6.27 - 19.42)	11.17 (6.27 - 19.42)	1.16 (0.65 - 2.02)

Notes
1. Assumes displacement rate of 0.000
2. Assumes avoidance rate of 0.980, with 0.000 displacement rate
3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-61: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.250, Calculated using Model-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	0.51 (0.31 - 0.84)	6.33 (3.56 - 10.78)	6.84 (3.87 - 11.62)	0.71 (0.40 - 1.21)
SEP	0.26 (0.20 - 0.37)	2.06 (1.16 - 3.78)	2.32 (1.36 - 4.15)	0.24 (0.14 - 0.43)
SEP and DEP	0.77 (0.51 - 1.21)	8.38 (4.70 - 14.57)	9.15 (5.21 - 15.78)	0.95 (0.54 - 1.64)

Notes
1. Assumes displacement rate of 0.250 and mortality rate of 1% of displaced birds
2. Assumes avoidance rate of 0.980, with 0.250 displacement rate
3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-62: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of North Norfolk Coast SPA Breeding Adult Sandwich Tern at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population, Assuming a Macro-Avoidance Rate of 0.500, Calculated using Model-Based Density Estimates

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
DEP	1.03 (0.62 - 1.68)	4.22 (2.37 - 7.19)	5.25 (2.99 - 8.87)	0.55 (0.31 - 0.92)
SEP	0.52 (0.41 - 0.75)	1.37 (0.77 - 2.52)	1.89 (1.18 - 3.27)	0.20 (0.12 - 0.34)

Site	Annual displacement mortality[1]	Annual collision mortality[2]	Annual displacement and collision mortality	% annual mortality increase[3]
SEP and DEP	1.54 (1.02 - 2.43)	5.59 (3.14 - 9.79)	7.13 (4.16 - 12.22)	0.74 (0.43 - 1.27)

Notes
1. Assumes displacement rate of 0.500 and mortality rate of 1% of displaced birds
2. Assumes avoidance rate of 0.980, with 0.500 displacement rate
3. Background population is North Norfolk Coast SPA breeding adults (9,443 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

1163. Of the scenarios presented, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Table 9-57** and **Table 9-60**). The conclusions for collision impacts alone (**Section 9.4.3.1.4.2**) covers this scenario. The conclusions for all other scenarios presented in the above tables result in very similar, but slightly smaller impacts being predicted. This also applies to any scenario where all the turbines at DEP are all placed in DEP-N.

1164. **It is concluded that predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the North Norfolk Coast SPA.**

1165. The confidence in the assessment is high, for the reasons provided in the individual displacement (**Section 9.4.3.1.4.1**) and collision (**Section 9.4.3.1.4.2**) assessments.

9.4.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.4.3.1.5.1 Operational Phase Displacement / Barrier Effects

1166. Operational displacement impacts on North Norfolk Coast SPA Sandwich tern have not previously been considered by other OWFs. A quantitative assessment for other OWFs within foraging range of this population of Sandwich terns was therefore undertaken, using the same input parameters and assumptions described in **Section 9.4.3.1.4.1**.

1167. For other OWFs, only flying bird densities were available. However, published literature suggests that Sandwich terns spend the overwhelming majority of their time at sea in flight (Garthe and Hüppop, 2004; Perrow *et al.*, 2017). This is supported by the fact that of the 1,710 Sandwich tern observations made during the SEP and DEP baseline surveys, 1,676 (98%) were of birds in flight. As a result, the lack of “all birds” data for other OWFs is not considered to materially affect the assessment.

1168. The annual total of Sandwich terns from the North Norfolk Coast SPA at risk of displacement from OWFs in the wider Wash area (including SEP and DEP) is 500 birds when design-based density estimates are used for SEP and DEP, and 532 birds when model-based density estimates are used for SEP and DEP (**Table 9-63**).

At displacement rates of 0.000 to 0.500 and a mortality rate of 1% for displaced birds (**Section 9.4.3.1.4.1**), 0 to 2.51 (using design-based density estimates for SEP and DEP), or 0 to 2.67 (using model-based density estimates for SEP and DEP) SPA breeding adults would be predicted to die each year due to displacement from these OWFs.

1169. This would increase annual mortality within this population by 0% to 0.26% (using design-based density estimates for SEP and DEP), or 0% to 0.28% (using model-based density estimates for SEP and DEP). The displacement matrices for both sets of in-combination displacement figures are presented in **Table 9-64** and

1170. **Table** 9-65.

1171. The predicted increases in baseline mortality of breeding adult Sandwich tern are low due to in-combination operational phase displacement. This is particularly true of the lower range of mortality predictions. These lower predictions for displacement mortality are considered to represent more realistic values for this species based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together, in-combination with other OWFs, would not adversely affect the integrity of the North Norfolk Coast SPA.**

Table 9-63: Annual Population Estimates of Sandwich Terns Apportioned to the North Norfolk Coast SPA at SEP, DEP and Other OWFs Included in the In-Combination Assessment

Tier	OWF	Sandwich terns at risk of displacement	Predicted displacement[1]	Predicted mortality[2]
1	DOW	58	0 - 29	0 - 0.29
1	Race Bank	130	0 - 66	0 - 0.66
1	SOW	12	0 - 6	0 - 0.06
2	Triton Knoll	23	0 - 11	0 - 0.11
TOTAL (excluding SEP and DEP)		225	223	0 - 112
5	DEP (design-based density estimates)	205	0 - 103	0 - 1.03
5	SEP (design-based density estimates)	72	0 - 36	0 - 0.36
5	DEP (model-based density estimates)	206	0 - 103	0 - 1.03
5	SEP (model-based density estimates)	103	0 - 52	0 - 0.52

Tier	OWF	Sandwich terns at risk of displacement	Predicted displacement[1]	Predicted mortality[2]
TOTAL (including SEP and DEP, design-based density estimates)		500	0 - 251	0 - 2.51
TOTAL (including SEP and DEP, model-based density estimates)		532	0 - 267	0 - 2.67
Notes 1. Based on 0.000 to 0.500 displacement rates 2. Based on 1% mortality of displaced birds				

Table 9-64: In-Combination Displacement Matrix for Sandwich Tern from Greater Wash SPA from OWFs in the UK North Sea (SEP and DEP Contributions Calculated from Design-Based Density Estimates), with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	1	1	2	2	3	5	10	15	25	40	50
	20	1	2	3	4	5	10	20	30	50	80	100
	30	2	3	5	6	8	15	30	45	75	120	150
	40	2	4	6	8	10	20	40	60	100	160	200
	50	3	5	8	10	13	25	50	75	125	200	250
	60	3	6	9	12	15	30	60	90	150	240	300
	70	4	7	11	14	18	35	70	105	175	280	350
	80	4	8	12	16	20	40	80	120	200	320	400
	90	5	9	14	18	23	45	90	135	225	360	450
	100	5	10	15	20	25	50	100	150	250	400	500

Table 9-65: In-Combination Displacement Matrix for Sandwich Tern from Greater Wash SPA from OWFs in the UK North Sea (SEP and DEP Contributions Calculated from Model-Based Density Estimates), with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	1	1	2	2	3	5	11	16	27	43	53
	20	1	2	3	4	5	11	21	32	53	85	106
	30	2	3	5	6	8	16	32	48	80	128	160
	40	2	4	6	9	11	21	43	64	106	170	213
	50	3	5	8	11	13	27	53	80	133	213	266
	60	3	6	10	13	16	32	64	96	160	255	319
	70	4	7	11	15	19	37	74	112	186	298	372
	80	4	9	13	17	21	43	85	128	213	340	426
	90	5	10	14	19	24	48	96	144	239	383	479
	100	5	11	16	21	27	53	106	160	266	426	532

9.4.3.1.5.2 Collision Risk

1172. Collision risk for North Norfolk Coast SPA Sandwich tern was previously calculated for other OWFs using models not currently recommended for use in OWF assessment by Natural England. Revised CRM for other OWFs was therefore undertaken. This amounts to investigations which go substantially beyond those typically carried out for an OWF assessment. Detailed methodology and input parameters for CRM, including the consented and as-built designs of existing OWFs, are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1173. The annual in-combination predicted collision mortality for the North Norfolk Coast SPA breeding adult Sandwich tern population presented in the following tables. CRM results obtained using consented OWF parameters (Scenario A) are presented in **Table 9-66** and as-built parameters (Scenario B) in **Table 9-67**.

1174. Whilst the CRM for the as-built scenario provides the most realistic outputs, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, albeit extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, three further sets of CRM outputs for hypothetical OWF designs have been produced. The first (**Table 9-68**) assumes that any unbuilt capacity at the consented OWFs is built out using turbines of the same specification as the consented design (Scenario C). The second (**Table 9-69**) assumes that any unbuilt capacity at the consented OWFs is built out using turbines of the same specification as those actually used at the OWF. (Scenario D). The final set of CRM outputs (Scenario E) (**Table 9-28**) is the same as Scenario D but with the assumption that the as-built layout of DOW is legally secured through a mechanism within the DCO (**Section 3.3.2**). Further details describing the mechanism for securing the as-built layout of DOW are provided in **ES Chapter 4 Project Description** (document reference 6.1.4). The avoidance rates (with and without macro-avoidance) are as per those considered in **Section 9.4.3.1.4.2**.

Table 9-66: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the North Norfolk Coast SPA using Consented OWF Parameters (Scenario A)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	40.1	30.1	20.0	23.5	14.0
1	Race Bank	89.6	67.2	44.8	52.4	31.4
1	SOW	16.9	12.7	8.4	9.9	5.9
2	Triton Knoll	17.8	13.4	8.9	10.4	6.2
TOTAL (excluding SEP and DEP)		164.4	123.3	82.2	96.2	57.5
5	DEP (design-based density estimates)	7.4	5.5	3.7	4.3	2.6

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
5	SEP (design-based density estimates)	1.9	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.4 (10.8)	6.3 (8.1)	4.2 (5.4)	4.9 (6.3)	3.0 (3.8)
5	SEP (model-based density estimates)	2.7	2.1	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		173.6	130.2	86.8	101.6	60.8
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		175.6 (177.9)	131.7 (133.4)	87.8 (89.0)	102.7 (104.1)	61.4 (62.3)

Table 9-67: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the North Norfolk Coast SPA using As-Built OWF Parameters (Scenario B)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	33.3	25.0	16.6	19.5	11.7
1	Race Bank	30.3	22.7	15.2	17.7	10.6
1	SOW	16.9	12.7	8.4	9.9	5.9
2	Triton Knoll	6.1	4.5	3.0	3.5	2.1
TOTAL (excluding SEP and DEP)		86.5	64.9	43.3	50.6	30.3
5	DEP (design-based density estimates)	7.4	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.9	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines	8.4 (10.8)	6.3 (8.1)	4.2 (5.4)	4.9 (6.3)	3.0 (3.8)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
	installed in DEP-N)					
5	SEP (model-based density estimates)	2.7	2.1	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		95.4	71.6	47.7	55.8	33.4
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		97.2 (99.5)	72.9 (74.7)	48.6 (49.8)	56.9 (58.2)	34.0 (34.8)

Table 9-68: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the North Norfolk Coast SPA using As-Built OWF Parameters, with Additional Unbuilt Capacity Built Out Using Consented Design Turbines (Scenario C)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	44.5	33.4	22.3	26.0	15.6
1	Race Bank	31.2	23.4	15.6	18.3	10.9
1	SOW	16.9	12.7	8.4	9.9	5.9
2	Triton Knoll	11.2	8.4	5.6	6.6	3.9
TOTAL (excluding SEP and DEP)		103.8	77.9	51.9	60.7	36.3
5	DEP (design-based density estimates)	7.4	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.9	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parenthese s assumes all turbines	8.4 (10.8)	6.3 (8.1)	4.2 (5.4)	4.9 (6.3)	3.0 (3.8)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
	installed in DEP-N)					
5	SEP (model-based density estimates)	2.7	2.1	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		113.1	84.8	56.5	66.1	39.6
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		115.0 (117.4)	86.2 (88.0)	57.5 (58.7)	67.3 (68.7)	40.2 (41.1)

Table 9-69: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the North Norfolk Coast SPA using As-Built OWF Parameters, with Additional Unbuilt Capacity Built Out using As-Built Design Turbines (Scenario D)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	42.6	32.0	21.3	24.9	14.9
1	Race Bank	30.6	23.0	15.3	17.9	10.7
1	SOW	16.9	12.7	8.4	9.9	5.9
2	Triton Knoll	7.8	5.9	3.9	4.6	2.7
TOTAL (excluding SEP and DEP)		97.9	73.4	49.0	57.3	34.3
5	DEP (design-based density estimates)	7.4	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.9	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.4 (10.8)	6.3 (8.1)	4.2 (5.4)	4.9 (6.3)	3.0 (3.8)
5	SEP (model-based density estimates)	2.7	2.1	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		107.2	80.4	53.6	62.7	37.5
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		109.1 (111.4)	81.8 (83.6)	54.5 (55.7)	63.8 (65.2)	38.2 (39.0)

Table 9-70: In-Combination Collision Risk for Breeding Adult Sandwich Terns of the North Norfolk Coast SPA using As-Built OWF Parameters, with Additional Unbuilt Capacity Built Out using As-Built Design Turbines Except for DOW, for Which the As-Built Design is Assumed to be Legally Secured (Scenario E)

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	DOW	33.3	25.0	16.6	19.5	11.7
1	Race Bank	30.6	23.0	15.3	17.9	10.7

Tier	OWF	0.980, 0.000 macro-avoidance	0.980, 0.250 macro-avoidance	0.980, 0.500 macro-avoidance	0.9883	0.993
1	SOW	16.9	12.7	8.4	9.9	5.9
2	Triton Knoll	7.8	5.9	3.9	4.6	2.7
TOTAL (excluding SEP and DEP)		88.6	66.4	44.3	51.8	31.0
5	DEP (design-based density estimates)	7.4	5.5	3.7	4.3	2.6
5	SEP (design-based density estimates)	1.9	1.4	0.9	1.1	0.6
5	DEP (model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)	8.4 (10.8)	6.3 (8.1)	4.2 (5.4)	4.9 (6.3)	3.0 (3.8)
5	SEP (model-based density estimates)	2.7	2.1	1.4	1.6	1.0
TOTAL (including SEP and DEP, design-based density estimates)		97.8	73.4	48.9	57.2	34.2
TOTAL (including SEP and DEP, model-based density estimates; values in parentheses assumes all turbines installed in DEP-N)		99.8 (102.1)	74.8 (76.6)	49.9 (51.1)	58.4 (59.7)	34.9 (35.7)

1175. Using the consented OWF designs (Scenario A - **Table 9-66**), along with the recommended avoidance rate (0.980), either 173.6 or 175.6 (0.000 macro-avoidance), 130.2 or 131.7 (0.250 macro-avoidance) or 86.8 or 87.8 (0.500 macro-avoidance) breeding adult North Norfolk Coast SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-66**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 4.3% and 1.1% of this total respectively (5.3% together) when CRMs calculated using design-based density estimates are used, or 4.8% and 1.6% of this total respectively (6.4% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual North Norfolk Coast SPA breeding adult Sandwich tern mortality rate of 18.0% or 18.2% (0.000 macro-avoidance rate), 13.5% or 13.7% (0.250 macro-avoidance rate) or 9.0% or 9.1% (0.500 macro-avoidance rate) depending on the macro-avoidance correction factor used, and the density estimation method at SEP and DEP (higher values of each pair of values above were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 18.5%, 13.9% or 9.2% depending on the macro-avoidance rate selected. Only three values were calculated for this scenario as only model-based density estimates could be used to assess Sandwich tern density, and therefore collision risk, at DEP-N.

1176. These mortality rates are considered to be unrealistically high, since the OWF designs used as CRM input parameters do not exist. For this situation to actually occur, the as-built DOW, Race Bank, SOW and Triton Knoll OWFs would need to be decommissioned and replaced by the consented designs. These designs included turbines that have been superseded by more modern designs. It is not clear how or why this situation would ever arise in reality and it is not considered to be a plausible scenario, though it is recognised that this is the current "legally secured" scenario.

1177. Using the as-built OWF designs (Scenario B), along with the recommended avoidance rate (0.980), either 95.4 or 97.2 (0.000 macro-avoidance), 71.6 or 72.9 (0.250 macro-avoidance), or 47.7 or 48.6 (0.500 macro-avoidance) breeding adult North Norfolk Coast SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-67**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 7.4% and 1.9% of this total respectively (9.6% together) when CRMs calculated using design-based density estimates are used, or 8.6% and 2.8% of this total respectively (11.4% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual North Norfolk Coast SPA breeding adult Sandwich tern mortality rate of 9.9% or 10.1% (0.000 macro-avoidance), 7.5% or 7.6% (0.250 macro-avoidance), or 5.0% or 5.1% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used, and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 10.4%, 7.8% or 5.2% depending on the macro-avoidance rate selected. Only three values were calculated for this scenario as only model-based density estimates could be used to assess Sandwich tern density, and therefore collision risk, at DEP-N.

1178. Whilst this situation is probably the most realistic in terms of OWF design, it does not account for the fact that the as-built designs are not legally secured.

1179. Using the as-built OWF designs with additional unbuilt capacity built out using consented design turbines (Scenario C), along with the recommended avoidance rate (0.980), either 113.1 or 115.0 (0.000 macro-avoidance), 84.8 or 86.2 (0.250 macro-avoidance), or 56.5 or 57.5 (0.500 macro-avoidance) breeding adult North Norfolk Coast SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-68**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 6.5% and 1.6% of this total respectively (8.2% together) when CRMs calculated using design-based density estimates are used, or 7.3% and 2.4% of this total respectively (9.7% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual North Norfolk Coast SPA breeding adult Sandwich tern mortality rate of 11.7% or 11.9% (0.000 macro-avoidance), 8.8% or 9.0% (0.250 macro-avoidance), or 5.9% or 6.0% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used, and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 12.2%, 9.1% or 6.1% depending on the macro-avoidance rate selected. Only three values were calculated for this scenario as only model-based density estimates could be used to assess Sandwich tern density, and therefore collision risk, at DEP-N.

1180. This situation represents a worst case scenario for the building out of as yet unbuilt capacity at the existing OWFs. However, this is not a highly likely scenario, because it requires any further build-out of existing OWFs to use turbine designs that have been superseded by more modern alternatives. Whilst possible, this does not seem like a realistic scenario.

1181. Using the as-built OWF designs with additional unbuilt capacity built out using as-built design turbines (Scenario D), along with the recommended avoidance rate (0.980), either 107.2 or 109.1 (0.000 macro-avoidance), 80.4 or 81.8 (0.250 macro-avoidance), or 53.6 or 54.5 (0.500 macro-avoidance) breeding adult North Norfolk Coast SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-69**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.7% and 6.9% of this total respectively (8.6% together) when CRMs calculated using design-based density estimates are used, or 7.7% and 2.2% of this total respectively (10.2% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual North Norfolk Coast SPA breeding adult Sandwich tern mortality rate of 11.1% or 11.3% (0.000 macro-avoidance), 8.3% or 8.5% (0.250 macro-avoidance), or 5.6% or 5.7% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used, and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 11.6%, 8.7% or 5.8% depending on the macro-avoidance rate selected. Only three values were calculated for this scenario as only model-based density estimates could be used to assess Sandwich tern density, and therefore collision risk, at DEP-N.

1182. This situation represents the most realistic scenario for the building out of as yet unbuilt capacity at the existing OWFs of the two presented.

1183. Using the as-built OWF designs with additional unbuilt capacity built out using as-built design turbines, but with the assumption that the DOW as-built design is legally secured (Scenario E), along with the recommended avoidance rate (0.980), either 97.8 or 99.8 (0.000 macro-avoidance), 73.4 or 74.8 (0.250 macro-avoidance) or 48.9 or 49.9 (0.500 macro-avoidance) breeding adult North Norfolk Coast SPA Sandwich terns per year are predicted to collide with operational OWFs in the wider Wash area (**Table 9-70**). The higher of each of the two values are predicted when model-based density estimates for SEP and DEP are used as CRM inputs. SEP and DEP contribute 1.9% and 7.5% of this total respectively (9.4% together) when CRMs calculated using design-based density estimates are used, or 2.7% and 8.5% of this total respectively (11.2% together) when CRMs calculated using model-based density estimates are used. The collision estimates would represent increases in the existing annual North Norfolk Coast SPA breeding adult Sandwich tern mortality rate of 10.4% or 10.2% (0.000 macro-avoidance), 7.8% or 7.6% (0.250 macro-avoidance) or 5.2% or 5.1% (0.500 macro-avoidance) depending on the macro-avoidance correction factor used, and the density estimation method at SEP and DEP (higher values were obtained from CRMs using model-based density estimates). Assuming that all of DEP's turbines would be installed at DEP-N increases the overall collision rate slightly, resulting in increases to existing Greater Wash SPA annual Sandwich tern mortality of 10.6%, 8.0% or 5.3% depending on the macro-avoidance rate selected. Only three values were calculated for this scenario as only model-based density estimates could be used to assess Sandwich tern density, and therefore collision risk, at DEP-N.

1184. This situation represents the most realistic scenario for the building out of as yet unbuilt capacity at the existing OWFs of the two presented, in addition to DOW being legally secured in its as-built form.

1185. Based on the predicted increases in annual mortality of the breeding adult Sandwich tern population of the North Norfolk Coast SPA, there is potential for significant effects to occur at the population level due to this impact pathway. PVAs for a selection of possible scenarios are presented in **Table 9-71** when the SEP and DEP CRMs were prepared using design-based density estimates, **Table 9-72** when the SEP and DEP CRMs were prepared using model-based density estimates, and **Table 9-73** when the SEP and DEP CRMs were prepared using model-based density estimates, but it is assumed that at DEP, all turbines will be installed in DEP-N rather than across DEP as a whole. For each Scenario (A to E), the population level effects of predicted annual collision mortality at three macro-avoidance rates has been examined.

Table 9-71: PVA Outputs for Breeding Adult North Norfolk Coast SPA Sandwich Terns Incorporating Collision Impacts of SEP and DEP (Based on CRMs using Design-Based Density Estimates) In-Combination with Other Projects

Scenario	Avoidance rate	Macro-avoidance rate	Annual mortality	Increase in existing mortality rate[1],[2]	Median CGR[3]	Median CPS[3]
A	0.980	0%	173.6	0.0207432190	0.977	0.381
	0.980	25%	131.7	0.0157366472	0.982	0.482
	0.980	50%	87.8	0.0104910981	0.988	0.616
B	0.980	0%	95.4	0.0113992114	0.987	0.590
	0.980	25%	71.6	0.0085553830	0.990	0.674
	0.980	50%	47.7	0.0056996057	0.994	0.769
C	0.980	0%	113.1	0.0135141594	0.985	0.535
	0.980	25%	84.8	0.0101326323	0.989	0.626
	0.980	50%	56.5	0.0067511053	0.992	0.733
D	0.980	0%	107.2	0.0128091767	0.986	0.553
	0.980	25%	80.4	0.0096068825	0.989	0.642
	0.980	0%	53.6	0.0064045884	0.993	0.744
E	0.980	25%	97.8	0.0116859840	0.987	0.583
	0.980	50%	73.4	0.0087704624	0.990	0.667
	0.980	0%	48.9	0.0058429920	0.993	0.764
Notes 1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced 2. Background population is North Norfolk Coast SPA breeding adults (8,369 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015) 3. After 40 years of operation						

Table 9-72: PVA Outputs for Breeding Adult North Norfolk Coast SPA Sandwich Terns Incorporating Collision Impacts of SEP and DEP (Based on CRMs using Model-Based Density Estimates) In-Combination with Other Projects

Scenario	Avoidance rate	Macro-avoidance rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
A	0.980	0%	175.6	0.0209821962	0.976	0.377
	0.980	25%	131.7	0.0157366472	0.982	0.482
	0.980	50%	87.8	0.0104910981	0.988	0.616
B	0.980	0%	97.2	0.0116142908	0.987	0.585
	0.980	25%	72.9	0.0087107181	0.990	0.669
	0.980	50%	48.6	0.0058071454	0.993	0.765
C	0.980	0%	115.0	0.0137411877	0.985	0.529
	0.980	25%	86.2	0.0102999164	0.988	0.621
	0.980	50%	57.5	0.0068705939	0.992	0.728
D	0.980	0%	109.1	0.0130362050	0.985	0.547
	0.980	25%	81.8	0.0097741666	0.989	0.637
	0.980	0%	54.5	0.0065121281	0.993	0.741
E	0.980	0%	99.8	0.0119249612	0.987	0.576
	0.980	25%	74.8	0.0089377464	0.990	0.662
	0.980	50%	49.9	0.0059624806	0.993	0.760

Notes

1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is North Norfolk Coast SPA breeding adults (8,369 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)
3. After 40 years of operation

Table 9-73: PVA Outputs for Breeding Adult North Norfolk Coast SPA Sandwich Terns Incorporating Collision Impacts of SEP and DEP (Based on CRMs using Model-Based Density Estimates, but Assuming All Turbines at DEP are Installed at DEP-N) In-Combination with Other Projects

Scenario	Avoidance rate	Macro-avoidance rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
A	0.980	0%	177.9	0.0212570200	0.976	0.372
	0.980	25%	133.4	0.0159397778	0.982	0.477
	0.980	50%	89.0	0.0106344844	0.988	0.612
B	0.980	0%	99.5	0.0118891146	0.987	0.577
	0.980	25%	74.7	0.0089257976	0.990	0.662
	0.980	50%	49.8	0.0059505317	0.993	0.760
C	0.980	0%	117.4	0.0140279603	0.984	0.522
	0.980	25%	88.0	0.0105149958	0.988	0.615
	0.980	50%	58.7	0.0070139802	0.992	0.724
D	0.980	0%	111.4	0.0133110288	0.985	0.540
	0.980	25%	83.6	0.0099892460	0.989	0.629
	0.980	0%	55.7	0.0066555144	0.993	0.736
E	0.980	0%	102.1	0.0121997849	0.986	0.569
	0.980	25%	76.6	0.0091528259	0.990	0.655
	0.980	50%	51.1	0.0061058669	0.993	0.755

Notes

1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is North Norfolk Coast SPA breeding adults (8,369 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)
3. After 40 years of operation

1186. The PVAs investigating the population-level effects of potential collision impacts for SEP and DEP in-combination with other projects produced median CGRs ranging from 0.976 to 0.994, and median CPSs ranging from 0.372 to 0.788. The CGRs and CPSs for PVAs produced using SEP and DEP CRMs that used either model-based or design-based density estimates were extremely similar, with slightly higher population impacts predicted for scenarios where CRM at SEP and DEP was calculated using model-based density estimates than design-based density estimates, and slightly higher again if it was assumed that all of the turbines at DEP would be installed in DEP-N. However, such small differences between the impacts predicted by the three sets of models would likely be indistinguishable at the population level.

1187. For reference, the annual rate of change in the North Norfolk Coast SPA breeding Sandwich tern population is -2.3%, 0.8%, -0.5% and 2.9% when measured over the last 40, 30, 20 and 10 years respectively. Compared to the 2019 count, the population increase at the North Norfolk Coast SPA has been 21.6%, 27.7%, 7.5% and 22.4% over the last 40, 30, 20 and 10 years respectively. The total predicted collision impacts of all OWFs considered by the in-combination assessment are similar to or larger than changes which have occurred at the colony in the last 40 years.

1188. The median CGR values for all scenarios are within the variation recorded in the growth rate at the colony over the last 40 years. However, such a consistent reduction in growth rate over a 40 year period would result in substantial reductions in population size at the end of the 40 year modelled period when compared to the unimpacted baseline scenario. This is reflected in the median CPS values for all scenarios considered by the PVAs.

1189. If it is assumed that no macro-avoidance will occur at the OWFs included in the assessment, the annual growth rate of the breeding adult Sandwich tern population of the North Norfolk Coast SPA will reduce by 1.3% to 2.4% compared with the unimpacted baseline scenario, with a corresponding reduction in population size after 40 years of operation of between 41.0% to 62.8% depending on the scenario in question. However, the assumption of no macro-avoidance occurring seems unlikely, based on the evidence examined by the assessment regarding the response of Sandwich terns to operational OWFs.

1190. Assuming that a level of macro-avoidance (either 25% or 50%) will occur during the operation of all OWFs, it is anticipated that the annual growth rate of the breeding adult Sandwich tern population of the North Norfolk Coast SPA will reduce by 0.6% to 1.8% when compared with the unimpacted baseline scenario, with a corresponding reduction in population size after 40 years of operation of between 23.1% to 52.3%.

1191. Scenario A was predicted to have the greatest impact at the population level by a large extent compared to the other scenarios. This is because the consented OWF parameters often consist of many more, smaller turbines than as-built designs. For reasons described in the paragraphs above, Scenario A is not considered to be a realistic scenario. The predicted decreases in annual growth rate for Scenarios B, C, D and E when compared with the unimpacted baseline scenario are considerably smaller than the corresponding decrease under Scenario A. This is covered in greater detail in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). It is clear that both the OWF design of existing OWFs selected for modelling, and macro-avoidance level have a considerable impact on the predicted population level impacts predicted as a result of in-combination collision risk. After Scenario A, the scenario with the next largest impact was Scenario C, followed by D, E, and B (i.e. as built which is the most realistic scenario), although the differences in these scenarios were not as large as the differences between Scenario A and all other scenarios. For reasons described in the paragraphs above, Scenario B is considered to be the most realistic scenario of the five presented.

1192. The counterfactuals calculated from the model outputs should be interpreted in light of the precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The assumption that all birds recorded, particularly at DEP, are breeding adults from this SPA, given the OWF is situated towards the edge of the typical foraging range for this species.
- The use of mean peak abundance estimates in displacement modelling may result in estimates of displaced birds being unrealistically high.
- The mortality rates assumed for displaced birds may be overestimated.
- The avoidance rate applied in the CRM (0.980) likely significantly underestimates the behavioural avoidance of this species to OWFs.
- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary.
- The North Norfolk Coast SPA Sandwich tern population is modelled as a closed population, with no emigration or immigration occurring.

1193. The contribution of SEP and DEP to the overall impact is relatively small in the context of the overall cumulative impact. Depending on the OWF designs considered, the contribution of DEP amounts to between 5% and 10% of all predicted North Norfolk Coast SPA Sandwich tern mortality due to OWF impacts, and SEP between 2% to 3%.

1194. On balance, the input parameters used in both the PVAs themselves, and the inputs into other processes that feed into PVA (e.g. density estimation, CRM and apportioning), are generally considered to be appropriately precautionary given the importance of the breeding Sandwich tern population under consideration and the uncertainty around a number of aspects of the assessment. The incorporation of avoidance rates that have a greater evidential basis, reduce population level impacts, but a degree of uncertainty exists as to the extent of macro-avoidance that will occur.

1195. In conclusion, it seems reasonable to assume that since the potential changes at the population level could be larger than the changes that have occurred at the colony over the last four decades, the annual mortalities considered in the PVAs summarised in **Table 9-71**, **Table 9-72**, and **Table 9-73** could cause quite substantial population level impacts on the breeding adult Sandwich tern population of the North Norfolk Coast SPA.

1196. **It is concluded that an adverse effect on the integrity of the North Norfolk Coast SPA cannot be ruled out as a result of predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.4.3.1.5.3 Combined Displacement / Barrier Effects and Collision Risk

1197. The predicted annual in-combination breeding adult North Norfolk Coast SPA Sandwich tern mortality from collision and displacement for OWFs in the Greater Wash area under different OWF design scenarios and macro-avoidance rates is shown in **Table 9-74** (displacement rate of 0.000, which will result in the same impacts as collision alone),

1198. **Table 9-75** (displacement rate of 0.250) and **Table 9-76** (displacement rate of 0.500). These scenarios use the avoidance rate recommended by Natural England (0.980), and incorporate a level of macro-avoidance which is close to many of the previously observed values for this effect in other studies (**ES Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). It should be noted that this section of the assessment focuses on the scenario that all turbines that are installed at DEP will be installed across DEP as a whole, not just DEP-N.

Table 9-74: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Sandwich Tern of the North Norfolk Coast SPA under Different OWF Designs, Assuming No Macro-Avoidance

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
Existing OWFs[1]	164.4 (17.1%)	86.5 (9.0%)	103.8 (10.8%)	97.9 (10.2%)	88.6 (9.2%)
DEP (design-based density estimates)	7.4	7.4	7.4	7.4	7.4
SEP (design-based density estimates)	1.9	1.9	1.9	1.9	1.9
DEP (model-based density estimates)	8.4	8.4	8.4	8.4	8.4
SEP (model-based density estimates)	2.7	2.7	2.7	2.7	2.7
TOTAL (including SEP and DEP, design-	173.6 (18.0%)	95.8 (9.9%)	113.1 (11.7%)	107.2 (11.1%)	97.8 (10.2%)

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
based density estimates) [1]					
TOTAL (including SEP and DEP, model-based density estimates) [1]	175.6 (18.2%)	97.7 (10.1%)	115.0 (11.9%)	109.1 (11.3%)	99.8 (10.4%)
Notes Assumes displacement rate of 0.000 for displacement assessment, and avoidance rate of 0.980, with 0.000 displacement rate for collision assessment 1. Values in parentheses are predicted increases in annual mortality of Greater Wash SPA breeding adult Sandwich terns, assuming population size of 9,443 individuals and adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)					

Table 9-75: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Sandwich Tern of the North Norfolk Coast SPA under Different OWF Designs, Assuming 0.250 Macro-Avoidance

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
Existing OWFs[1]	123.9 (12.9%)	65.5 (6.8%)	78.4 (8.1%)	74.0 (7.7%)	67.0 (7.0%)
DEP (design-based density estimates)	6.1	6.1	6.1	6.1	6.1
SEP (design-based density estimates)	1.6	1.6	1.6	1.6	1.6
DEP (model-based density estimates)	6.8	6.8	6.8	6.8	6.8
SEP (model-based density estimates)	2.2	2.2	2.2	2.2	2.2
TOTAL (including	131.5 (13.7%)	73.1 (7.6%)	86.1 (8.9%)	81.6 (8.5%)	74.6 (7.7%)

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
SEP and DEP, design-based density estimates) [1]					
TOTAL (including SEP and DEP, model-based density estimates) [1]	132.9 (13.8%)	74.5 (7.7%)	87.5 (9.1%)	83.0 (8.6%)	76.0 (7.9%)
Notes Assumes displacement rate of 0.250 and mortality rate of 1% of displaced birds for displacement assessment, avoidance rate of 0.980, with 0.250 displacement rate for collision assessment 1. Values in parentheses are predicted increases in annual mortality of Greater Wash SPA breeding adult Sandwich terns, assuming population size of 9,443 individuals and adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)					

Table 9-76: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Sandwich Tern of the North Norfolk Coast SPA under Different OWF Designs, Assuming 0.500 Macro-Avoidance

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
Existing OWFs[1]	83.3 (8.7%)	44.4 (4.6%)	53.0 (5.5%)	50.1 (5.2%)	45.4 (4.7%)
DEP (design-based density estimates)	4.7	4.7	4.7	4.7	4.7
SEP (design-based density estimates)	1.3	1.3	1.3	1.3	1.3
DEP (model-based density estimates)	5.2	5.2	5.2	5.2	5.2
SEP (model-based density estimates)	1.8	1.8	1.8	1.8	1.8

OWF	Consented (Scenario A)	As-built (Scenario B)	As-built, built out to consented capacity with consented turbines (Scenario C)	As-built, built out to consented capacity with as-built turbines (Scenario D)	As-built, built out to consented capacity with as-built turbines, DOW legally secured (Scenario E)
TOTAL (including SEP and DEP, design-based density estimates) [1]	89.3 (9.3%)	50.4 (5.2%)	59.0 (6.1%)	56.1 (5.8%)	51.4 (5.3%)
TOTAL (including SEP and DEP, model-based density estimates) [1]	90.2 (9.4%)	51.3 (5.3%)	59.9 (6.2%)	57.0 (5.9%)	52.3 (5.4%)
Notes Assumes displacement rate of 0.500 and mortality rate of 1% of displaced birds for displacement assessment, avoidance rate of 0.980, with 0.500 displacement rate for collision assessment 1. Values in parentheses are predicted increases in annual mortality of Greater Wash SPA breeding adult Sandwich terns, assuming population size of 9,443 individuals and adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)					

1199. As with the project alone scenarios examined, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur). The conclusions for all other scenarios presented in the above tables result in very similar, but slightly smaller impacts being predicted.

1200. PVAs examining the effect of the mortality rates generated by these scenarios at the population level are presented in **Table 9-77** when the SEP and DEP CRMs were prepared using design-based density estimates, and **Table 9-78** when the SEP and DEP CRMs were prepared using model-based density estimates. CGR and CPS derived from the model outputs are presented. These measure changes in annual growth rate and population size at the end of the impacted period relative to the unimpacted scenario, which in this case is 40 years. These outputs are favoured due to their relatively high tolerance for misspecification of input parameters, which is common in population modelling (Jitlal *et al.*, 2017).

1201. The increase in existing mortality rate due to the predicted impact is also presented. This is a PVA input and was calculated by adding the predicted mortality to existing mortality, dividing the resultant total by the starting population to calculate a new mortality rate, and subtracting the original mortality rate from the new mortality rate to obtain the difference between the two. It has been presented to 10 decimal places to allow the model to be reproduced.

Table 9-77: PVA Outputs for Breeding Adult North Norfolk Coast SPA Sandwich Terns Incorporating Mean Collision and Displacement Impacts of SEP and DEP (based on CRMs using Design-Based Density Estimates) In-Combination with Other Projects

Existing OWF design scenario	Avoidance rate	Macro-avoidance rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
A	0.98	0.000	173.6	0.0207432190	0.977	0.381
A	0.98	0.250	131.5	0.0157127494	0.982	0.483
A	0.98	0.500	89.3	0.0106703310	0.988	0.611
B	0.98	0.000	95.8	0.0114470068	0.987	0.589
B	0.98	0.250	73.1	0.0087346158	0.990	0.668
B	0.98	0.500	50.4	0.0060222249	0.993	0.758
C	0.98	0.000	113.1	0.0135141594	0.985	0.535
C	0.98	0.250	86.1	0.0102879675	0.988	0.622
C	0.98	0.500	59.0	0.0070498267	0.992	0.722
D	0.98	0.000	107.2	0.0128091767	0.986	0.553
D	0.98	0.250	81.6	0.0097502688	0.989	0.637
D	0.98	0.500	56.1	0.0067033098	0.992	0.734
E	0.98	0.000	97.8	0.0116859840	0.987	0.582
E	0.98	0.250	74.6	0.0089138487	0.990	0.663
E	0.98	0.500	51.4	0.0061417135	0.993	0.753

Notes
1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is North Norfolk Coast SPA breeding adults (8,369 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)
3. After 40 years of operation

Table 9-78: PVA Outputs for Breeding Adult North Norfolk Coast SPA Sandwich Terns Incorporating Mean Collision and Displacement Impacts of SEP and DEP (Based on CRMs using Model-Based Density Estimates) In-Combination with Other Projects

Existing OWF design scenario	Avoidance rate	Macro-avoidance rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
A	0.98	0.000	175.6	0.0209821962	0.976	0.376
A	0.98	0.250	132.9	0.0158800335	0.982	0.479
A	0.98	0.500	90.2	0.0107778707	0.988	0.608
B	0.98	0.000	97.7	0.0116740351	0.987	0.582
B	0.98	0.250	74.5	0.0089018999	0.990	0.663
B	0.98	0.500	51.3	0.0061297646	0.993	0.754
C	0.98	0.000	115.0	0.0137411877	0.985	0.529
C	0.98	0.250	87.5	0.0104552515	0.988	0.617
C	0.98	0.500	59.9	0.0071573665	0.992	0.719
D	0.98	0.000	109.1	0.0130362050	0.985	0.547
D	0.98	0.250	83.0	0.0099175529	0.989	0.632
D	0.98	0.500	57.0	0.0068108496	0.992	0.730
E	0.98	0.000	99.8	0.0119249612	0.987	0.576
E	0.98	0.250	76.0	0.0090811328	0.990	0.657
E	0.98	0.500	52.3	0.0062492532	0.993	0.749

Notes
1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is North Norfolk Coast SPA breeding adults (8,369 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)
3. After 40 years of operation

1202. The PVAs investigating the population-level effects of potential collision and displacement impacts for SEP and DEP in-combination with other projects produced median CGRs ranging from 0.976 to 0.993, and median CPSs ranging from 0.376 to 0.758. The CGRs and CPSs for PVAs produced using SEP and DEP CRMs that used either model-based or design-based density estimates were extremely similar, with slightly higher population impacts predicted for scenarios where CRM at SEP and DEP was calculated using model-based density estimates than design-based density estimates. However, such small differences between the impacts predicted by the three sets of models would likely be indistinguishable at the population level.

1203. If it is assumed that no macro-avoidance will occur at the OWFs included in the assessment, the annual growth rate of the breeding adult Sandwich tern population of the North Norfolk Coast SPA will reduce by 1.3% to 2.4% compared with the unimpacted baseline scenario, with a corresponding reduction in population size after 40 years of operation of between 41.1% to 62.4% depending on the scenario in question. However, the assumption of no macro-avoidance occurring seems unlikely, based on the evidence examined by the assessment regarding the response of Sandwich terns to operational OWFs.

1204. Assuming that a level of macro-avoidance (either 25% or 50%) will occur during the operation of all OWFs, it is anticipated that the annual growth rate of the breeding adult Sandwich tern population of the North Norfolk Coast SPA will reduce by 0.7% to 1.8% when compared with the unimpacted baseline scenario, with a corresponding reduction in population size after 40 years of operation of between 24.2% to 52.1%.

1205. The discussion regarding the impact magnitudes and interpretation of the PVA counterfactuals presented for collision impacts only (**Section 9.4.3.1.5.2**) remains relevant for the combined impact of displacement and collision.

1206. In conclusion, it seems reasonable to assume that since the potential changes at the population level could be larger than the changes that have occurred at the colony over the last four decades, the annual mortalities considered in the PVAs summarised in **Table 9-77** and **Table 9-78** could cause quite substantial population level impacts on the breeding adult Sandwich tern population of the North Norfolk Coast SPA.

1207. **It is concluded that an adverse effect on the integrity of the North Norfolk Coast SPA cannot be ruled out as a result of predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.4.3.2 Common Tern

9.4.3.2.1 Status

1208. The citation for the Greater Wash SPA (Natural England, 2018a) states that the population of common terns associated with the SPA is 510 pairs (1,020 individuals), which was the peak mean count of birds present at the North Norfolk Coast SPA and Ramsar site between 2010 and 2014. The most recent count is 289 pairs, or 578 breeding adults, in 2020 (JNCC, 2022). This is used as the reference population for the assessment. The baseline annual mortality of this population, assuming an adult mortality rate of 11.7% (Horswill and Robinson, 2015), is 68 birds.

1209. Supplementary advice on the overarching conservation objectives were added for qualifying features in 2019 (Natural England, 2019b). For common tern, these are:

- Restore the size of the breeding population to a level which is above 1,000 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.
- Maintain safe passage of birds moving between nesting and feeding areas.
- Reduce the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed.
- Restrict predation and disturbance caused by native and non-native predators.
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk).
- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised.
- Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at levels described in site specific supporting notes.
- Maintain the distribution, abundance and availability of key food and prey items (e.g. sandeel, sprat) at preferred sizes. The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population.
- Maintain the availability of shallow sloping nesting sites, grading to <30cm above water level, restricting the probability that they will flood.
- Maintain vegetation cover which should be <10% throughout areas used for nesting, providing sufficient bare ground for the colony as a whole.
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels.
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels.

- Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels.
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.4.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1210. The assessment assumes that 100% of common terns present at SEP and DEP during the full breeding season (May to August; Furness (2015)) are breeding adults from the North Norfolk Coast SPA and Ramsar site population. It seems, however, as though this may be an unrealistically precautionary assumption. DEP is considerably beyond the mean maximum foraging range (18.0km (sd 8.9km)) (Woodward *et al.*, 2019), of birds from both the Scolt Head (51km) and Blakeney Point (38km) colonies. SEP is closer, but still beyond the mean maximum foraging range of Scolt Head (33km) and Blakeney Point (22km). Whilst SEP is within the mean maximum foraging range plus one standard deviation for Blakeney Point, this measurement is considered to be a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony. It is therefore probable that a proportion of the birds using SEP will actually be non-breeding birds, and perhaps that none of the birds using DEP are breeding adult birds from any of the colonies which contribute birds to the North Norfolk Coast SPA and Ramsar site population.

1211. Outside the breeding season breeding common terns are assumed to range widely and to mix with birds of all ages from breeding colonies in the UK and further afield. The relevant background population is considered to be the UK North Sea and Channel BDMPS, consisting of 144,911 individuals during autumn migration (late July to early September), and spring migration (April to May) (Furness, 2015).

1212. Estimates of the proportion of common terns present at SEP and DEP during the autumn and spring migration seasons which originate from the North Norfolk Coast SPA and Ramsar site are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS (Furness 2015). During both autumn and spring migration seasons, breeding adult common terns from the North Norfolk Coast SPA and Ramsar site make up 0.2% of the total BDMPS population. The same percentage of impacts are therefore attributable to birds from this SPA during these times of year.

9.4.3.2.3 Potential Effects on the Qualifying Feature

1213. The common tern qualifying feature of the North Norfolk Coast SPA and Ramsar site has been screened into the Appropriate Assessment due to the potential risk of collision.

9.4.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.4.3.2.4.1 Collision Risk

1214. Collision risk predictions for North Norfolk Coast SPA and Ramsar site common terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-79**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-80**. Outputs are based on Option 2 of the Band Model and avoidance rates of 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). The methodology and input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1215. For DEP, the mean annual collision estimate (0.36) increases the annual baseline mortality by 0.54%. The predicted increase in the annual baseline mortality of Greater Wash SPA common terns is greater than 1% for the annual upper 95% CI output (1.61 collisions per year; 2.39%). For SEP, the mean annual collision estimate (0.36) increases the annual baseline mortality by 0.54%, and the upper 95% CI output (1.64) increases the baseline mortality by 2.45%. For SEP and DEP together, the mean collision rate (0.73) represents slightly more than a 1% increase in the existing mortality of the population (1.08%), along with the upper 95% CI collision rate (4.84%). These values all assume an extremely precautionary 100% of birds present at SEP and DEP belonging to the North Norfolk Coast and Ramsar site SPA population.

1216. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 36 flying birds were observed across DEP (of which 29 were within DEP-N, and seven within DEP-S). When corrected for the different survey transect lengths in both regions of DEP this means that encounter rate was 32.2% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude could lead to increases in mortality of greater than 1% being predicted. However, since the difference in encounter rate between DEP-N and DEP-S is unlikely to be statistically significant, it is still considered that effects will likely be undetectable within the context of natural variation.

Table 9-79: Predicted Monthly Breeding Season Collision Mortality for Common Tern at SEP and DEP Apportioned to North Norfolk Coast SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.19	0.05	0.00	0.13	0.00	0.00	0.00	0.00	0.36
	Density	95% UCI	0.00	0.00	0.00	0.00	0.77	0.34	0.00	0.50	0.00	0.00	0.00	0.00	1.61
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.30	0.08	0.00	0.21	0.00	0.00	0.00	0.00	0.59
		95% LCI	0.00	0.00	0.00	0.00	0.09	0.02	0.00	0.06	0.00	0.00	0.00	0.00	0.17
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.10	0.15	0.00	0.10	0.00	0.00	0.00	0.00	0.36
	Density	95% UCI	0.00	0.00	0.00	0.00	0.75	0.28	0.00	0.61	0.02	0.00	0.00	0.00	1.66
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.17	0.25	0.00	0.17	0.01	0.00	0.00	0.00	0.60
		95% LCI	0.00	0.00	0.00	0.00	0.05	0.07	0.00	0.05	0.00	0.00	0.00	0.00	0.17
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.29	0.20	0.00	0.23	0.00	0.00	0.00	0.00	0.73
	Density	95% UCI	0.00	0.00	0.00	0.00	1.52	0.62	0.00	1.11	0.02	0.00	0.00	0.00	3.27
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.47	0.32	0.00	0.38	0.01	0.00	0.00	0.00	1.19
		95% LCI	0.00	0.00	0.00	0.00	0.13	0.09	0.00	0.11	0.00	0.00	0.00	0.00	0.34
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out.

Table 9-80: Predicted Annual Breeding Season Collision Mortality for Common Tern at SEP and DEP Apportioned to North Norfolk Coast SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	0.36 (0.00 - 1.61)	0.54 (0.00 - 2.39)
SEP	0.36 (0.00 - 1.64)	0.54 (0.00 - 2.45)
SEP and DEP	0.73 (0.00 - 3.25)	1.08 (0.00 - 4.84)
Notes 1. Background population is North Norfolk Coast SPA and Ramsar site breeding adults (578 individuals), adult age class annual mortality rate of 11.7% (Horswill and Robinson, 2015)		

1217. In summary, the mean common tern collision rates predicted at SEP and DEP using an avoidance rate of 0.980 do not produce impacts of a sufficient magnitude to lead to an adverse effect on integrity of the North Norfolk Coast SPA and Ramsar site. Predicted increases in mortality using the mean collision outputs are slightly greater than the 1% threshold in existing mortality increase, beyond which impacts may be detectable. However, it is considered that these increases in mortality are substantially overestimated.

1218. Both SEP and DEP lie a considerable distance from the breeding colonies from which the North Norfolk Coast SPA population originates relative to the published mean maximum foraging range. In addition, approximately 90% of the annual collision risk at SEP and DEP occurred in May and August. Whilst these months are part of the full breeding season, they are also in the spring and autumn passage periods respectively for this species (Furness, 2015). Therefore, the majority of collisions predicted are likely to involve birds from other colonies on passage, and not breeding adults associated with the North Norfolk Coast SPA and Ramsar site.

1219. It is concluded that predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the North Norfolk Coast SPA and Ramsar site.

1220. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters, and the avoidance rate, the selected parameters are considered to be sufficiently precautionary based on expert opinion and information drawn from the literature to provide confidence that collision rates are not underestimated, and may in fact be overestimated.

9.4.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.4.3.2.5.1 Collision Risk

1221. Of the other OWFs within the Greater Wash area for which assessments were consulted (i.e. SOW, DOW, Race Bank OWF and Triton Knoll), common tern collisions were predicted at SOW only. Three collisions per year were estimated, at an avoidance rate of 0.980 (SCIRA Offshore Energy Ltd, 2006). SOW is located approximately 32km from Scolt Head, and 19km from Blakeney Point at its nearest point. It therefore lies outside the mean maximum foraging range (18.0km (sd 8.9km)) (Woodward *et al*., 2019) of both breeding locations from which North Norfolk Coast SPA and Ramsar site common terns originate, but within the mean maximum foraging range plus one standard deviation of Blakeney Point. However, this measurement is considered to be poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity.

1222. As a result, it is anticipated that a proportion of birds present at SOW will not belong to the North Norfolk Coast SPA and Ramsar site population. Furthermore, approximately 80% of the annual collision risk at SOW occurred in August, with the remainder in May. Whilst these months are part of the full breeding season, they are also in the autumn and spring passage periods respectively for this species (Furness, 2015). Therefore, the majority of collisions predicted at SOW are likely to involve birds from other colonies on passage, and not breeding adults associated with the Greater Wash SPA. The same arguments apply to the predicted impacts of SEP and DEP.

1223. Outside the breeding season, there is potential for other OWFs to impact this qualifying feature during the spring and autumn migration seasons. However, a review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. As approximately just 0.2% of migration season impacts on this species would be apportioned to this SPA population (Furness, 2015), it is considered unlikely that in-combination effects on this qualifying feature will occur to the level where an adverse effect on the integrity of the site would be possible.

1224. It is concluded that an adverse effect on the integrity of the North Norfolk Coast SPA **can be ruled out as a result of predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.4.3.3 All Qualifying Migratory Waterbird Features

9.4.3.3.1 Status

1225. The status of each qualifying feature screened into the Appropriate Assessment is presented in **Table 9-81**. This consists of the site population at designation, 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and national population in 2012 (Wright *et al*., 2012).

9.4.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1226. All qualifying features of this designated site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. The qualifying features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and

DEP. However, it is recognised that the qualifying features may pass through the habitat in SEP and DEP during migration periods, and may have been missed by the surveys.

1227. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the Great Britain populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.4.3.3.3 Potential Effects on the Qualifying Features

1228. The qualifying features of this designated site have been screened into the Appropriate Assessment due to the potential risk of collision.

1229. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al.*, 2012).

9.4.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.4.3.3.4.1 Collision Risk

1230. The estimated annual collision risk for each qualifying feature from this designated site for SEP and DEP together, along with the conclusion of the assessment based on this annual collision rate, is presented in **Table 9-81**. An avoidance rate of 0.980 has been assumed for all species.

1231. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1232. It is concluded that the predicted mortality of all qualifying features due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the North Norfolk Coast SPA and Ramsar site.

1233. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

Table 9-81: Information to Inform the Appropriate Assessment for North Norfolk Coast SPA and Ramsar Site (Non-Breeding Waterbird Qualifying Features, SEP and DEP)

Qualifying feature	SPA population (citation)	Ramsar site population (citation)	Five year peak mean 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Pink-footed goose (SPA and Ramsar site)	6,000	16,787	44,505	360,000	0.060	No. Numbers of collisions so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Dark-bellied brent goose (SPA and Ramsar site)	9,000	8,690	7,273	91,000	0.165	
Wigeon (SPA and Ramsar site)	5,600	17,940	11,120	522,370	0.030	
Knot (SPA)	6,000		10,226	338,970	0.050	
Pintail (SPA and Ramsar site)	991	1,148	540	30,235	0.006	
Waterbird assemblage (SPA and Ramsar site)	>20,000	98,462	118,454	-	-	No. Based on the small number of collisions predicted for named qualifying features, no adverse effect on integrity is anticipated.

9.4.3.3.1 Potential Effects of SEP and DEP In-Combination with Other Projects

9.4.3.3.1.1 Collision Risk

1234. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying features from this designated site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other OWFs in UK waters. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1235. **It is concluded that predicted mortality of all qualifying migratory waterbird features due to collision at SEP, DEP and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the North Norfolk Coast SPA and Ramsar site.**

9.5 Outer Thames Estuary SPA

9.5.1 Description of Designation

1236. The Outer Thames Estuary SPA is located on the east coast of England between the counties of Norfolk (on the north side) and Kent (on the south side), and extends into the North Sea. The site comprises areas of shallow and deeper water, high tidal current streams and a range of mobile mud, sand, silt and gravely sediments extending into the marine environment, incorporating areas of sand banks often exposed at low tide. Intertidal mud and sand flats are found further towards the coast and within creeks and inlets inland down the Blyth estuary and the Crouch and Roach estuaries. In total, approximately 3,924km^2 of habitat is included within the SPA boundary.

9.5.2 Conservation Objectives

1237. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features.
- The structure and function of the habitats of the qualifying features.
- The supporting processes on which the habitats of the qualifying features rely.
- The populations of each of the qualifying features.
- The distribution of qualifying features within the site.

9.5.3 Appropriate Assessment

1238. The only qualifying feature of this SPA screened into the Appropriate Assessment is non-breeding red-throated diver **Table 5-2**.

9.5.3.1 Red-Throated Diver

9.5.3.1.1 Status

1239. At citation, the population of red-throated diver was 6,466 non-breeding individuals (Natural England, 2013). This was calculated using populations estimate derived from distance-corrected visual aerial surveys between 1989 and 2006/07.

1240. More recent population estimates have found the non-breeding red-throated diver population of the Outer Thames Estuary SPA to be considerably larger (Goodship *et al.*, 2015; Irwin *et al.*, 2019). The most recent population estimate for the now enlarged SPA is 22,280 non-breeding individuals. This is used as the reference population by the assessment. The annual baseline mortality of this population, assuming that the published all age class mortality rate of 22.8% applies (Horswill and Robinson 2015), is 5,080 birds.

9.5.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1241. The Outer Thames Estuary SPA boundary was selected to include important marine areas for this qualifying feature. All red-throated divers within the SPA belong to its population. Birds situated outside the SPA boundary are not associated with the SPA.

1242. The Outer Thames Estuary SPA is located approximately 75km from SEP and DEP at its nearest point, with the export cable corridor situated slightly closer. These distances are too great for effects to occur on the designated site due to activities within SEP, DEP and the export cable corridor during all project phases.

1243. The proposed operations and maintenance base for SEP and DEP is situated in Great Yarmouth. Vessels transiting to and from SEP and DEP to the base will be required to transit through the Outer Thames Estuary SPA. There is potential for disturbance and displacement of SPA qualifying birds due to these activities.

9.5.3.1.3 Potential Effects on the Qualifying Feature

1244. The red-throated diver qualifying feature of the Outer Thames Estuary SPA has been screened into the Appropriate Assessment due to the potential risk of disturbance and displacement during the operational phase of SEP and DEP as a result of vessels associated with the OWFs transiting part of the northern section of the SPA from Great Yarmouth, for a distance of around 10km.

1245. These effects could impact the qualifying feature either directly (displacing birds from habitats within the SPA boundary), or indirectly (displacing birds into the SPA, which can have knock on effects on birds already within it). Indirect effects are not considered to represent a sufficiently large impact that adverse effect on the integrity of the site could result. This is because the numbers of birds displaced by vessels outside the SPA would be relatively small, and of the birds displaced, those displaced into the Outer Thames Estuary SPA are highly unlikely to occur in sufficient numbers to cause substantial, if any, mortality within the SPA population. They are therefore not considered further by the assessment.

9.5.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.5.3.1.4.1 Operational Phase Displacement/Barrier Effects due to Operation and Maintenance Vessel Activity

1246. The aerial survey study area from which baseline survey data were collected did not include any of the Outer Thames Estuary SPA, as it is situated greater than 4km from both SEP and DEP. The Appropriate Assessment therefore utilises data from Irwin *et al.* (2019) and Goodship *et al.* (2015) to evaluate the magnitude of potential operational phase disturbance and displacement effects on the Outer Thames Estuary SPA population of red-throated diver due to the presence of vessels within the SPA.

1247. The operation and maintenance vessels that will be used during the operational phase of SEP and DEP will transit from the operation and maintenance base located in Great Yarmouth across the Outer Thames Estuary SPA, for a distance of around 10km. The operation and maintenance base is already used by vessels servicing the operational OWFs SOW and DOW, as is the transit route across the SPA. The main component of the SPA overlaps the approaches to Great Yarmouth, and therefore it is not possible to avoid transiting through this part of the SPA. However, the transit corridor follows the navigation approaches to Great Yarmouth, and thus limits the impact of the vessel movements to areas of existing navigation routes where the densities of red-throated diver are typically relatively low. At present, approximately 660 vessel movements take place in the SPA annually due to these activities, which has been the case since 2021. Prior to that, a lower (but unknown) number of vessel transits occurred, which were associated with operation and maintenance vessels of DOW only, since prior to 2021, the operations and maintenance vessels associated with SOW were based at Wells-next-the-Sea.

1248. In the best case scenario, SEP and DEP will not add to the existing total of vessel movements, since daughter craft from a larger vessel which transits from Great Yarmouth will be used for operation and maintenance activities at SEP and DEP, as well as SOW and DOW. These craft will only depart the larger vessel once it has arrived at the relevant OWF, and will rejoin the vessel before it departs for the return journey to Great Yarmouth. In the worst case, an additional 1,200 vessel movements per year through the Outer Thames Estuary SPA could occur as a result of operation and maintenance activities associated with SEP and DEP. These additional movements would use the same general route that is currently used by the operation and maintenance vessels associated with SOW and DOW. Additionally, a best practice protocol for minimising disturbance to red-throated divers as secured through the **Outline PEMP** (document reference 9.10) would be adhered to by SEP and/or DEP operation and maintenance vessels.

1249. Literature indicates that the majority of red-throated divers present will flush from approaching vessels at a distance of 1km or less (Bellebaum *et al.*, 2006; Jarrett *et al.*, 2018; Topping and Petersen, 2011). Fliessbach *et al.* (2019) stated that 95% of red-throated divers observed during their study elicited an escape response when approached by a vessel, with a mean escape distance of 750m (standard deviation 437m) and a maximum escape distance of 1,700m. Unidentified diver species were recorded flushing at distances of 2km from the survey vessel. On the balance of this information, 100% displacement at 2km from operation and maintenance vessels is considered to be appropriately precautionary.

1250. Information on the repopulation of areas by red-throated diver following displacement by vessels was identified from a single source (Burger *et al*., 2019). This suggested that birds may partially return into areas a vessel has passed through after around seven hours, though the displacement effect may be greater where faster vessels are concerned. Increasing the number of vessel transits through the transit corridor may result in birds being more frequently displaced, which potentially could have energetic consequences. That being said, it is clear that red-throated divers avoid shipping lanes within the Outer Thames Estuary SPA (Irwin *et al*., 2019), so it seems reasonable to assume that an increase in the number of vessel movements might cause birds to avoid the transit corridor altogether.

1251. The available evidence regarding red-throated diver displacement by operational OWFs suggests that there will be little or no impact on adult survival as a result of displacement, and that any impact would probably be undetectable at the population level. No evidence has been identified which supports the upper range of mortality effects for displaced birds currently advised by Natural England for displacement by operational OWFs (i.e. up to 10%), and a review of the available evidence indicates that a mortality rate of 1% is considered to appropriately precautionary (MacArthur Green, 2019a). It is assumed that these conclusions can also be applied to birds displaced by operation and maintenance vessels in the transit corridor between SEP and DEP and the Great Yarmouth base that overlaps with the Outer Thames Estuary SPA.

1252. Including a 2km buffer, the transit corridor used by the SOW and DOW operation and maintenance vessels occupies 38.34km^2 of the Outer Thames Estuary SPA, or approximately 1% of the total habitat within the SPA boundary. The abundance of birds within the transit corridor (calculated from mean modelled density estimates from the 2013 and 2019 surveys (Goodship *et al*., 2015; Irwin *et al*., 2019)) is presented in **Table 9-82**, along with the percentage of the total Outer Thames Estuary SPA population estimated to be present within the transit corridor.

Table 9-82: Red-Throated Diver Abundance within Operation and Maintenance Vessel Transit Corridor Overlapping Outer Thames Estuary SPA, and Abundance Across Entire SPA During Four Most Recent Surveys of Outer Thames Estuary SPA

Parameter	2013 Survey 1	2013 Survey 2	2019 Survey 1	2019 Survey 2
DOW/SOW/DEP/SEP transit corridor abundance	111	13	5	57
Outer Thames Estuary SPA abundance[1]	10,703	12,735	10,148	22,280

Parameter	2013 Survey 1	2013 Survey 2	2019 Survey 1	2019 Survey 2
% of SPA population within transit corridor	1.04%	0.10%	0.05%	0.26%
Estimated mortality due to displacement from transit corridor[2]	1.11	0.13	0.05	0.57
% increase in existing mortality[3]	0.05	0.00	0.00	0.01
Notes 1. The overall SPA population estimates for the 2013 surveys was calculated from the density surface model data. For the 2019 surveys, SPA population estimates were taken from the report 2. Assumes a mortality rate of 1% of birds displaced from the transit corridor 3. Background population of second row in this table, adult age class annual mortality rate of 22.8% (Horswill and Robinson, 2015)				

1253. Assuming a mortality rate of 1% of displaced birds, up to 1.11 birds could be lost to the population based on the available survey data, which could represent an increase in existing mortality within the Outer Thames Estuary SPA population of up to 0.05%. However, data from the other three surveys that were available suggested the effect might be smaller. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. It is possible that birds may be displaced slightly more frequently as a result of the increase in vessel traffic. However, red-throated diver is considered to be a mobile species, and no evidence has been identified to suggest that a relatively modest increase in vessel movements would result in the conservation objectives for the SPA not being met.

1254. It could also be argued that since this impact might already be occurring due to the activities of vessels associated with SOW and DOW (and impacts attributed to these vessels only may be smaller than suggested above due to the ongoing effects of other vessels within the transit corridor), the actual impact that results from operation and maintenance activities of vessels associated with SEP and DEP in the Outer Thames Estuary SPA is very low.

1255. **It is concluded that predicted red-throated diver mortality due to operational phase displacement within the operation and maintenance vessel transit corridor of SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Outer Thames Estuary SPA.**

1256. The confidence in the assessment is high. The evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. In addition, the data on which the assessment is based, are the best available and are considered to be up to date.

1257. A number of best practice measures will be implemented regarding the operation and maintenance of SEP and DEP. These measures will minimise the potential impacts of vessels on red-throated diver. These are secured through the **Outline PEMP** (document reference 9.10) and include:

- Avoiding and minimising maintenance vessel traffic, where possible, during the most sensitive time period in October to March (inclusive);
- Restricting vessel movements where possible to existing navigation routes (where the densities of red-throated divers are typically relatively low);
- As far as possible maintaining direct transit routes (to minimise transit distances through areas used by red-throated diver), where it is necessary to go outside of established navigational routes, avoid rafting birds either en-route to the wind farm sites from port and/or within the wind farm sites (dependent on location) and where possible avoid disturbance to areas with consistently high diver density;
- Avoidance of over-revving of engines (to minimise noise disturbance); and
- Briefing of vessel crew on the importance of the species and the associated mitigation measure through tool box talks.

9.5.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.5.3.1.5.1 Operational Phase Displacement/Barrier Effects due to Operation and Maintenance Vessel Activity

1258. The in-combination effect of operation and maintenance vessel activity on Outer Thames Estuary SPA red-throated divers was considered in the Appropriate Assessments for the East Anglia One North and Two OWFs (BEIS, 2022a, 2022b).

1259. For both OWFs, the developer committed to a Bird Protection Plan (BPP) to minimise disturbance to red-throated divers from vessels. Natural England confirmed that it was satisfied that the BPP provided appropriate best practice to mitigate disturbance from vessels transiting the SPA.

1260. The Examining Authority was content that that an adverse effect on the red-throated diver feature of the SPA from disturbance and displacement effects arising from vessel traffic associated with site maintenance (operation) could be ruled out in-combination with other projects. The Secretary of State was content that that an AEoI of the SPA from disturbance and displacement of red-throated divers arising from offshore cable laying activities (construction) and from vessel traffic associated with site maintenance (operation) could be ruled out in-combination with other projects.

1261. The small impact resulting from the DOW/SOW/DEP/SEP transit corridor is already occurring due to the activities of vessels associated with SOW and DOW (and other vessels active within the transit corridor, which overlaps with a navigational approach to Great Yarmouth). It is therefore the case the potential impact that results from larger numbers of operation and maintenance activities within the transit corridor that overlaps the Outer Thames Estuary SPA due to SEP and DEP could be close to zero.

1262. **It is concluded that predicted red-throated diver mortality due to operational phase displacement within the operation and maintenance vessel transit**

corridor of SEP, DEP and SEP and DEP together, in-combination with similar activities associated with other OWFs, would not adversely affect the integrity of the Outer Thames Estuary SPA.

1263. The confidence in the assessment is high. The evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, those selected are considered to be sufficiently precautionary based on expert opinion. The conclusion of the assessment is the same irrespective of whether the mean, 95% upper CI or maximum densities are used to calculate potential mortality and increases in the baseline mortality rate of the background population. In addition, the data on which the assessment is based, are the best available and are considered to be up to date.

9.6 Breydon Water SPA and Ramsar Site

9.6.1 Description of Designation

1264. Breydon Water SPA and Ramsar site consists of an inland tidal estuary with extensive areas of mudflats. These are exposed at low tide and represent the only intertidal flats occurring on the east coast of Norfolk. Also protected are a mosaic of small areas of saltmarsh, reedbeds and brackish water communities in the surrounding borrow dykes, which support considerable botanical and invertebrate interest.

1265. Large numbers of wildfowl and waders spend the non-breeding season at the site, presumably attracted by the abundant food supply.

9.6.2 Conservation Objectives

1266. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.6.3 Appropriate Assessment

1267. As this is a designated site for non-breeding birds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1268. The list of species considered is presented in **Table 5-2**, and again in **Table 9-83**. The latter provides information on whether qualifying features are listed as features on the SPA citation (English Nature, 2000), Ramsar site citation (JNCC, 2000), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022a). Any species occurring on the citation, but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.6.3.1 All Qualifying Migratory Waterbird Features

9.6.3.1.1 Status

1269. The status of each qualifying feature screened into the Appropriate Assessment is presented in **Table 9-83**. This consists of the site population at designation, 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and national population in 2012 (Wright *et al*., 2012).

9.6.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1270. All qualifying features of this designated site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. Other than golden plover and lapwing, the qualifying features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP. However, it is recognised that the qualifying features may pass through the habitat in SEP and DEP during migration periods, and may have been missed by the surveys.

1271. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the Great Britain populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.6.3.1.3 Potential Effects on the Qualifying Features

1272. The qualifying features of this designated site have been screened into the Appropriate Assessment due to the potential risk of collision.

1273. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.6.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.6.3.1.4.1 Collision Risk

1274. The estimated annual collision risk for of each qualifying feature from this designated site for SEP and DEP together, along with the conclusion of the assessment based on this annual collision rate, is presented in **Table 9-83**. An avoidance rate of 0.980 has been assumed for all species.

1275. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1276. **It is concluded that the predicted mortality of all qualifying features due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Breydon Water SPA and Ramsar site.**

1277. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

Table 9-83: Information to inform the Appropriate Assessment for Breydon Water SPA and Ramsar site (SEP and DEP together)

Qualifying feature	SPA population (citation)	Ramsar site population (citation)	Five year peak mean 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Avocet (SPA)	33	33	1,385	7,500	0.0004	No. Numbers of collisions so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Bewick's swan (SPA and Ramsar site)	391	391	78	7,380	0.014	
Golden plover (SPA)	5,040	5,040	23,086	400,000	0.055	
Lapwing (SPA and Ramsar site)	24,940	24,940	13,190	465,000	0.304	
Ruff (SPA)	15	54	15	800	0.0001	
Waterbird assemblage (SPA and Ramsar site)	43,225	43,225	101,160	-	-	No. Based on the small number of collisions predicted for named qualifying features, no adverse effect on integrity is anticipated.

9.6.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.6.3.1.5.1 Collision Risk

1278. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying features from this designated site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other OWFs in UK waters. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1279. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Breydon Water SPA and Ramsar site.**

9.7 The Wash SPA and Ramsar Site

9.7.1 Description of Designation

1280. The Wash SPA and Ramsar site is composed of tidal rivers, estuaries, lagoons, mud and sand flats and, in the centre, deep channels surrounded by shallower waters. These areas predominantly consist of saltmarsh, intertidal banks of sand and mud, sandy and shingle beaches and subtidal sandy sediments.

1281. Shallow coastal waters support small fish which are preyed upon by tern species. A range of habitats are present within and adjacent to the site that serve as foraging or roosting habitat for a wide range of non-breeding waterbird species. These include intertidal mud and sand flats (which support a variety of algae, polychaete worms and bivalve molluscs including cockle and mussel beds), saltmarsh, bordering agricultural land and pasture, sandy, shingle and gravel beaches, as well as the riverine habitats of the River Nene and River Ouse.

9.7.2 Conservation Objectives

1282. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.7.3 Appropriate Assessment

1283. As this is a designated site for non-breeding birds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1284. The list of species considered is presented in **Table 5-2** and again in **Table 9-84**. The latter provides information on whether qualifying features are listed as features on the SPA citation (Natural England, 2006), Ramsar site citation (JNCC, 2005), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022a). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.7.3.1 All Qualifying Migratory Waterbird Features

9.7.3.1.1 Status

1285. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-84**. This consists of the site population at designation, the 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and the national population in 2012 (Wright *et al*., 2012).

9.7.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1286. All qualifying features of this site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. Common scoter, golden plover, knot, lapwing, oystercatcher and shelduck were all recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP, and it is recognised these may have originated from the respective SPA and/or Ramsar site populations. It is also recognised that other qualifying features may pass through the habitat in SEP and DEP during migration seasons and may have been missed by the surveys.

1287. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the GB populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.7.3.1.3 Potential Effects on the Qualifying Features

1288. The qualifying features of this site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1289. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.7.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.7.3.1.4.1 *Collision Risk*

1290. The estimated annual collision rate for each qualifying feature of this designated site is presented in **Table 9-84** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and DEP together and assuming an avoidance rate of 0.980 for all features.

1291. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1292. **It is concluded that the predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together would not adversely affect the integrity of The Wash SPA and Ramsar site.**

1293. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.7.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.7.3.1.5.1 Collision Risk

1294. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1295. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of The Wash SPA and Ramsar site.**

Table 9-84: Information to Inform Appropriate Assessment for The Wash SPA and Ramsar Site (SEP and DEP)

Qualifying feature	SPA population (citation)	Ramsar site population (citation)	Five-year peak mean; 2014/15 to 2018/19	GB population (Wright *et al.*, 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Bar-tailed godwit (SPA)	8,200	-	18,579	54,280	0.081	No. Numbers of collisions are so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Bewick's swan (SPA and Ramsar site)	130	16,546	5	7,380	0.005	
Black-tailed godwit (SPA and Ramsar site)	260	6,849	7,805	56,880	0.002	
Common scoter (SPA)	830	-	1,342	123,190	0.009	
Curlew (SPA and Ramsar site)	3,700	9,438	6,653	191,650	0.001	
Dark-bellied brent goose (SPA and Ramsar site)	17,000	20,861	13,545	91,000	0.312	
Dunlin (SPA and Ramsar site)	29,000	36,600	27,258	438,480	0.270	
Gadwall (SPA)	128	-	128	25,630	0.001	
Goldeneye (SPA)	74	-	74	29,665	0.000	
Golden plover (Ramsar site)	-	22,033	13,421	400,000	0.239	
Grey plover (SPA and Ramsar site)	9,132	13,129	9,132	49,315	0.080	
Knot (SPA and Ramsar site)	7,500	68,987	177,869	338,970	0.063	

Qualifying feature	SPA population (citation)	Ramsar site population (citation)	Five-year peak mean; 2014/15 to 2018/19	GB population (Wright *et al.*, 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Lapwing (Ramsar site)	-	46,422	11,483	465,000	0.565	
Oystercatcher (SPA and Ramsar site)	24,000	15,616	20,471	320,000	0.220	
Pink-footed goose (SPA and Ramsar site)	7,300	29,099	34,211	360,000	0.073	
Pintail (SPA)	1,700	-	458	30,235	0.010	
Redshank (SPA and Ramsar site)	4,331	6,373	5,239	400,000	0.045	
Ringed plover (Ramsar site)	-	1,500	1,291	34,000	0.008	
Sanderling (SPA and Ramsar site)	500	3,505	9,052	22,680	0.004	
Shelduck (SPA and Ramsar site)	16,000	9,746	2,250	75,610	0.098	
Turnstone (SPA)	980	-	809	59,810	0.008	
Wigeon (SPA)	3,900	-	12,172	522,370	0.021	
Waterbird assemblage (SPA)	214,000	-	381,498	-	-	No. Based on the small number of collisions predicted for named qualifying features, no adverse effect on integrity is anticipated.

9.8 Gibraltar Point SPA and Ramsar Site

9.8.1 Description of Designation

1296. Gibraltar Point SPA and Ramsar site is an actively accreting dune system which forms extensive sand dunes on the Lincolnshire Coast. It is the north-eastern most part of The Wash. Due to continued deposition of sediment and the shelter provided by wide beaches and sand flats, the site supports extensive and well-developed saltmarsh. Extensive areas of intertidal mud and sand support high densities of marine invertebrates, such as molluscs. There are also freshwater pools, freshwater marshland and grassland, some of which is grazed. These habitats provide key feeding and roosting habitats for internationally important populations of wading birds.

9.8.2 Conservation Objectives

1297. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.8.3 Appropriate Assessment

1298. As this is a designated site for non-breeding birds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1299. The list of species considered is presented in **Table 5-2** and again in **Table 9-85**. The latter provides information on whether qualifying features are listed as features on the SPA citation (English Nature, 1996b), Ramsar site citation (JNCC, 2008b), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.8.3.1 All Qualifying Migratory Waterbird Features

9.8.3.1.1 Status

1300. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-85**. This consists of the site population at designation, 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and national population in 2012 (Wright *et al*., 2012).

9.8.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1301. All qualifying features of this designated site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. The qualifying features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP. However, it is recognised that the qualifying features may pass through the habitat in SEP and DEP during migration seasons and may have been missed by the surveys.

1302. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the Great Britain populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.8.3.1.3 Potential Effects on the Qualifying Features

1303. The qualifying features of this designated site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1304. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.8.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.8.3.1.4.1 Collision Risk

1305. The estimated annual collision rate for each qualifying feature of this designated site is presented in **Table 9-85** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and DEP together and assuming an avoidance rate of 0.980 for all features.

1306. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1307. **It is concluded that the predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together would not adversely affect the integrity of Gibraltar Point SPA and Ramsar site.**

1308. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.8.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.8.3.1.5.1 Collision Risk

1309. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this designated site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1310. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of Gibraltar Point SPA and Ramsar site.**

Table 9-85: Information to Inform Appropriate Assessment for Gibraltar Point SPA and Ramsar Site (SEP and DEP)

Qualifying feature	SPA population (citation)	Ramsar site population (citation)	Five-year peak mean; 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Bar-tailed godwit (SPA and Ramsar site)	8,800	10,000	Unavailable	54,280	0.087	No. Numbers of collisions are so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Dark-bellied brent goose (Ramsar site)	-	3,000	Unavailable	91,000	0.055	
Grey plover (SPA and Ramsar site)	3,980	3,000	Unavailable	49,315	0.035	
Sanderling (SPA and Ramsar site)	1,140	2,300	Unavailable	22,680	0.009	
Waterbird assemblage (Ramsar site)	-	20,000	-	-	-	No. Based on the small number of collisions predicted for named qualifying features, no adverse effect on integrity is anticipated.

9.9 Humber Estuary SPA and Ramsar Site

9.9.1 Description of Designation

1311. The Humber Estuary SPA and Ramsar site is located on the east coast of England and comprises extensive wetland and coastal habitats. The inner estuary supports extensive areas of reedbed, with areas of mature and developing saltmarsh backed by grazing marsh in the middle and outer estuary. On the north Lincolnshire coast, the saltmarsh is backed by low sand dunes with marshy slacks and brackish pools. The estuary supports important numbers of waterbirds (especially geese, ducks and waders) during the migration periods and in winter.

9.9.2 Conservation Objectives

1312. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.9.3 Appropriate Assessment

1313. As this is a designated site for non-breeding birds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1314. The list of species considered is presented in **Table 5-2** and again in **Table 9-86**. The latter provides information on whether qualifying features are listed as features on the SPA citation (Natural England, 2007), Ramsar site citation (JNCC, 2007), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.9.3.1 All Qualifying Migratory Waterbird Features

9.9.3.1.1 Status

1315. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-86**. This consists of the site population at designation, 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and national population in 2012 (Wright *et al*., 2012).

9.9.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1316. All qualifying features of this site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. Golden plover, knot and shelduck were recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP, and it is recognised that these may have originated from the SPA / Ramsar populations. It is also recognised that other qualifying features may pass through the habitat in SEP and DEP during migration seasons and may have been missed by the surveys.

1317. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the Great Britain populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.9.3.1.3 Potential Effects on the Qualifying Features

1318. The qualifying features of this designated site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1319. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al,* 2012).

9.9.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.9.3.1.4.1 Collision Risk

1320. The estimated annual collision rate for each qualifying feature of this designated site is presented in **Table 9-86** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and DEP together and assuming an avoidance rate of 0.980 for all features.

1321. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1322. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Humber Estuary SPA and Ramsar site.**

1323. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.9.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.9.3.1.5.1 Collision Risk

1324. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1325. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of Humber Estuary SPA and Ramsar site.**

Table 9-86: Information to Inform Appropriate Assessment for Humber Estuary SPA and Ramsar Site (SEP and DEP)

Qualifying Feature	SPA population (citation)	Ramsar site population (citation)	Five-year peak mean; 2014/15 to 2018/19	GB population (Wright *et al.*, 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Avocet (SPA)	59	-	2,187	7,500	0.001	No. Numbers of collisions so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Bar-tailed godwit (SPA and Ramsar site)	2,752	2,752	1,331	54,280	0.027	
Bittern (SPA)	4	-	3	600	0.000	
Black-tailed godwit (SPA and Ramsar site)	1,113 wintering, 915 passage	1,113	3,662	56,880	0.009	
Dunlin (SPA and Ramsar site)	22,222 wintering, 20,269 passage	22,222	15,941	438,480	0.207	
Golden plover (SPA and Ramsar site)	30,709	30,709	32,113	400,000	0.334	
Knot (SPA and Ramsar site)	28,165 wintering, 18,500 passage	28,165	22,500	338,970	0.235	
Redshank (SPA and Ramsar site)	4,632 wintering, 7,462 passage	4,632	3,058	400,000	0.048	
Ruff (SPA)	128	-	82	800	0.001	
Shelduck (SPA and Ramsar site)	4,464	4,464	4,687	75,610	0.027	
Waterbird assemblage (SPA and Ramsar site)	153,934	153,934	140,188	-	-	No. Based on the small number of collisions predicted for named qualifying features, no adverse effect on integrity is anticipated.

9.10 Broadland SPA and Ramsar Site

9.10.1 Description of Designation

1326. The Broadland SPA and Ramsar site is a low-lying wetland complex located in eastern England. The Broads are a series of flooded medieval peat cuttings, lying within the floodplains of five principal river systems, known as Broadland. The area includes the river valley systems of the Bure, Yare and Waveney and their major tributaries. The distinctive open landscape comprises a complex and interlinked mosaic of wetland habitats including open water, reedbeds, carr woodland, grazing marsh, tall herb fen, transition mire and fen meadow, forming one of the finest marshland complexes in the UK. The differing types of management of the vegetation for reed, sedge and marsh hay, coupled with variations in hydrology and substrate, support an extremely diverse range of plant communities.

1327. The area is of international importance for a variety of wintering and breeding raptors and waterbirds associated with extensive lowland marshes. The estuary at the mouth of Broadland is Breydon Water SPA and Ramsar site, and the two sites adjoin each other at Halvergate Marshes. Breeding and wintering raptors, and wintering waterbirds spend time on feeding areas outside the site boundary.

9.10.2 Conservation Objectives

1328. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.10.3 Appropriate Assessment

1329. As this is a designated site for non-breeding waterbirds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1330. The list of species considered is presented in **Table 5-2** and again in **Table 9-87**. The latter provides information on whether qualifying features are listed as features on the SPA citation (English Nature, 1998a), Ramsar site citation (JNCC, 2008c), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying

'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.10.3.1 All Qualifying Migratory Waterbird Features

9.10.3.1.1 Status

1331. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-87**. This consists of the site population at designation, the 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and the national population in 2012 (Wright *et al*., 2012).

9.10.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1332. All qualifying features of this site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. The qualifying features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP. However, it is recognised that the qualifying species may pass through the habitat in SEP and DEP during migration seasons and may have been missed by the surveys.

1333. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the GB populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.10.3.1.3 Potential Effects on the Qualifying Features

1334. The qualifying features of this site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1335. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.10.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.10.3.1.4.1 Collision Risk

1336. The estimated annual collision rate for each qualifying feature of this designated site is presented in **Table 9-87** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and DEP together and assuming an avoidance rate of 0.980 for all features.

1337. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1338. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Broadland SPA and Ramsar site.**

1339. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.10.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.10.3.1.5.1 Collision Risk

1340. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this designated site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1341. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of the Broadland SPA and Ramsar site.**

Table 9-87: Information to Inform Appropriate Assessment for Broadland SPA and Ramsar Site (SEP and DEP)

Qualifying Feature	SPA population (citation)	Ramsar Site population (citation)	Five-year peak mean; 2014/15 to 2018/19	GB population (Wright *et al.*, 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Bewick's swan (SPA and Ramsar site)	495	495	Unavailable	7,380	0.018	No. Numbers of collisions so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Gadwall (SPA and Ramsar site)	486	486	Unavailable	25,630	0.003	
Ruff (SPA)	96	-	Unavailable	800	0.001	
Shoveler (SPA and Ramsar site)	675	675	Unavailable	20,545	0.004	
Whooper swan (SPA)	121	-	Unavailable	23,730	0.004	
Wigeon (SPA and Ramsar site)	8,966	8,966	Unavailable	522,370	0.048	

9.11 Ouse Washes SPA and Ramsar Site

9.11.1 Description of Designation

1342. The Ouse Washes SPA and Ramsar Site is a wetland of major international importance comprising seasonally flooded washlands which are agriculturally managed in a traditional manner. It provides breeding and winter habitats for important assemblages of wetland bird species, particularly wildfowl and waders.

9.11.2 Conservation Objectives

1343. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features.;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.11.3 Appropriate Assessment

1344. As this is a designated site for non-breeding waterbird species located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1345. The list of species considered is presented in **Table 5-2** and again in **Table 9-88**. The latter provides information on whether qualifying features are listed as features on the SPA citation (English Nature, 1996c), Ramsar site citation (JNCC, 2008d), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.11.3.1 All Qualifying Migratory Waterbird Features

9.11.3.1.1 Status

1346. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-88**. This consists of the site population at designation, the 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and the national population in 2012 (Wright *et al*., 2012).

9.11.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1347. All qualifying features of this designated site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. The qualifying features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP. However, it is recognised that the qualifying species may pass through the habitat in SEP and DEP during migration seasons and may have been missed by the surveys

1348. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the GB populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.11.3.1.3 Potential Effects on the Qualifying Features

1349. The qualifying features of this site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1350. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.11.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.11.3.1.4.1 Collision Risk

1351. The estimated annual collision risk for each qualifying feature of this designated site is presented in **Table 9-88** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and DEP together and assuming an avoidance rate of 0.980 for all features.

1352. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1353. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, would not adversely affect the integrity of the Ouse Washes SPA and Ramsar site.**

1354. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.11.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.11.3.1.5.1 Collision Risk

1355. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1356. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of the Ouse Washes SPA and Ramsar site.**

Table 9-88: Information to Inform Appropriate Assessment for the Ouse Washes SPA and Ramsar Site (SEP and DEP)

Qualifying Feature	SPA population (citation)	Ramsar Site population (citation)	Five year peak mean; 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Bewick's swan (SPA and Ramsar site)	4,980	1,140	1,911	7,380	0.177	No. Numbers of collisions so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Black-tailed godwit (SPA)	52	2,647 (future inclusion)	2,972	56,880	0.022 (Ramsar site citation figure used)	
Gadwall (SPA and Ramsar site)	222 breeding, 320 wintering	438 wintering	712	25,630	0.002	
Garganey (SPA)	28	-	2	-	-	This species breeds in the UK in very small numbers and is not included in Wright *et al* (2012). On the basis that adverse effects on integrity have not been identified for other duck species, it is presumed the same applies to garganey.

Qualifying Feature	SPA population (citation)	Ramsar Site population (citation)	Five year peak mean; 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Pintail (SPA and Ramsar site)	1,450	2,108	809	30,235	0.008	
Pochard (SPA)	2,100	4,678	2,643	75,780	0.002	
Ruff (SPA)	57	-	90	800	0.000	
Shoveler (SPA and Ramsar site)	750	627	1,009	20,545	0.004	
Teal (SPA and Ramsar site)	4,100	3,384	7,972	255,010	0.021	
Whooper swan (SPA and Ramsar site)	590	653	8,063	23,730	0.021	
Wigeon (SPA and Ramsar site)	38,000	22,630	23,268	522,370	0.204	
Waterbird assemblage (SPA and Ramsar site)	60,950	59,133	73,225	-	-	No. Based on the small number of collisions predicted for named qualifying features, no adverse effect on integrity is anticipated.

9.12 Minsmere-Walberswick SPA and Ramsar Site

9.12.1 Description of Designation

1357. Minsmere-Walberswick SPA and Ramsar Site lies on the Suffolk coast between Southwold and Sizewell. It contains a mosaic of habitat that support a wide range of qualifying bird species. There are extensive areas of freshwater and coastal grazing marsh, coastal reedbeds, saltmarsh, lowland heathland, woodland, intertidal mud and mixed sediment within the site boundary.

1358. During severe winter weather Minsmere-Walberswick SPA and Ramsar Site can assume even greater national and international importance as wildfowl and waders from many other areas arrive, attracted by relatively mild climate, compared with continental areas, and the abundant food resources available.

9.12.2 Conservation Objectives

1359. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.12.3 Appropriate Assessment

1360. As this is a designated site for non-breeding birds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1361. The list of species considered is presented in **Table 5-2** and again in **Table 9-89**. The latter provides information on whether qualifying features are listed as features on the SPA citation (English Nature, 1998b), Ramsar site citation (JNCC, 2008e), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.12.3.1 All Qualifying Migratory Waterbird Features

9.12.3.1.1 Status

1362. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-89**. This consists of the site population at designation, the 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and the national population in 2012 (Wright *et al*., 2012).

9.12.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1363. All qualifying features of this site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. The qualifying waterbird features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP. However, it is recognised that the qualifying species may pass through in SEP and DEP during migration seasons and may have been missed by the surveys.

1364. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the GB populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.12.3.1.3 Potential Effects on the Qualifying Features

1365. The qualifying features of this site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1366. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.12.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.12.3.1.4.1 Collision Risk

1367. The estimated annual collision risk for each qualifying feature of this designated site is presented in **Table 9-89** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and DEP together and assuming an avoidance rate of 0.980 for all features.

1368. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1369. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Minsmere-Walberswick SPA and Ramsar site.**

1370. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.12.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.12.3.1.5.1 Collision Risk

1371. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1372. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of the Minsmere-Walberswick SPA and Ramsar site.**

Table 9-89: Information to Inform Appropriate Assessment for the Minsmere-Walberswick SPA and Ramsar Site (SEP and DEP)

Qualifying feature	SPA population (citation)	Ramsar Site population (citation)	Five year peak mean; 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Avocet (SPA)	Not quantified	329	186	7,500	0.004 (Ramsar site citation figure used)	No. Numbers of collisions so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
European white-fronted goose (SPA)	67	-	3	2,400	0.001	
Gadwall (SPA)	48 breeding	261	281	25,630	0.002 (Ramsar site citation figure used)	
Shoveler (SPA)	46 breeding	238	192	20,545	0.001 (Ramsar site citation figure used)	
Teal (SPA)	146 breeding, not quantified in winter	3,083	1,358	255,010	0.016 (Ramsar site citation figure used)	

9.13 Nene Washes SPA and Ramsar Site

9.13.1 Description of Designation

1373. The Nene Washes SPA is an area of seasonally flooding grassland and grazing marsh in the lower reaches of the River Nene in Cambridgeshire. It contains habitats important for a variety of non-breeding waterbirds.

1374. During severe winter weather elsewhere, the Nene Washes can assume even greater national and international importance as wildfowl and waders from many other areas arrive, attracted by the relatively mild climate, compared with continental European areas, and the abundant food resources available. It can also assume greater importance at times during deep flooding on the nearby Ouse Washes when it holds displaced birds.

9.13.2 Conservation Objectives

1375. The site's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.13.3 Appropriate Assessment

1376. As this is a designated site for non-breeding birds located within 100km of SEP and DEP, all qualifying migratory waterbird features of the site are considered in the Appropriate Assessment.

1377. The list of species considered is presented in **Table 5-2** and again in **Table 9-90**. The latter provides information on whether qualifying features are listed as features on the SPA citation (English Nature, 1992), Ramsar site citation (JNCC, 2008f), or both. The SPA citation was checked against Natural England's online designated sites resource (Natural England, 2022). Any species occurring on the citation but not the online resource have not been included in the assessment. For the Ramsar site, the qualifying interest features listed are those which are identified as qualifying 'Ramsar criteria' in the *Information Sheet on Ramsar Wetlands*. Other 'noteworthy flora and fauna' are not included as qualifying interest features of the Ramsar site.

9.13.3.1 All Qualifying Migratory Waterbird Features

9.13.3.1.1 Status

1378. The status of each qualifying feature screened into the Appropriate Assessment for this site is presented in **Table 9-90**. This consists of the site population at designation, the 2014/15 to 2018/19 peak mean count (Frost *et al*., 2020) and the national population in 2012 (Wright *et al*., 2012).

9.13.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1379. All qualifying features of this site have been screened into the Appropriate Assessment due to the risk of potential impacts occurring during the spring and autumn migration seasons. The qualifying waterbird features were not recorded in the aerial survey study area during the baseline surveys undertaken at SEP and DEP. However, it is recognised that the qualifying species may pass through habitat in SEP and DEP during migration seasons and may have been missed by the surveys.

1380. The apportioning of impacts to this designated site was calculated for each qualifying feature by dividing the number of collisions calculated at the national level by the proportion of the national population that were members of the designated site population at citation. The numbers used to define the national populations were the GB populations presented in Wright *et al.* (2012). Designated site populations were obtained from the SPA citation, or the Ramsar site population if the SPA citation did not include a population estimate.

9.13.3.1.3 Potential Effects on the Qualifying Features

1381. The qualifying features of this site have been screened into the Appropriate Assessment due to the potential risk of collision during the spring and autumn migration seasons.

1382. The magnitude of potential collision impacts have been investigated using the SOSSMAT tool (Wright *et al*., 2012).

9.13.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.13.3.1.4.1 Collision Risk

1383. The estimated annual collision rate for each qualifying feature of this designated site is presented in **Table 9-90** along with the conclusion of the assessment based on this estimated collision rate. The estimated collision rate has been calculated based on operation of both SEP and Dep together and assuming an avoidance rate of 0.980 for all features.

1384. The number of annual collisions predicted for all qualifying features is very low. It is expected that the increases to existing mortality rates for each qualifying feature due to collisions would be undetectable within the site populations. Such impacts would consequently not result in any measurable effect.

1385. **It is concluded that the predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together would not adversely affect the integrity of the Nene Washes SPA and Ramsar site.**

1386. Whilst extensive information exists on the responses of waterbirds to onshore OWFs, there is substantial uncertainty regarding waterbird movements at sea. The confidence level assigned to this section of the assessment is therefore medium. However, since such low levels of collision are predicted, an adverse effect on the integrity of the site is considered highly unlikely even in the unlikely event that impacts have been underestimated.

9.13.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.13.3.1.5.1 Collision Risk

1387. The migration corridors identified by Wright *et al.* (2012) indicate that migration activity of all qualifying species from this designated site is widespread across UK waters. Similarly low numbers of birds, and hence collisions, are therefore expected at other UK OWFs. The total collision mortality of non-breeding waterbirds at all UK OWFs is still likely to be small in the context of their respective national populations, and the number of collisions associated with this designated site will be smaller still. It is expected that the increases to existing mortality rates for each qualifying feature due to this impact would be undetectable within the site population. Such impacts would consequently not result in any measurable effect.

1388. **It is concluded that predicted mortality of all qualifying features due to collision at SEP, DEP and SEP and DEP together, in combination with other projects, would not adversely affect the integrity of the Nene Washes SPA and Ramsar site.**

Table 9-90: Information to Inform Appropriate Assessment for the Nene Washes SPA and Ramsar Site (SEP and DEP)

Qualifying feature	SPA population (citation)	Ramsar Site population (citation)	Five-year peak mean; 2014/15 to 2018/19	GB population (Wright *et al*., 2012)	Predicted annual collisions (SEP and DEP together, avoidance rate 0.980)	Conclusion of adverse effect on site integrity
Bewick's swan (SPA and Ramsar site)	1,300	1,300	354	7,380	0.046	No. Numbers of collisions are so small that effects on population would be extremely small. It would not be possible for impacts of this magnitude to have an effect at the site level given the background populations.
Black-tailed godwit (SPA and Ramsar site)	32 breeding,	32	1,768 wintering	56,880	0.000	
Shoveler (SPA and Ramsar site)	72 breeding, 110 wintering	627	505	20,545	0.001	
Teal (SPA)	980	3,384	2,996	255,010	0.005	
Whooper swan (Ramsar site)	-	653	1,244	23,730	0.023	
Wigeon (SPA)	3,640	22,630	13,510	522,370	0.020	

9.14 Alde-Ore Estuary SPA and Ramsar Site

9.14.1 Description of Designation

1389. Situated on the east Suffolk coast, the Alde Ore Estuary and Ramsar site covers an estuary complex of the rivers Alde, Burley and Ore, including Havergate Island and Orfordness. The designated site supports a variety of habitats for breeding and wintering birds within its boundary, including vegetated shingle, intertidal mudflats, semi-improved grazing marsh, saltmarsh and saline lagoons.

9.14.2 Conservation Objectives

1390. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.14.3 Appropriate Assessment

1391. The only qualifying species screened into the Appropriate Assessment from this site is breeding lesser black-backed gull **Table 5-2**.

9.14.3.1 Lesser Black-Backed Gull

9.14.3.1.1 Status

1392. The SPA citation for the Alde-Ore Estuary does not provide a population estimate for lesser black-backed gull (English Nature, 1996d). The Seabird 2000 census recorded 5,790 apparently occupied nests at the site (JNCC, 2008g). The most recent count for Havergate Island is 1,670 pairs in 2019, or 3,340 breeding adults (JNCC, 2022). The baseline annual mortality of this population, assuming an adult mortality rate of 11.5% (Horswill and Robinson, 2015), is 384 birds.

1393. For lesser black-backed gull, the supplementary advice on the conservation objectives are:

- Restore the size of the breeding population to a level which is above 14,074 whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent;
- Maintain safe passage of birds moving between nesting and feeding areas;
- Reduce the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed;

- Restrict predation and disturbance caused by native and non-native predators.
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System (www.apis.ac.uk);
- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised;
- Maintain the extent, distribution and availability of suitable habitat (either within or outside the site boundary) which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at levels described in site specific supporting notes;
- Maintain the distribution, abundance and availability of key food and prey items (e.g. voles, small seabirds, waders, sandeel, sprat, cod, herring, roach, rudd, beetles, flies, earthworm, shellfish) at preferred sizes. The availability of an abundant food supply is critically important for successful breeding, adult fitness and survival and the overall sustainability of the population;
- Maintain the extent and distribution of predominantly medium to tall (i.e. 20-60 cm) grassland swards;
- Reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels;
- Maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features, avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.14.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1394. SEP and DEP are situated approximately 114km and 120km respectively from Havergate Island, the breeding location for lesser black-backed gull within the Alde-Ore Estuary SPA, at the nearest point. The mean maximum foraging range of lesser black-backed gull is 127km (±109km) and the maximum foraging range is 533km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of lesser black-backed gull from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 141km (±51km) based on data from three sites. The updated review of Woodward *et al.* (2019), based on 18 sites, gives a smaller mean maximum foraging range.

1395. SEP and DEP are therefore just within the mean maximum foraging range of lesser black-backed gull from the Alde-Ore Estuary SPA. However, large parts of both OWFs are beyond the mean maximum foraging range, though they are within the mean maximum foraging range plus one standard deviation, and the maximum foraging range for this species from this SPA. The latter two measurements are considered to be poor indicators of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity.

1396. Modelled at-sea distributions derived from tracking data during the breeding season (April to August) from breeding adult birds (Thaxter *et al*., 2015) indicate that SEP and DEP are outside the home foraging range (i.e. beyond the 95% utilisation distribution) of lesser black-backed gulls from the Alde-Ore Estuary SPA. This information does not mean that breeding adult lesser black-backed gulls from the Alde-Ore Estuary SPA will not be present at SEP and DEP during the breeding season. However, it does suggest that the majority of birds recorded on site during the breeding season are unlikely to be breeding adults from the SPA.

1397. SEP and DEP are not within foraging range of breeding lesser black-backed gulls from any other SPAs. However, there are several breeding locations for this species located on the north Norfolk coast, including Blakeney Point (latest count 10 nests in 2020), Holkham (latest count 5 nests in 2020), Berney Marshes (latest count 20 nests in 2019), Outer Trial Bank (latest count 1,294 nests in 2018) and Hunstanton town (latest count one nest in 2019) (JNCC, 2022). These breeding locations are all within 80km of SEP and DEP, which is a much shorter distance than birds breeding at the Alde-Ore Estuary SPA. It therefore seems likely based on the above foraging range and utilisation distributions that the majority of birds recorded at SEP and DEP during the breeding season are birds from these breeding colonies.

1398. During the pre and post breeding periods, breeding lesser black-backed gulls from the Alde-Ore Estuary SPA migrate through UK waters, whilst some birds remain in the UK during the winter. The relevant reference population is considered to be the UK North Sea and Channel BDMPS. This consists of 209,007 individuals during autumn migration (September to October), 39,314 individuals during winter (November to February) and 197,483 individuals during spring migration (March) (Furness, 2015).

1399. Estimates of the proportion of lesser black-backed gulls present at SEP and DEP which originate from the Alde-Ore Estuary SPA during the non-breeding season (and therefore the proportion of predicted mortalities from the SPA population) are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS during the season at which it is largest. During autumn migration, winter, and spring migration, 0.9%, 1.7%, and 1.0% of impacts are considered to affect birds from the SPA respectively (Furness, 2015).

9.14.3.1.3 Potential Effects on the Qualifying Feature

1400. The lesser black-backed gull qualifying feature of the Alde-Ore Estuary SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.14.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.14.3.1.4.1 Collision Risk

1401. Information to inform the Appropriate Assessment for collision risk on breeding adult lesser black-backed gulls belonging to the Alde-Ore Estuary SPA population is presented in **Table 9-91**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-92**. The avoidance rate used was 0.995, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1402. Based on the mean collision rates, the annual total of breeding adult lesser black-backed gulls from the Alde-Ore Estuary SPA at risk of collision at DEP is <0.01, and zero at SEP. This gives a combined total annual collision rate for SEP and DEP together of <0.01 Alde-Ore Estuary SPA breeding adult lesser black-backed gulls. This would increase the existing mortality of the SPA breeding population by 0.0003%.

1403. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. The small sample size of flying birds recorded across DEP as a whole (16 birds) means that any differences in encounter rate between DEP and DEP-N are highly unlikely to be statistically significant for this species. Therefore, the collision rates presented here are a reasonable representation of the worst case scenario for DEP.

Table 9-91: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Lesser Black-Backed Gull at SEP and DEP Apportioned to Alde-Ore Estuary SPA

Site	Variable		J[2]	F[2]	M[3]	A[4]	M[4]	J[4]	J[4]	A[4]	S[1]	O[1]	N[2]	D[2]	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable		J[2]	F[2]	M[3]	A[4]	M[4]	J[4]	J[4]	A[4]	S[1]	O[1]	N[2]	D[2]	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes

1. For autumn migration season (Sept-Oct), assumes 0.9% of birds present are Alde-Ore Estuary SPA breeders (Furness 2015)

2. For winter season (Nov-Feb), assumes 1.7% of birds present are Alde-Ore Estuary SPA breeders (Furness 2015)

3. For spring migration season (Mar), assumes 0.9% of birds present are Alde-Ore Estuary SPA breeders (Furness 2015)

4. For breeding season (Apr-Aug), assumes 0% of birds present are Alde-Ore Estuary SPA breeders based on relevant information in published literature

Table 9-92: Predicted Annual Breeding Season Collision Mortality for Breeding Adult Lesser Black-Backed Gull at SEP and DEP Apportioned to Alde-Ore Estuary SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase[1]
DEP	0.001 (0 - 0.007)	0.0003 (0 - 0.0017)
SEP	0	0
SEP and DEP	0.001 (0 - 0.007)	0.0003 (0 - 0.0017)
Notes 1. Background population is Alde-Ore Estuary SPA breeding adults (3,340 individuals), adult age class annual mortality rate of 11.5% (Horswill and Robinson, 2015)		

1404. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP, or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.0017% due to the collision impacts of SEP and DEP together.

1405. **It is concluded that predicted lesser black-backed gull mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Alde-Ore Estuary SPA and Ramsar.**

1406. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.14.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.14.3.1.5.1 Collision Risk

1407. The HRAs for the East Anglia One North and Two OWFs (BEIS, 2022a, 2022b) state that approximately 44 lesser black-backed gulls from the Alde-Ore Estuary SPA will be lost annually due to collision with OWFs.

1408. The conservation objectives for the Alde-Ore Estuary SPA requires the restoration of the lesser black-back gull population to the level for which it was designated. Any adverse impacts on the population are likely to prevent or delay the achievement of the objectives. For this reason, the HRAs for East Anglia One North and Two OWFs concluded that collision effects could undermine the conservation objectives for lesser black-backed gull. An adverse effect on the integrity of the Alde-Ore Estuary

SPA and Ramsar site from the effects of lesser black-backed gull collision mortality from the East Anglia One North and Two, in-combination with other projects, could therefore not be ruled out.

1409. The predicted annual collision rate of Alde-Ore Estuary SPA lesser black-backed gull at SEP and DEP together is 0.001 (mean collision rate), or 0.007 if the 95% upper CI collision rate is considered (**Table 9-92**). This means that time it would take for the impacts to add up to a single bird being lost through this impact would be 1,000 years in the case of the mean collision rate, or 143 years in the case of the upper 95% CI collision rate. Both of these time periods are considerably greater than the 40 year operational period of SEP and DEP. Given the extremely small magnitude of the predicted impact, it is considered that collision impacts at SEP and DEP do not contribute substantially to the in-combination impacts on this qualifying feature, and will not delay, or prevent the achievement of the conservation objectives.

1410. **It is concluded that predicted lesser black-backed gull mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Alde-Ore Estuary SPA and Ramsar.**

9.15 Flamborough and Filey Coast SPA

9.15.1 Description of Designation

1411. The Flamborough and Filey Coast SPA was designated in 2018. It is a geographical extension to the former Flamborough Head and Bempton Cliffs SPA, which was designated in 1993 (Natural England, 2018b).

1412. The SPA is located on the Yorkshire coast between Bridlington and Scarborough, and is composed of two sections. The northern section runs from Cunstone Nab to Filey Brigg, and the southern section from Speeton, around Flamborough Head, to South Landing. The seaward boundary extends 2km offshore and applies to both sections of the SPA.

1413. The predominantly chalk cliffs of Flamborough Head rise to 135m and have been eroded into a series of bays, arches, pinnacles and gullies. The cliffs from Filey Brigg to Cunstone Nab are formed from various sedimentary rocks including shales and sandstones. The adjacent sea out to 2km off Flamborough Head as well as Filey Brigg to Cunstone Nab is characterised by reefs supporting kelp forest communities in the shallow subtidal, and faunal turf communities in deeper water. The southern side of Filey Brigg shelves off gently from the rocks to the sandy bottom of Filey Bay. This site does not support any priority habitats or species (Natural England, 2018b).

1414. The coastal areas of the SPA cover cliffs supporting internationally important breeding populations of seabirds, the marine extension includes areas close to the colony used by seabirds for maintenance behaviours (loafing, preening etc).

9.15.2 Conservation Objectives

1415. The site's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.15.3 Appropriate Assessment

1416. All named qualifying species of this designated site have been screened into the Appropriate Assessment. These are breeding gannet, breeding kittiwake, breeding guillemot, and breeding razorbill (**Table 5-2**).

9.15.3.1 Gannet

9.15.3.1.1 Status

1417. Within the Flamborough and Filey Coast SPA, gannets nest along a 5km stretch of Bempton Cliffs. Numbers have increased steadily since the colony was established in the 1930's (Cramp *et al.*, 1974). Natural England (2020) gives counts of 3,940 pairs in 2004 and 7,859 in 2009, indicating that colony size more or less doubled over this period. JNCC (2022) indicates that on average, the colony has grown by 700 pairs each year between 2009 and 2017, and that on average, numbers have increased by just over 10% for the last thirty years. The growth rate of the population has increased since 2000, and there is potential for further increase because large numbers of sub-adult birds are associated with the colony (Langston *et al.*, 2013; Natural England, 2020). The colony counts between 1986 and 2017, along with a linear trend line, are presented in **Plate 9-3**. Between these years, the average annual increase in counts of apparently occupied nests was 12%. The average annual increase declined to 4% during the last five years for which counts were available (2012 to 2017). Despite this recent slowing of the growth rate, it seems quite clear that the breeding gannet population at the Flamborough and Filey Coast SPA is of FCS.

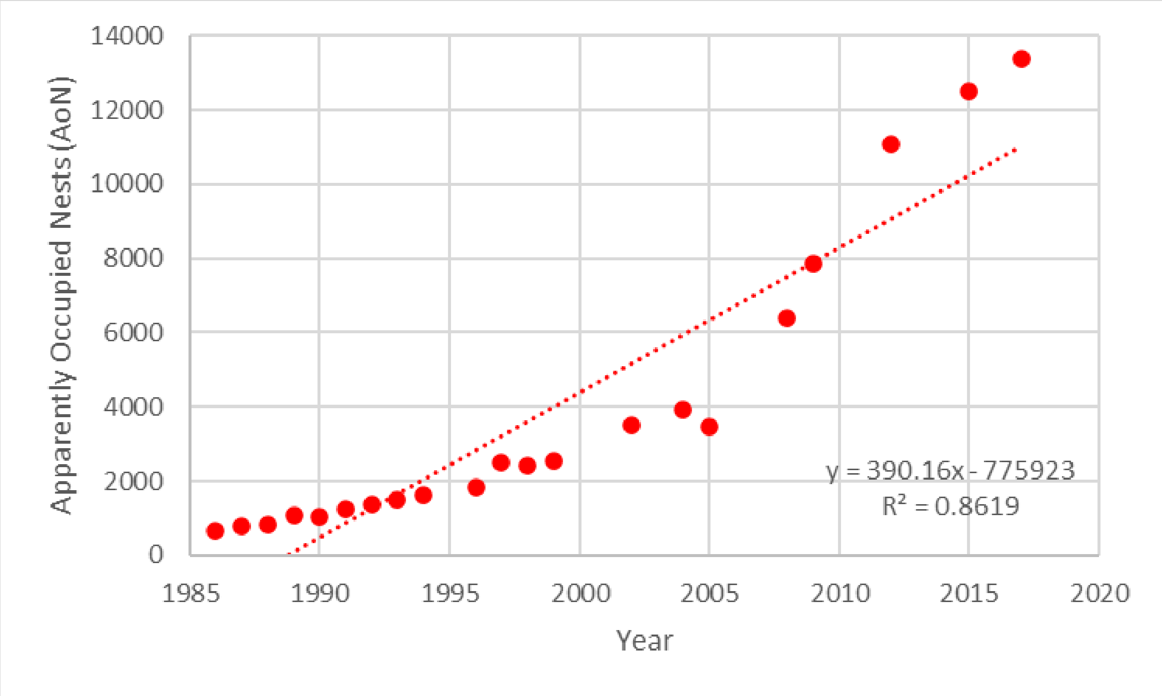

Plate 9-3: Gannet Counts (Apparently Occupied Nests) at the Flamborough and Filey Coast SPA between 1986 and 2017, with Linear Trendline

1418. The SPA breeding population at classification was 8,469 pairs or 16,938 breeding adults, for the period 2008 to 2012 (Natural England, 2018b). The most recent whole colony census, carried out in 2017, counted 13,392 pairs or 26,784 breeding adults (Aitken *et al.*, 2017). The latter estimate is considered the best available evidence for the gannet population of this designated site. Using the published adult mortality rate of 8.1% (Horswill and Robinson, 2015), 2,170 birds would be expected to die annually from the breeding adult population of 26,784 individuals.

1419. Supplementary advice on the conservation objectives were added for qualifying features of the Flamborough and Filey Coast SPA in 2020 (Natural England, 2020). For gannet, these are:

- Maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent;
- Maintain safe passage of birds moving between nesting and feeding areas;
- Restrict the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed;
- Restrict predation and disturbance caused by native and non-native predators;
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System;

- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised;
- Maintain the extent, distribution and availability of suitable breeding habitat which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at: current extent;
- Maintain the distribution, abundance and availability of key food and prey items (e.g. herring, mackerel, sprat, sandeel) at preferred sizes;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels;
- Maintain water quality and specifically mean winter dissolved inorganic nitrogen (DIN) at a concentration equating to High Ecological Status (specifically mean winter DIN is <12µM for coastal waters), avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.15.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1420. SEP and DEP are 112km and 116km respectively from the Flamborough and Filey Coast SPA boundary at the nearest point. The mean maximum foraging range of gannet is 315.2km (±194.2km), and the maximum foraging range is 709km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of gannet from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 229.4km (±124.3km) based on data from seven studies. The updated review of Woodward *et al*. (2019), based on data from 21 studies, gives a considerably larger mean maximum foraging range.

1421. Modelled at-sea utilisation distributions of breeding adult birds during the breeding season have been published, based on GPS tracking data (Langston *et al.*, 2013; Wakefield *et al.*, 2013). These suggest that SEP and DEP are not within the core foraging range. There is clearly connectivity between the SPA and SEP and DEP during the breeding season, but SEP, DEP and the habitats surrounding them may not be of particularly high importance to Flamborough and Filey Coast SPA breeding adult gannets during the breeding season.

1422. SEP and DEP are not within mean maximum foraging range of breeding gannets from any other SPA, although they are within maximum foraging range of breeding gannets at the Forth Islands SPA (390km) and the Fair Isle SPA (710km). Data presented by Wakefield *et al.* (2013) indicate that gannets breeding at the Forth Islands SPA are unlikely to occur within SEP and DEP during the breeding season. This is thought to be due to the distance between SEP and DEP, and the fact that the foraging ranges of gannets from different breeding colonies tend not to overlap. There is no modelled at-sea distribution data for gannets breeding at the Fair Isle SPA. Based on distance from SEP and DEP and the evidence for space-partitioning between colonies (Wakefield *et al*., 2013), it is considered that breeding gannets from the Fair Isle SPA are unlikely to regularly occur at SEP and DEP during the breeding season.

1423. Breeding adult gannets present at SEP and DEP during the full breeding season (March to September (Furness, 2015)) are therefore assumed to originate from the Flamborough and Filey Coast SPA, even though non-breeding adults from a range of breeding colonies are also likely to be present.

1424. In addition, some of the gannets recorded at SEP and DEP during the breeding season will be sub-adult birds. During the full breeding season, 703 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 320 birds were able to be assigned to an age class, and of these, 245 birds (76.6% of those assigned to an age class) were classified as adults. It is therefore assumed that this proportion of gannets recorded at SEP and DEP during the full breeding season are breeding adult birds from the Flamborough and Filey Coast SPA.

1425. Outside the breeding season breeding gannets, including those from the Flamborough and Filey Coast SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with gannets of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea and Channel BDMPS. This consists of 456,298 individuals during autumn migration (September to November), and 248,385 individuals during spring migration (December to March) (Furness, 2015).

1426. During autumn migration, all of the Flamborough and Filey Coast SPA breeding adults are thought to be present in the BDMPS, representing 4.8% of the total BDMPS population (456,298 individuals of all ages). During this season, 458 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 182 birds were able to be assigned to an age class. 170 birds (93.4% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Flamborough and Filey Coast SPA is 4.5% (i.e. 0.048 x 0.934).

1427. During spring migration 70% of Flamborough and Filey Coast SPA breeding adults are thought to be present in the BDMPS, representing 6.2% of the BDMPS population (248,385 individuals of all ages). During this season, 28 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 21 birds were able to be assigned to an age class. 20 birds (95.2% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Flamborough and Filey Coast SPA is 5.9% (i.e. 0.062 x 0.952).

9.15.3.1.3 Potential Effects on the Qualifying Feature

1428. The gannet qualifying feature of the Flamborough and Filey Coast SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.15.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.15.3.1.4.1 Operational Phase Displacement/Barrier Effects

1429. Following statutory guidance (UK SNCBs, 2017), abundance estimates for gannet for DEP and its 2km buffer, and SEP and its 2km buffer have been used to produce displacement matrices. Based on the recommended displacement rate of Cook *et al.* (2018) and the findings of Skov *et al*. (2018), displacement rates of 0.600 to 0.800 are considered. These rates appear to be broadly in line with recent research on gannet displacement by OWFs (Peschko *et al*., 2021).

1430. The mortality rate of displaced birds due to displacement is assumed to be a maximum of 1%. This value has been selected firstly because gannet is known to possess high habitat flexibility (Furness and Wade, 2012). This suggests that displaced birds will readily find alternative habitats including foraging areas. Secondly, no evidence of displacement-induced mortality has been identified, which means there is limited justification for setting predicted mortality rates at a higher level.

1431. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult gannets belonging to the Flamborough and Filey Coast SPA population is presented in **Table 9-93** (DEP), **Table 9-94** (SEP) and **Table 9-95** (SEP and DEP together). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult gannets belonging to the Flamborough and Filey Coast SPA population by season. An estimated annual mortality for the population is provided, along with the increase of existing mortality within the breeding adult SPA population that would occur due to such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-93: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Gannets at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	554 (autumn) 103 (spring) 692 (breeding) 1,349 (year round)	25 (autumn) 6 (spring) 530 (breeding) 561 (year round)	3 - 4	0.16 - 0.21
Mean	343 (autumn) 47 (spring)	15 (autumn) 3 (spring)	2 - 3	0.09 - 0.12

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
	417 (breeding) 807 (year round)	319 (breeding) 338 (year round)		
Lower 95% CI	186 (autumn) 10 (spring) 180 (breeding) 376 (year round)	8 (autumn) 1 (spring) 138 (breeding) 147 (year round)	1 - 1	0.04 - 0.05

Notes
1. For autumn migration season (Oct-Nov), assumes 4.8% of adult birds are Flamborough and Filey Coast SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 6.2% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 100% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 76.7% of gannets allocated an age class during breeding season baseline surveys as being adults

2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds

3. Background population is Flamborough and Filey Coast SPA breeding adults (26,784 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

Table 9-94: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Gannets at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	426 (autumn) 31 (spring) 47 (breeding) 504 (year round)	19 (autumn) 2 (spring) 36 (breeding) 57 (year round)	0 - 0	0.02 - 0.02
Mean	295 (autumn) 11 (spring) 23 (breeding) 329 (year round)	13 (autumn) 1 (spring) 18 (breeding) 31 (year round)	0 - 0	0.01 - 0.01
Lower 95% CI	193 (autumn) 0 (spring) 3 (breeding) 196 (year round)	9 (autumn) 0 (spring) 2 (breeding) 11 (year round)	0 - 0	0.00 - 0.00

Notes
1. For autumn migration season (Oct-Nov), assumes 4.8% of adult birds are Flamborough and Filey Coast SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 6.2% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 100% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 76.7% of gannets allocated an age class during breeding season baseline surveys as being adults

2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
3. Background population is Flamborough and Filey Coast SPA breeding adults (26,784 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

Table 9-95: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Gannets at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	980 (autumn) 133 (spring) 739 (breeding) 1,852 (year round)	44 (autumn) 8 (spring) 566 (breeding) 618 (year round)	4 - 5	0.17 - 0.23
Mean	638 (autumn) 57 (spring) 440 (breeding) 1,135 (year round)	29 (autumn) 3 (spring) 337 (breeding) 369 (year round)	2 - 3	0.10 - 0.14
Lower 95% CI	378 (autumn) 10 (spring) 183 (breeding) 571 (year round)	17 (autumn) 1 (spring) 140 (breeding) 157 (year round)	1 - 1	0.04 - 0.06
Notes 1. For autumn migration season (Oct-Nov), assumes 4.8% of adult birds are Flamborough and Filey Coast SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 6.2% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 100% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 76.7% of gannets allocated an age class during breeding season baseline surveys as being adults 2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds 3. Background population is Flamborough and Filey Coast SPA breeding adults (26,784 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

1432. Based on the mean peak abundances, the annual total of breeding adult gannets from the Flamborough and Filey Coast SPA at risk of displacement from DEP is 337, 32 from SEP, and 369 for SEP and DEP together. At displacement rates of 0.600 to 0.800 and a maximum mortality rate of 1% for displaced birds, between two and three SPA breeding adults would be predicted to die each year due to displacement from both OWFs (**Table 9-95**). The combined displacement mortality of SEP and DEP would increase the existing mortality of the SPA breeding population by between 0.10% and 0.14%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

1433. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 22.0% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1434. **It is concluded that predicted gannet mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

1435. The confidence in the assessment is high for several reasons. Firstly, the evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.15.3.1.4.2 Collision Risk

1436. Information to inform the Appropriate Assessment for collision risk on breeding adult gannets belonging to the Flamborough and Filey Coast SPA population is presented in **Table 9-96**. An estimated monthly and annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). The methodology and input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1437. The annual total of breeding adult gannets from the Flamborough and Filey Coast SPA at risk of collision at DEP is 1.55 (95% CIs 0.09 to 4.86), with 0.22 (95% CIs 0.00 to 1.04) collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 1.77 (95% CIs 0.09 to 5.90) Flamborough and Filey Coast SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.08% (0.07% due to DEP, and 0.01% due to SEP).

1438. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. If macro-avoidance rates of 0.600 or 0.800 are applied to the predicted collision rates for SEP and DEP together, the collision rate becomes 0.35 (95% CIs 0.02 to 1.18) or 0.71 (95% CIs 0.04 to 2.36) respectively.

1439. Using an evidence-based nocturnal activity factor of 8% (Furness *et al*., 2018), which has been calculated more recently than the value of 25% recommended for use in CRM by Natural England (originally estimated by Garthe and Hüppop (2004)), reduces the mean collision rate (assuming no macro-avoidance correction) to 0.19 and 1.37 birds per year for SEP and DEP respectively. This reduces the annual mortality increase due to collision risk of SEP and DEP together to 0.08%.

1440. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peaks are used as an input into the assessment, since the maximum predicted mortality increase that could occur is 0.27%. The probability of this occurring is extremely small. For context, the probability of an entire full breeding season of such values occurring at SEP and DEP is one in 1 in 163,840,000,000 (i.e. one hundred and sixty three billion, eight hundred and forty million).

1441. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 59 flying birds were observed across DEP (of which 41 were within DEP-N, and 18 within DEP-S). This means that encounter rate was 14.0% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

1442. **It is concluded that predicted gannet mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

1443. The confidence in the assessment is high. The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

Table 9-96: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Gannet at SEP and DEP Apportioned to Flamborough and Filey Coast SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
DEP	Mean	-	0.00	0.00	0.18	0.64	0.08	0.07	0.08	0.07	0.28	0.06	0.07	0.01	1.55
	Density	95% UCI	0.00	0.00	0.85	1.48	0.35	0.43	0.33	0.30	0.73	0.21	0.14	0.05	4.86
		95% LCI	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
	Flight Height	95% UCI	0.00	0.00	0.33	1.15	0.15	0.13	0.14	0.13	0.51	0.11	0.12	0.02	2.79
		95% LCI	0.00	0.00	0.07	0.25	0.03	0.03	0.03	0.03	0.11	0.02	0.03	0.00	0.61
	Avoidance Rate	-2 SD	0.00	0.00	0.21	0.75	0.10	0.09	0.09	0.09	0.33	0.07	0.08	0.01	1.83
		+2 SD	0.00	0.00	0.15	0.52	0.07	0.06	0.06	0.06	0.23	0.05	0.06	0.01	1.27
	Noct. Act.	EB	0.00	0.00	0.16	0.57	0.08	0.07	0.07	0.07	0.25	0.05	0.05	0.01	1.37
SEP	Mean	-	0.00	0.00	0.00	0.09	0.00	0.00	0.03	0.03	0.04	0.00	0.03	0.00	0.22
	Density	95% UCI	0.00	0.00	0.00	0.35	0.00	0.00	0.20	0.19	0.23	0.00	0.07	0.00	1.04
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.16	0.00	0.00	0.06	0.05	0.07	0.00	0.05	0.00	0.40
		95% LCI	0.00	0.00	0.00	0.03	0.00	0.00	0.01	0.01	0.02	0.00	0.01	0.00	0.09
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.10	0.00	0.00	0.04	0.03	0.05	0.00	0.04	0.00	0.26
		+2 SD	0.00	0.00	0.00	0.07	0.00	0.00	0.03	0.02	0.03	0.00	0.02	0.00	0.18
	Noct. Act.	EB	0.00	0.00	0.00	0.08	0.00	0.00	0.03	0.03	0.04	0.00	0.02	0.00	0.19

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
SEP and DEP	Mean	-	0.00	0.00	0.18	0.73	0.08	0.07	0.11	0.10	0.32	0.06	0.10	0.01	1.77
	Density	95% UCI	0.00	0.00	0.85	1.83	0.35	0.43	0.53	0.49	0.96	0.21	0.20	0.05	5.90
		95% LCI	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09
	Flight Height	95% UCI	0.00	0.00	0.33	1.31	0.15	0.13	0.19	0.18	0.58	0.11	0.18	0.02	3.19
		95% LCI	0.00	0.00	0.07	0.29	0.03	0.03	0.04	0.04	0.13	0.02	0.04	0.00	0.70
	Avoidance Rate	-2 SD	0.00	0.00	0.21	0.86	0.10	0.09	0.13	0.12	0.38	0.07	0.12	0.01	2.09
		+2 SD	0.00	0.00	0.15	0.59	0.07	0.06	0.09	0.08	0.26	0.05	0.08	0.01	1.44
	Noct. Act.	EB	0.00	0.00	0.16	0.65	0.08	0.07	0.10	0.09	0.28	0.05	0.08	0.01	1.56

Notes

1. For autumn migration season (Oct-Nov), assumes 4.8% of adult birds are Flamborough and Filey Coast SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Dec-Feb), assumes 6.2% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Sept), assumes 100% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 76.7% of gannets allocated an age class during breeding season baseline surveys as being adults

9.15.3.1.4.3 Combined Displacement/Barrier Effects and Collision Risk

1444. The mean combined displacement and collision rates for breeding adult gannet from the Flamborough and Filey Coast SPA for SEP and DEP in isolation and together are presented in **Table 9-97**.

Table 9-97: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Flamborough and Filey Coast SPA Breeding Adult Gannets at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population

Site	Annual displacement mortality[1]	Annual collision mortality	Annual displacement and collision mortality	% annual mortality increase[2]
DEP	2.36 (1.03 - 3.93)	1.55 (0.09 - 4.86)	3.91 (1.12 - 8.79)	0.18 (0.05 - 0.41)
SEP	0.22 (0.07 - 0.40)	0.22 (0.00 - 1.04)	0.44 (0.07 - 1.44)	0.02 (0.00 - 0.07)
SEP and DEP	2.58 (1.10 - 4.33)	1.77 (0.09 - 5.90)	4.35 (1.19 - 10.23)	0.20 (0.05 - 0.47)
Notes 1. Assumes displacement rate of 0.700 and mortality rate of 1% of displaced birds 2. Background population is Flamborough and Filey Coast SPA breeding adults (26,784 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

1445. The annual mortality of breeding adult gannets from the Flamborough and Filey Coast SPA at DEP is 3.91 (95% CIs 1.12 to 8.79), and 0.44 (95% CIs 0.07 to 0.44) at SEP. This gives a combined total annual displacement and collision mortality rate for SEP and DEP together of 4.35 (95% CIs 1.19 to 10.23) Flamborough and Filey Coast SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.20%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates are likely in a typical year of impacts due to SEP and DEP. The use of upper 95% CI outputs would not alter the conclusions of the assessment.

1446. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. If macro-avoidance rates of 0.600 or 0.800 are applied to the predicted collision rates for SEP and DEP together, the predicted mortality rate for combined collision and displacement mortality becomes 2.92 (95% CIs 0.98 to 6.07), 3.11 (95% CIs 1.13 to 6.09) or 3.30 (95% CIs 1.28 to 6.12) at macro-avoidance rates of 0.600, 0.700 and 0.800 respectively.

1447. **It is concluded that predicted gannet mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

1448. The confidence in the assessment is high, for the reasons provided in the individual displacement and collision assessments.

9.15.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.15.3.1.5.1 Operational Phase Displacement/Barrier Effects

1449. Seasonal and annual population estimates of breeding adult gannets of the Flamborough and Filey Coast SPA at all OWFs included in the in-combination assessment are presented in **Table 9-98**. This information was taken from the latest numbers presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a). The Hornsea Project Four ES Chapter has been published since the publication of the above document. However, relevant representations of Natural England (Natural England, 2021) make it clear that apportioning of gannets (and therefore the apportioning of impacts) has not occurred according to their preferred methodology. For this reason, the estimated gannet mortality for displacement due to Hornsea Project Four is taken from the PEIR. This assessment will be updated as further information becomes available.

1450. The estimated annual total of breeding adult gannets from Flamborough and Filey Coast SPA at risk of displacement from all OWFs within the UK North Sea BDMPS combined is 10,148 (**Table 9-98**). Of this total, SEP and DEP contribute 0.3% and 3.3% respectively. Using displacement rates of 0.600 to 0.800 and a maximum mortality rate of 1% of displaced birds (UK SNCBs, 2017), the number of Flamborough and Filey Coast SPA birds predicted to die each year would be between 61 to 81 (**Table 9-99**).

1451. The estimated increase in mortality of Flamborough and Filey Coast SPA breeding adult gannets due to in-combination displacement is between 2.81% and 3.74%. Increases in the existing mortality rate of greater than 1% could be detectable against natural variation.

1452. PVAs for a selection of possible scenarios are presented in **Section 9.15.3.1.5.3** for impacts due to combined collision and displacement effects. The total annual mortality for these impacts is considerably larger than mortality due to displacement alone. However, the conclusions made in the sections below for combined collision and displacement impacts apply equally to displacement impacts on their own.

1453. **It is concluded that predicted gannet mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together in-combination with other projects would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

Table 9-98: Seasonal and Annual Population Estimates of All Gannets at SEP, DEP and Other OWFs Included in the In-Combination Assessment, and Breeding Adult Birds Apportioned to Flamborough and Filey Coast SPA

Tier	OWF	Seasonal population at risk of displacement[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	151	0	0	0	0	0	151	0
1	Beatrice Demonstrator	-	-	-	-	-	-	-	-
1	Blyth Demonstration Project	-	-	-	-	-	-	-	-
1	Dudgeon	53	53	25	1.2	11	0.7	89	54.9
1	East Anglia ONE	161	161	3638	174.6	76	4.7	3875	340.3
1	European Offshore Wind Deployment Centre	35	0	5	0.2	0	0	40	0.2
1	Galloper	360	0	907	43.5	276	17.1	1543	60.6
1	Greater Gabbard	252	0	69	3.3	105	6.5	426	9.8
1	Gunfleet Sands	0	0	12	0.6	9	0.6	21	1.2
1	Hornsea Project One	671	671	694	33.3	250	15.5	1615	719.8
1	Humber Gateway	-	-	-	-	-	-	-	-
1	Hywind	10	0	0	0	4	0.2	14	0.2
1	Kentish Flats	-	-	-	-	-	-	-	-
1	Kentish Flats Extension	0	0	13	0.6	0	0	13	0.6
1	Kincardine	120	0	0	0	0	0	120	0
1	Lincs	-	-	-	-	-	-	-	-
1	London Array	-	-	-	-	-	-	-	-
1	Race Bank	92	92	32	1.5	29	1.8	153	95.3
1	Rampion	0	0	590	28.3	0	0	590	28.3

Tier	OWF	Seasonal population at risk of displacement[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Scroby Sands	-	-	-	-	-	-	-	-
1	Sheringham Shoal	47	47	31	1.5	2	0.1	80	48.6
1	Teesside	1	0.5	0	0	0	0	1	0.5
1	Thanet	-	-	-	-	-	-	-	-
1	Westermost Rough	-	-	-	-	-	-	-	-
2	Triton Knoll	211	211	15	0.7	24	1.5	250	213.2
3	Dogger Bank Creyke Beck Projects A and B	1155	577.5	2048	98.3	394	24.4	3597	700.2
3	Dogger Bank Project C and Sofia	2250	1125	887	42.6	464	28.8	3601	1196.4
3	East Anglia THREE	412	412	1269	60.9	524	32.5	2205	505.4
3	Firth of Forth Alpha and Bravo	2956	0	664	31.9	332	20.6	3952	52.5
3	Hornsea Project Three	1333	844	984	47	524	32.5	2841	924
3	Hornsea Project Two	457	457	1140	54.7	124	7.7	1721	519.4
3	Inch Cape	2398	0	703	33.7	212	13.1	3313	46.8
3	Methil	23	0	0	0	0	0	23	0
3	Moray Firth (EDA)	564	0	292	14	27	1.7	883	15.7
3	Moray West	2827	0	439	21.1	144	8.9	3410	30
3	Neart na Gaoithe	1987	0	552	26.5	281	17.4	2820	43.9
3	Norfolk Boreas	1229	1229	1723	82.7	526	32.6	3478	1344.3
3	Norfolk Vanguard	271	271	2453	117.7	437	27.1	3161	415.8
3	East Anglia ONE North	149	149	468	22.5	44	2.7	661	174.2
3	East Anglia TWO	192	192	891	42.8	192	11.9	1275	246.7

Tier	OWF	Seasonal population at risk of displacement[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
Total (all projects above)		**19505**	**6439**	**19538**	**938**	**4615**	**286**	**43658**	**7663**
5	*Hornsea 4 (PEIR)*	*1892*	*1892*	*1192*	*57.2*	*659*	*40.9*	*3743*	*1990.1*
5	*DEP*	*417*	*319*	*343*	*15*	*47*	*3*	*807*	*337*
5	*SEP*	*23*	*18*	*295*	*13*	*11*	*1*	*329*	*32*
Total (all projects)		**22699**	**8721**	**22374**	**1071**	**5728**	**356**	**50801**	**10148**

Notes

1. The preferred standard is the OWF plus a 2km buffer, however the buffer zones included in this assessment varied between 0-4km depending on the data available, see **Appendix 11.2 Supplementary Information to Inform the Offshore Ornithology Cumulative Impact Assessment** (document reference 6.3.11.2) for further details and sources of seasonal populations for other OWFs besides SEP and DEP. Dashes indicate no data available for a given OWF.

Table 9-99: In-Combination Displacement Matrix for Gannet from Flamborough and Filey Coast SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
Displacement (%)		1	2	3	4	5	10	20	30	50	80	100
	10	10	20	30	41	51	101	203	304	507	812	1015
	20	20	41	61	81	101	203	406	609	1015	1624	2030
	30	30	61	91	122	152	304	609	913	1522	2436	3044
	40	41	81	122	162	203	406	812	1218	2030	3247	4059
	50	51	101	152	203	254	507	1015	1522	2537	4059	5074
	60	61	122	183	244	304	609	1218	1827	3044	4871	6089
	70	71	142	213	284	355	710	1421	2131	3552	5683	7104
	80	81	162	244	325	406	812	1624	2436	4059	6495	8118
	90	91	183	274	365	457	913	1827	2740	4567	7307	9133
	100	101	203	304	406	507	1015	2030	3044	5074	8118	10148

9.15.3.1.5.2 Collision Risk

1454. Seasonal and annual in-combination totals of estimated collision mortality of breeding adult gannets of the Flamborough and Filey Coast SPA at all OWFs included in the in-combination assessment are presented in **Table 9-100**. This information was taken from the latest numbers presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a). The Hornsea Project Four ES Chapter has been published since the publication of the above document. However, relevant representations of Natural England (Natural England, 2021) make it clear that apportioning of gannets (and therefore the apportioning of impacts) has not occurred according to their preferred methodology. For this reason, the estimate gannet mortality for collision impacts due to Hornsea Project Four is taken from the PEIR. This assessment will be updated as further information becomes available.

1455. These collision rates are based largely on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than their consent allows. These will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

1456. The total predicted annual collision mortality for breeding adult gannets from the Flamborough and Filey Coast SPA is 339 individuals (**Table 9-100**). Between them, SEP and DEP contribute 1.8 birds to this total, or 0.5%. The predicted in-combination mortality would increase the baseline adult mortality rate of the Flamborough and Filey Coast SPA breeding adult gannet population by 15.5%. This magnitude of increase could result in detectable population level effects.

1457. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. If macro-avoidance rates of 0.600 or 0.800 are applied to the predicted collision rates for SEP and DEP together, the total in-combination collision rate becomes 67.8 or 135.6 respectively. The predicted in-combination mortality would increase the baseline adult mortality rate of the Flamborough and Filey Coast SPA breeding adult gannet population by 3.1% to 6.3%. This magnitude of increase could still result in detectable population level effects, but is considerably smaller than if no macro-avoidance correction is incorporated.

1458. PVAs for a selection of possible scenarios are presented in **Table 9-102** and **Section 9.15.3.1.5.3** for impacts due to combined collision and displacement effects. The total annual mortality for these impacts is larger than mortality due to collision alone. However, the conclusions made in the sections below for combined collision and displacement impacts apply equally to collision impacts on their own.

1459. Whilst there is no agreed threshold beyond which an effect could or should be considered significant, the median CGR derived from the PVA represents a relatively small change to the growth rate of a population which has seen mean annual population increases of just over 10% over the last three decades, and 4% over the last five years for which data are available (2012 to 2017). The reduction of the population growth rate of 1.8% to 1.9%, or perhaps more realistically, 0.7% to 0.9% (assuming collisions rates corrected for macro-avoidance are more realistic than the uncorrected collision rates), will not result in population decline, but rather a slowing of the population growth rate. Whilst the CPS suggests a large change in population, this is somewhat inevitable over the length of the operational phase, even when the predicted annual impacts appear smaller.

1460. Natural England have previously assessed population trends recorded at other gannet colonies (Natural England, 2022b). The average annual growth rate calculated over a period of more than 90 years from colony establishment is 1.8%. The mean annual growth rate over the most recent years of their records (80+ years) has been 1.2% per annum (or 1.3% excluding Sula Sgeir, as the growth rate is likely to be influenced by an annual licenced harvest of young birds). At present, Flamborough and Filey Coast SPA growth rates are substantially greater than this (12% between 1985 and 2017, and 4% between 2012 and 2017).

1461. The Flamborough and Filey Coast SPA gannet population is believed to be robust enough to allow the conservation objective to maintain the population at (or above) designation levels and sustain the level of additional mortalities presented in **Table 9-100**. At an annual growth rate of 2% or more per annum over the coming decades, the integrity of the site for this feature is high, with high rates for self-repair, and self-renewal under dynamic conditions with minimal external management. In addition, the colony would remain at a size greater than the 8,469 pairs or 16,938 adults required by the population size Conservation Objective.

1462. **It is concluded that predicted gannet mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

Table 9-100: Estimated Collision Mortality at UK North Sea OWFs for Gannet by Season, Including those Apportioned to Flamborough and Filey Coast SPA Breeding Adult Population

Tier	OWF	Seasonal population at risk of collision[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	37.4	0	48.8	2.34	9.5	0.59	95.7	2.9
1	Beatrice Demonstrator	0.6	0	0.9	0.04	0.7	0.05	2.2	0.1
1	Blyth Demonstration Project	3.5	0	2.1	0.1	2.8	0.17	8.4	0.3
1	Dudgeon	22.3	22.3	38.9	1.87	19.1	1.18	80.3	25.3
1	East Anglia ONE	3.4	3.4	131	6.3	6.3	0.4	141	10.1
1	European Offshore Wind Deployment Centre	4.2	0	5.1	0.25	0.1	0	9.3	0.3
1	Galloper	18.1	0	30.9	1.48	12.6	0.78	61.6	2.3
1	Greater Gabbard	14	0	8.8	0.42	4.8	0.3	27.5	0.7
1	Gunfleet Sands	-	-	-	-	-	-	-	-
1	Hornsea Project One	11.5	11.5	32	1.54	22.5	1.4	66	14.4
1	Humber Gateway	1.9	1.9	1.1	0.05	1.5	0.09	4.5	2
1	Hywind	5.6	0	0.8	0.04	0.8	0.05	7.2	0.1
1	Kentish Flats	1.4	0	0.8	0.04	1.1	0.07	3.3	0.1
1	Kentish Flats Extension	-	-	-	-	-	-	-	-
1	Kincardine	3	0	0	0	0	0	3	0
1	Lincs	2.1	2.1	1.3	0.06	1.7	0.1	5	2.3
1	London Array	2.3	0	1.4	0.07	1.8	0.11	5.5	0.2
1	Lynn and Inner Dowsing	0.2	0.2	0.1	0.01	0.2	0.01	0.5	0.2

Tier	OWF	Seasonal population at risk of collision[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Race Bank	33.7	33.7	11.7	0.56	4.1	0.25	49.5	34.5
1	Rampion	36.2	0	63.5	3.05	2.1	0.13	101.8	3.2
1	Scroby Sands	-	-	-	-	-	-	-	-
1	Sheringham Shoal	14.1	14.1	3.5	0.17	0	0	17.6	14.3
1	Teesside	4.9	2.4	1.7	0.08	0	0	6.7	2.5
1	Thanet	1.1	0	0	0	0	0	1.1	0
1	Westermost Rough	0.2	0.2	0.1	0.01	0.2	0.01	0.5	0.2
2	Triton Knoll	26.8	26.8	64.1	3.08	30.1	1.87	121	31.7
3	Dogger Bank Creyke Beck Projects A and B	81.1	40.6	83.5	4	54.4	3.4	219	47.9
3	Dogger Bank Project C and Sofia	14.8	7.4	10.1	0.49	10.8	0.67	35.7	8.5
3	East Anglia THREE	6.1	6.1	33.3	1.6	9.6	0.6	49	8.3
3	Firth of Forth Alpha and Bravo	800.8	0	49.3	2.37	65.8	4.08	915.9	6.4
3	Hornsea Project Three	10	6	5	0	4	0	19	7
3	Hornsea Project Two	7	7	14	0.67	6	0.37	27	8
3	Inch Cape	336.9	0	29.2	1.4	5.2	0.32	371.3	1.7
3	Methil	6	0	0	0	0	0	6	0
3	Moray Firth (EDA)	80.6	0	35.4	1.7	8.9	0.55	124.9	2.3
3	Moray West	10	0	2	0.1	1	0.06	13	0.2
3	Neart na Gaoithe	143	0	47	2.26	23	1.43	213	3.7
3	Norfolk Boreas	14.1	14.2	12.7	0.61	3.9	0.24	30.7	15.1
3	Norfolk Vanguard	8.2	8.2	18.6	0.89	5.3	0.33	32.1	9.4

Tier	OWF	Seasonal population at risk of collision[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	East Anglia ONE North	12.4	12.4	11	0.52	1.1	0.07	24.5	13
3	East Anglia TWO	12.5	12.5	23.1	1.1	4	0.2	39.6	13.8
Total (all projects above)		**1792.0**	**233.0**	**822.8**	**39.3**	**325.0**	**19.9**	**2939.9**	**293.0**
5	*Hornsea 4 (PEIR)*	*43.3*	*43.3*	*9.9*	*0.48*	*8.1*	*0.5*	*61.3*	*44.3*
5	*DEP*	*1.8*	*1.4*	*2.8*	*0.1*	*0.2*	*0.0*	*4.9*	*1.6*
5	*SEP*	*0.3*	*0.2*	*0.7*	*0.0*	*0.0*	*0.0*	*0.9*	*0.2*
Total (all projects)		**1837.4**	**277.9**	**836.2**	**39.9**	**333.3**	**20.4**	**3007.0**	**339.1**

Notes

1. See **Appendix 11.2 Supplementary Information to Inform the Offshore Ornithology Cumulative Impact Assessment** (document reference 6.3.11.2) for further details and sources of seasonal populations for other OWFs besides SEP and DEP. Dashes indicate no data available for a given OWF.

9.15.3.1.5.3 Combined Displacement/Barrier Effects and Collision Risk

1463. The predicted annual in-combination breeding adult Flamborough and Filey Coast SPA gannet mortality from collision and displacement of OWFs screened into the Appropriate Assessment (**Table 9-98** and **Table 9-100**) is shown in **Table 9-101**. SEP and DEP contributed approximately 1.1% of the total predicted impact of these scenarios. The predicted mortality would increase the baseline adult mortality rate of the Flamborough and Filey Coast SPA breeding adult gannet population by greater than 1% (up to 19.3% in the worst case). This magnitude of increase could result in detectable population level effects.

Table 9-101: Predicted In-Combination Annual Collision and Displacement Mortality for Breeding Adult Gannet of the Flamborough and Filey Coast SPA Under Different OWF Designs

OWF	Displacement			Collision				Displacement and Collision (assuming no macro-avoidance in CRMs)		
	0.600 disp., 1% mort.	0.700 disp., 1% mort.	0.800 disp., 1% mort.	0% MA	60% MA	70% MA	80% MA	0.600 disp., 1% mort.	0.700 disp., 1% mort.	0.800 disp., 1% mort.
Tier 1-3	43.5	50.7	57.9	266.2	106.5	79.9	53.2	309.7	316.9	324.1
Tier 4	14.5	16.9	19.3	71.1	28.4	21.3	14.2	85.6	88.0	90.4
SEP and DEP	2.2	2.6	3.0	1.8	0.7	0.5	0.4	4.0	4.4	4.8
All	60.9	70.2	80.2	339.1	135.6	101.7	67.8	400.0	409.3	419.3

1464. PVAs examining the effect of the mortality rates generated by these scenarios at the population level have been produced (**Table 9-102**). CGR and CPS have been produced from the model outputs and are presented. These measure changes in annual growth rate and population size at the end of the impacted period relative to the unimpacted scenario, which in this case is 40 years. These outputs are favoured due to their relatively high tolerance for misspecification of input parameters, which is common in population modelling (Jitlal *et al*., 2017).

1465. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. If macro-avoidance rates of 0.600 or 0.800 are applied to the predicted collision rates for DEP and SEP together, the predicted in-combination mortality is considerably smaller than if no macro-avoidance correction is incorporated.

1466. The increase in existing mortality rate due to the predicted impact is also presented. This is a PVA input and was calculated by adding the predicted mortality to existing mortality, dividing the resultant total by the starting population to calculate a new mortality rate, and subtracting the original mortality rate from the new mortality rate to obtain the difference between the two. It has been presented to 10 decimal places to allow the model to be reproduced.

Table 9-102: PVA Outputs for Breeding Adult Flamborough and Filey Coast SPA Gannets Incorporating Mean Collision and Displacement Impacts of SEP and DEP In-Combination with Other Projects

PVA description	Annual mortality[1]	Increase in existing mortality rate[2,3]	Median CGR[4]	Median CPS[4]
Tier 1-4 OWFs plus SEP and DEP, no collision rate macro-avoidance correction, 0.600 displacement, 1% mortality of displaced birds	400.0	0.0149342891	0.982	0.481
Tier 1-4 OWFs plus SEP and DEP, no collision rate macro-avoidance correction, 0.700 displacement, 1% mortality of displaced birds	409.3	0.0152815114	0.982	0.473
Tier 1-4 OWFs plus SEP and DEP, no collision rate macro-avoidance correction, 0.800 displacement, 1% mortality of displaced birds	419.3	0.0156548686	0.981	0.465
Tier 1-4 OWFs plus SEP and DEP, no collision rate macro-avoidance correction, 0.600 displacement, 1% mortality of displaced birds	196.5	0.0073364695	0.991	0.700
Tier 1-4 OWFs plus SEP and DEP, no collision rate macro-avoidance correction, 0.700 displacement, 1% mortality of displaced birds	171.9	0.0064180108	0.992	0.732
Tier 1-4 OWFs plus SEP and DEP, no collision rate macro-avoidance correction, 0.800 displacement, 1% mortality of displaced birds	148.0	0.0055256870	0.993	0.764

Notes
1. Assumes 0.800 displacement rate and 1% mortality of displaced birds
2. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
3. Background population is Flamborough and Filey Coast SPA breeding adults (26,784 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)
4. After 40 years of operation

1467. The PVA investigating the population-level effects of potential collision and displacement impacts for SEP and DEP in-combination with other projects produced a median CGR of 0.981 to 0.982 and a CPS of 0.465 to 0.481, if no macro-avoidance correction was applied to predicted collision rates. With a degree of macro-avoidance correction incorporated into the CRM outputs, the median CGR increased to 0.991 to 0.993, and the median CPS to 0.700 to 0.764. These counterfactuals all assumed a 40 year operational phase.

1468. The CGR presented indicates that the annual growth rate of the population compared with the baseline, unimpacted scenario would be reduced by 1.8% to 1.9% due to the predicted impacts if no macro-avoidance corrections are applied to the predicted collision rate, or 0.7% to 0.9% if macro-avoidance corrections of 0.600 to 0.800 are applied. The median CPS indicates that after 40 years of operation of

SEP and DEP, along with all other OWFs included in the in-combination assessment (**Table 9-98** and **Table 9-100**), the impacted population would be 51.9% to 53.5% smaller than the unimpacted scenario for scenarios where macro-avoidance corrections are not applied to predicted collision rates, or 23.6% to 30.0% if macro-avoidance corrections of 0.600 to 0.800 are applied.

1469. The counterfactuals calculated from the model outputs should be interpreted according to the level of precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The use of mean peak abundance estimates in displacement modelling may result in estimates of displaced birds being unrealistically high;
- The displacement rates used in PVA are at the upper end of the range advised for use in assessments;
- The mortality rates assumed for displaced birds may be overestimated;
- The use of consented OWF designs in the CRM;
- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary; and
- The Flamborough and Filey Coast SPA gannet population is modelled as a closed population, with no emigration or immigration occurring.

1470. The impacts predicted at SEP and DEP, in-combination with other projects, will not prevent the majority of the Conservation Objectives from being met. However, there is potential for the Conservation Objective for the gannet population size of the Flamborough and Filey Coast SPA not being met due to the predicted impacts. This is to maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

1471. Whilst there is no agreed threshold beyond which an effect could or should be considered significant, the median CGR derived from the PVA represents a relatively small change to the growth rate of a population which has seen mean annual population increases of just over 10% over the last three decades, and 4% over the last five years for which data are available (2012 to 2017). The reduction of the population growth rate of 1.8% to 1.9%, or perhaps more realistically, 0.7% to 0.9% (assuming collisions rates corrected for macro-avoidance are more realistic than the uncorrected collision rates), will not result in population decline, but rather a slowing of the population growth rate. Whilst the CPS suggests a large change in population, this is somewhat inevitable over the length of the operational phase, even when the predicted annual impacts appear smaller.

1472. Natural England have previously assessed population trends recorded at other gannet colonies (Natural England, 2022b). The average annual growth rate calculated over a period of more than 90 years from colony establishment is 1.8%. The mean annual growth rate over the most recent years of their records (80+ years) has been 1.2% per annum (or 1.3% excluding Sula Sgeir, as the growth rate is likely to be influenced by an annual licenced harvest of young birds). At present, Flamborough and Filey Coast SPA growth rates are substantially greater than this (12% between 1985 and 2017, and 4% between 2012 and 2017).

1473. The Flamborough and Filey Coast SPA gannet population is believed to be robust enough to allow the conservation objective to maintain the population at (or above) designation levels and sustain the level of additional mortalities presented in **Table 9-101**. At an annual growth rate of 2% or more per annum over the coming decades, the integrity of the site for this feature is high, with high rates for self-repair, and self-renewal under dynamic conditions with minimal external management. In addition, the colony would remain at a size greater than the 8,469 pairs or 16,938 adults required by the population size Conservation Objective.

1474. The combined displacement and collision impacts predicted at SEP and DEP, in-combination with other projects, will not prevent all of the other Conservation Objectives from being met.

1475. **It is concluded that predicted gannet mortality due to the combined impacts of operational phase displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

9.15.3.2 Kittiwake

9.15.3.2.1 Status

1476. At the time of the classification of the former Flamborough Head and Bempton Cliffs SPA in 1993, the kittiwake breeding population was cited as 83,370 breeding pairs. This was based on a count carried out in 1987. The breeding adult kittiwake population of the Flamborough and Filey Coast SPA at classification in 2018 was cited as 44,420 pairs or 89,040 breeding adults. This was based on counts carried out between 2008 and 2011 (Natural England, 2018b). This suggests a decline of about 50% in the size of the breeding population between 1987 and 2008 to 2011.

1477. There is uncertainty as to whether there were ever as many as 83,370 pairs of kittiwakes at this site. This number has been challenged repeatedly. The colony should have been increasing in numbers based on monitoring data on its productivity (Coulson, 2017). The apparent decline from 83,370 pairs in 1987 to 37,617 pairs in 2008 (i.e. by 50%) therefore does not correspond with population trajectories based on the influence of productivity on population change. No details of the methodology that were followed during the 1987 count have ever been published. It has previously been suggested that the count in 1987 may have been expressed as individuals rather than pairs, and then mistakenly recorded as pairs (Coulson, 2011). That would fit well with previous and subsequent counts which have consistently been around 40,000 to 50,000 pairs (**Plate 9-4** and **Plate 9-5**).

1478. Recent counts indicate increases in the kittiwake breeding population since 2008, with estimates of 51,001 pairs or 102,002 breeding adults in 2016 (Babcock *et al*., 2016) and 51,535 pairs or 103,070 breeding adults in 2017 (Aitken *et al*., 2017). The latter was a complete census of the colony and is considered to represent the best available evidence of the current population size.

1479. Since the Seabird 2000 national seabird colony census (Mitchell *et al*., 2004) the kittiwake population at the Flamborough and Filey Coast has increased by 7% (Aitken *et al*., 2017; JNCC, 2022, 2020). This is in contrast to the declining trend of the species in the UK (JNCC, 2022, 2020).

1480. Using the published adult mortality rate of 14.6% (Horswill and Robinson, 2015), 15,048 birds would be expected to die annually from the breeding adult population of 103,070 individuals.

1481. This count of 1987, which has previously been disputed, has a substantial effect on the longer term population trend (and subsequently the conservation status of the qualifying feature), as shown in **Plate 9-4** (which assumes the 1987 count to be breeding pairs) and **Plate 9-5** (which assumes the 1987 count to be breeding adults).

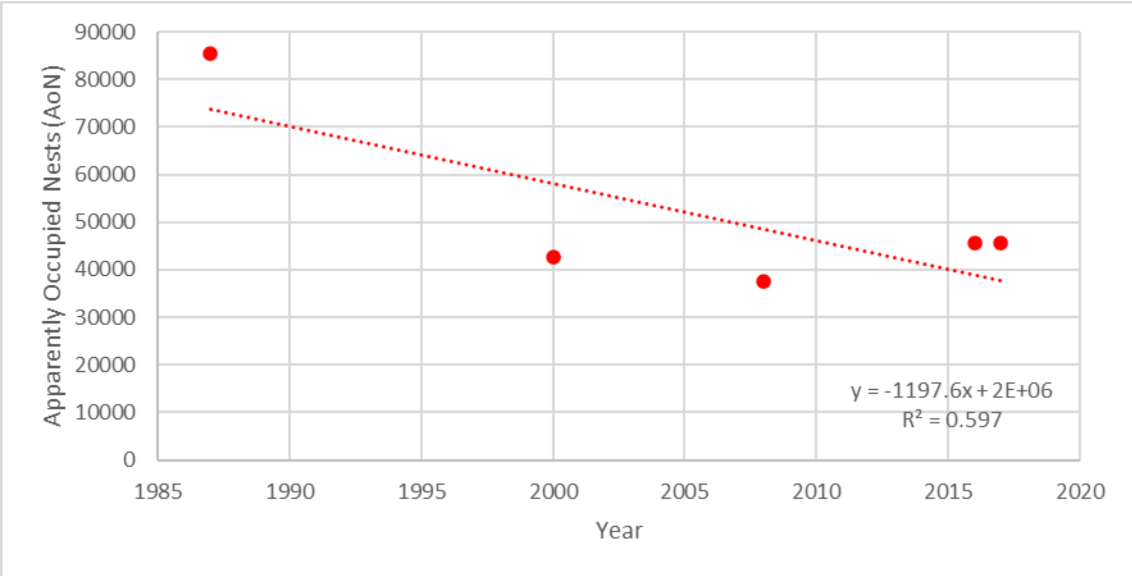

Plate 9-4: Kittiwake Counts (Apparently Occupied Nests) at the Flamborough and Filey Coast SPA between 1986 and 2017 Included in the SMP Database (JNCC, 2022), with Linear Trendline. The 1986 Count is Presumed to have Reflected the Number of Breeding Pairs Present

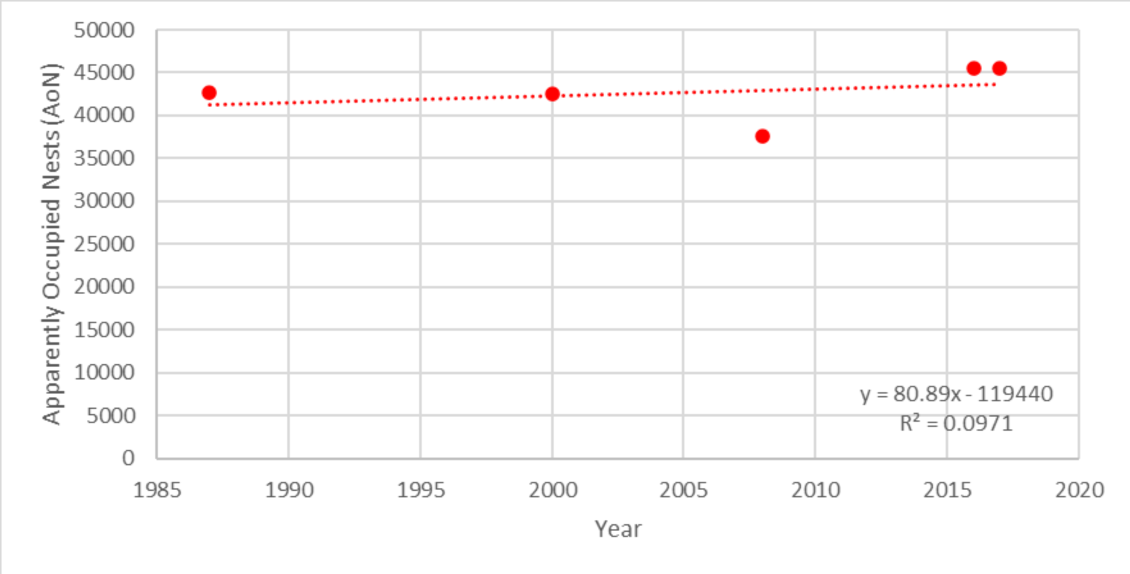

Plate 9-5: Kittiwake Counts (Apparently Occupied Nests) at the Flamborough and Filey Coast SPA between 1986 and 2017 Included in the SMP Database (JNCC, 2022), with Linear Trendline. The 1986 Count is Presumed to have Reflected the Number of Breeding Adults Present

1482. Supplementary advice on the conservation objectives were added for qualifying features of the Flamborough and Filey Coast SPA in 2020 (Natural England, 2020). For kittiwake, these are:

- Restore the size of the breeding population at a level which is above 83,700 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent;
- Restore safe passage of birds moving between nesting and feeding areas;
- Restrict the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed;
- Restrict predation and disturbance caused by native and non-native predators.
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System;
- Restore the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised;
- Maintain the extent, distribution and availability of suitable breeding habitat which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at: current extent;

- Restore the distribution, abundance and availability of key food and prey items (e.g. sandeel, sprat, cod, squid, shrimps) at preferred sizes;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels;
- Maintain water quality and specifically mean winter dissolved inorganic nitrogen (DIN) at a concentration equating to High Ecological Status (specifically mean winter DIN is <12µM for coastal waters), avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.15.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1483. SEP and DEP are 112km and 116km respectively from the Flamborough and Filey Coast SPA boundary at the nearest point. The mean maximum foraging range of kittiwake is 156.1km (±144.5km), and the maximum foraging range is 770km (Woodward *et al.*, 2019). Modelled at-sea utilisation distributions from tracking studies of kittiwakes from the SPA (Cleasby *et al*., 2020, 2018; Wakefield *et al*., 2017; Wischnewski *et al*., 2017) indicate that SEP and DEP fall within the foraging range of birds breeding at the Flamborough and Filey Coast SPA.

1484. SEP and DEP are not within the published mean maximum foraging range of any other SPAs designated for breeding kittiwakes. They are however within the maximum foraging range of a number of SPAs where kittiwake is a qualifying feature, or named as a component of a breeding seabird assemblage qualifying feature. Given evidence for the foraging areas of different breeding kittiwake colonies tending not to overlap, (Wakefield *et al*., 2017), it is considered unlikely that breeding kittiwakes from other colonies further away than Flamborough and Filey Coast SPA would forage at SEP and DEP either regularly, or in substantial numbers, during the breeding season.

1485. Any breeding adult kittiwakes present within SEP and DEP during the full breeding season would therefore be likely to have originated from the Flamborough and Filey Coast SPA. It is also likely that kittiwakes recorded within SEP and DEP during the breeding season will include sub-adult birds and non-breeding adults from the Flamborough and Filey Coast SPA, and/or a range of other breeding colonies. During the full breeding season (March to August (Furness 2015)), 2,573 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 935 birds were able to be assigned to an age class. 784 birds (83.9% of those assigned to an age class) were classified as adults. It is therefore assumed that this proportion of kittiwakes recorded at SEP and DEP during the breeding season are breeding adult birds from the Flamborough and Filey Coast SPA.

1486. Outside the breeding season breeding kittiwakes, including those from the Flamborough and Filey Coast SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with kittiwakes of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea BDMPS. This consists of 829,937 individuals during the autumn migration season (August to December), and 627,816 individuals during the spring migration season (January to April) (Furness, 2015).

1487. During the autumn migration season, 60% of the Flamborough and Filey Coast SPA breeding adults are assumed to be present in the BDMPS, representing 5.4% of the BDMPS population (829,937 individuals of all ages). During this season, 1,609 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 487 birds were able to be assigned to an age class. 400 birds (82.1% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Flamborough and Filey Coast SPA is 4.4% (i.e. 0.054 x 0.821).

1488. 60% of SPA breeding adults are also assumed to be present in the BDMPS during the spring migration season, representing 7.2% of the BDMPS population (627,816 individuals of all ages). During this season, 63 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 23 birds were able to be assigned to an age class. 21 birds (91.3% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Flamborough and Filey Coast SPA is 6.6% (i.e. 0.072 x 0.913).

9.15.3.2.3 Potential Effects on the Qualifying Feature

1489. The kittiwake qualifying feature of the Flamborough and Filey Coast SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.15.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.15.3.2.4.1 Collision Risk

1490. Information to inform the Appropriate Assessment for collision risk on breeding adult kittiwakes belonging to the Flamborough and Filey Coast SPA population is presented in **Table 9-103**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-104**. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1491. Based on the mean collision rates, the annual total of breeding adult kittiwakes from the Flamborough and Filey Coast SPA at risk of collision at DEP is 8.09, with 0.78 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 8.86 Flamborough and Filey Coast SPA breeding adult kittiwakes. This would increase the existing mortality of the SPA breeding population by 0.06% (0.05% due to DEP, and 0.01% due to SEP). Using an evidence-based nocturnal activity factor of 20% (MacArthur Green, 2019b) rather than the value of 50% recommended for use in CRM by Natural England reduces the mean collision rate to 0.65 and 6.84 birds per year for SEP and DEP respectively (7.50 for both OWFs combined). This reduces the annual mortality increase in the Flamborough and Filey Coast SPA breeding kittiwake population due to collision risk of SEP and DEP together to 0.05%.

1492. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 205 flying birds were observed across DEP (of which 158 were within DEP-N, and 47 within DEP-S). When corrected for the different survey transect lengths in both regions of DEP, this means that encounter rate was 26.5% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

Table 9-103: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Flamborough and Filey Coast SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
DEP	Mean	-	0.07	0.05	0.25	4.55	1.32	0.12	0.41	0.98	0.19	0.08	0.01	0.05	8.09
	Density	95% UCI	0.18	0.12	0.93	8.27	4.37	0.68	1.09	3.45	0.56	0.19	0.05	0.09	20.00
		95% LCI	0.00	0.00	0.00	1.23	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.25
	Flight Height	95% UCI	0.09	0.06	0.30	5.48	1.59	0.15	0.50	1.18	0.23	0.10	0.01	0.06	9.75
		95% LCI	0.05	0.04	0.18	3.27	0.95	0.09	0.30	0.71	0.14	0.06	0.01	0.03	5.81
	Avoidance Rate	-2 SD	0.09	0.06	0.29	5.37	1.56	0.15	0.49	1.16	0.22	0.10	0.01	0.06	9.56
		+2 SD	0.06	0.04	0.20	3.72	1.08	0.10	0.34	0.80	0.15	0.07	0.01	0.04	6.62
	Noct. Act.	EB	0.05	0.04	0.20	3.82	1.16	0.11	0.37	0.84	0.15	0.06	0.01	0.03	6.84
SEP	Mean	-	0.00	0.00	0.00	0.62	0.00	0.07	0.00	0.00	0.04	0.00	0.02	0.03	0.78
	Density	95% UCI	0.00	0.00	0.00	2.98	0.00	0.41	0.00	0.00	0.16	0.00	0.07	0.13	3.76
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.75	0.00	0.09	0.00	0.00	0.05	0.00	0.02	0.03	0.94
		95% LCI	0.00	0.00	0.00	0.45	0.00	0.05	0.00	0.00	0.03	0.00	0.01	0.02	0.56
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.74	0.00	0.08	0.00	0.00	0.05	0.00	0.02	0.03	0.92
		+2 SD	0.00	0.00	0.00	0.51	0.00	0.06	0.00	0.00	0.03	0.00	0.02	0.02	0.64
	Noct. Act.	EB	0.00	0.00	0.00	0.52	0.00	0.06	0.00	0.00	0.03	0.00	0.01	0.02	0.65

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
SEP and DEP	Mean	-	0.07	0.05	0.25	5.17	1.32	0.20	0.41	0.98	0.23	0.08	0.03	0.07	8.86
	Density	95% UCI	0.18	0.12	0.93	11.26	4.37	1.09	1.09	3.45	0.71	0.19	0.13	0.23	23.76
		95% LCI	0.00	0.00	0.00	1.23	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	1.25
	Flight Height	95% UCI	0.09	0.06	0.30	6.24	1.59	0.24	0.50	1.18	0.28	0.10	0.04	0.09	10.70
		95% LCI	0.05	0.04	0.18	3.71	0.95	0.14	0.30	0.71	0.16	0.06	0.02	0.05	6.37
	Avoidance Rate	-2 SD	0.09	0.06	0.29	6.11	1.56	0.23	0.49	1.16	0.27	0.10	0.03	0.09	10.48
		+2 SD	0.06	0.04	0.20	4.23	1.08	0.16	0.34	0.80	0.19	0.07	0.02	0.06	7.25
	Noct. Act.	EB	0.05	0.04	0.20	4.35	1.16	0.17	0.37	0.84	0.19	0.06	0.02	0.05	7.50

Notes

1. For autumn migration season (Sept-Dec), assumes 5.4% of adult birds are Flamborough and Filey Coast SPA breeders (Furness 2015), combined with 82.1% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Jan-Feb), assumes 7.2% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 91.3% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Aug), assumes 100% of adult birds are Flamborough and Filey Coast SPA breeders, combined with 83.9% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

Table 9-104: Predicted Annual Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Flamborough and Filey Coast SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase[1]
DEP	8.09 (1.25 - 20.00)	0.05 (0.01 - 0.13)
SEP	0.78 (0.00 - 3.76)	0.01 (0.00 - 0.02)
SEP and DEP	8.86 (1.25 - 23.76)	0.06 (0.01 - 0.16)
Notes 1. Background population is Flamborough and Filey Coast SPA breeding adults (103,070 individuals), adult age class annual mortality rate of 14.6% (Horswill and Robinson, 2015)		

1493. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.16% due to the collision impacts of SEP and DEP together. The probability of this level of impact occurring is extremely small, since an entire year of monthly upper 95% CI density values would have to occur at both SEP and DEP. For context, the probability of an entire full breeding season of such values occurring at SEP and DEP is one in 1 in 4,096,000,000 (i.e. four billion and ninety six million). Whilst the temporal limitations of the baseline data are acknowledged (which are very similar for all OWF assessments), it is still considered that the probability of these events actually occurring is too small to credibly refer to them as a realistic worst case scenario.

1494. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

1495. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.15.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.15.3.2.5.1 Collision Risk

1496. Seasonal and annual in-combination totals of estimated collision mortality of breeding adult kittiwakes of the Flamborough and Filey Coast SPA at all OWFs included in the in-combination assessment are presented in **Table 9-105**. This information was taken from the latest numbers presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a). The Hornsea Project Four ES Chapter has been published since the publication of the above document. However, the relevant representations of Natural England (Natural England, 2021) make it clear that apportioning of kittiwakes (and therefore the apportioning of impacts) has not occurred according to their preferred methodology. For this reason, the estimated kittiwake mortality for collision impacts due to Hornsea Project Four is taken from the PEIR. This assessment will be updated as further information becomes available.

1497. The collision rates presented in **Table 9-105** are based largely on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than suggested by their consents. These as-built designs will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

1498. The total predicted annual collision mortality for breeding adult kittiwakes from the Flamborough and Filey Coast SPA is 487.9 individuals (**Table 9-105**). Between them, SEP and DEP contribute 8.9 birds to this total, or 1.8%. The predicted in-combination mortality would increase the baseline adult mortality rate of the Flamborough and Filey Coast SPA breeding adult kittiwake population by 3.2%. This magnitude of increase could result in detectable population level effects.

Table 9-105: Estimated Collision Mortality at UK North Sea OWFs for Kittiwake by Season, Including those Apportioned to Flamborough and Filey Coast SPA Breeding Adult Population

Tier	OWF	Seasonal population at risk of collision[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	94.7	0	10.7	0.6	39.8	2.9	145.2	3.5
1	Beatrice Demonstrator	0	0	2.1	0.1	1.7	0.1	3.8	0.2
1	Blyth Demonstration Project	1.7	0	2.3	0.1	1.4	0.1	5.4	0.2
1	Dudgeon	-	-	-	-	-	-	-	-
1	East Anglia ONE	1.8	0	160.4	8.7	46.8	3.4	209	12
1	European Offshore Wind Deployment Centre	11.8	0	5.8	0.3	1.1	0.1	18.7	0.4
1	Galloper	6.3	0	27.8	1.5	31.8	2.3	65.9	3.8
1	Greater Gabbard	1.1	0	15	0.8	11.4	0.8	27.5	1.6
1	Gunfleet Sands	-	-	-	-	-	-	-	
1	Hornsea Project One	44	36.5	55.9	3	20.9	1.5	120.8	41
1	Humber Gateway	1.9	1.9	3.2	0.2	1.9	0.1	7	2.2
1	Hywind	16.6	0	0.9	0.1	0.9	0.1	18.3	0.1
1	Kentish Flats	0	0	0.9	0.1	0.7	0.1	1.6	0.1
1	Kentish Flats Extension	0	0	0	0	2.7	0.2	2.7	0.2
1	Kincardine	22	0	9	0.5	1	0.1	32	0.6
1	Lincs	0.7	0.7	1.2	0.1	0.7	0.1	2.6	0.8
1	London Array	1.4	0	2.3	0.1	1.8	0.1	5.5	0.3
1	Lynn and Inner Dowsing	-	-	-	-	-	-	-	
1	Race Bank	1.9	1.9	23.9	1.3	5.6	0.4	31.4	3.6

Tier	OWF	Seasonal population at risk of collision[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Rampion	54.4	0	37.4	2	29.7	2.1	121.5	4.2
1	Scroby Sands	-	-	-	-	-	-	-	
1	Sheringham Shoal	-	-	-	-	-	-	-	
1	Teesside	38.4	0	24	1.3	2.5	0.2	64.9	1.5
1	Thanet	0.2	0	0.5	0	0.4	0	1.1	0.1
1	Westermost Rough	0.1	0.1	0.2	0	0.1	0	0.5	0.1
2	Triton Knoll	24.6	24.6	139	7.5	45.4	3.3	209	35.4
3	Dogger Bank Creyke Beck Projects A and B	288.6	55.8	135	7.3	295.4	21.3	719	84.3
3	Dogger Bank Teesside Projects A and B	136.9	26.4	90.7	4.9	216.9	15.6	444.5	46.9
3	East Anglia THREE	6.1	0	69	3.7	37.6	2.7	112.7	6.4
3	Firth of Forth Alpha and Bravo	153.1	0	313.1	16.9	247.6	17.8	713.8	34.7
3	Hornsea Project Three[2]	77	0 (72)	38	0 (2)	8	0 (1)	123	0 (75)
3	Hornsea Project Two	16	13.3	9	0.5	3	0.2	28	14
3	Inch Cape	13.1	0	224.8	12.1	63.5	4.6	301.4	16.7
3	Methil	0.4	0	0	0	0	0	0.4	0
3	Moray Firth (EDA)	43.6	0	2	0.1	19.3	1.4	64.9	1.5
3	Moray West	79	0	24	1.3	7	0.5	110	1.8
3	Neart na Gaoithe	32.9	0	56.1	3	4.4	0.3	93.4	3.4
3	Norfolk Boreas[2]	13.3	0 (11.4)	32.2	0 (1.7)	11.9	0 (0.9)	57.5	0 (14)
3	Norfolk Vanguard[2]	21.8	0 (18.7)	16.4	0 (0.9)	19.3	0 (1.4)	57.5	0 (21)

Tier	OWF	Seasonal population at risk of collision[1]							
		Breeding		Autumn migration		Spring migration		Annual	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	East Anglia ONE North	40.4	0	8.1	0 (0.4)	3.5	0 (0.3)	52	0 (0.7)
3	East Anglia TWO	29.5	0	5.4	0 (0.3)	7.4	0 (0.5)	42.3	0 (0.8)
Total (all projects above)		**1275.3**	**161.2**	**1546.3**	**78.1**	**1193.1**	**82.4**	**4014.8**	**321.6**
5	*Hornsea 4 (PEIR)*	*153.3*	*153.3*	*34.7*	*1.9*	*9.9*	*0.7*	*197.9*	*155.9*
5	*DEP*	*9.1*	*7.6*	*4.6*	*0.3*	*1.3*	*0.1*	*15.0*	*8.1*
5	*SEP*	*0.8*	*0.7*	*1.2*	*0.1*	*0*	*0.0*	*2.0*	*0.8*
Total (all projects)		**1438.5**	**322.8**	**1586.8**	**80.4**	**1204.3**	**83.2**	**4229.7**	**486.5**

Notes
1. See **Appendix 11.2 Supplementary Information to Inform the Offshore Ornithology Cumulative Impact Assessment** (document reference 6.3.11.2) for further details and sources of seasonal populations for other OWFs besides SEP and DEP. Dashes indicate no data available for a given OWF.

2. Hornsea Project THREE, Norfolk Vanguard, Norfolk Boreas, East Anglia ONE North and East Anglia TWO have been consented on the condition that impacts on Flamborough and Filey Coast SPA kittiwakes are compensated. Therefore, the number of birds from this population lost due to impacts at these OWFs are assumed to be zero, which is reflected in the totals. The original values from the relevant assessments are presented in parentheses in their relevant rows.

1499. A PVA examining the effect of the mortality rates generated by this level of in-combination mortality at the population level have been carried out (**Table 9-106**). CGR and CPS have been produced from the model outputs and are presented. These measure changes in annual growth rate and population size at the end of the impacted period relative to the unimpacted scenario, which in this case is 40 years. These outputs are favoured due to their relatively high tolerance for misspecification of input parameters, which is common in population modelling (Jitlal *et al.*, 2017). It should be noted that these PVAs include mortality for East Anglia ONE North and TWO, despite the fact that this will be compensated for. This further adds to the precaution of the model.

1500. The increase in existing mortality rate due to the predicted impact is also presented. This is a PVA input and was calculated by adding the predicted mortality to existing mortality, dividing the resultant total by the starting population to calculate a new mortality rate, and subtracting the original mortality rate from the new mortality rate to obtain the difference between the two.

Table 9-106: PVA Outputs for Breeding Adult Flamborough and Filey Coast SPA Kittiwakes Incorporating Mean Collision Impacts of SEP and DEP In-Combination with Other Projects

PVA description	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
Tier 1-3 OWFs	323.1	0.0031347628	0.996	0.859
Tier 1-4 OWFs	479.0	0.0046473271	0.995	0.798
Tier 1-4 OWFs plus SEP and DEP	487.9	0.0047336761	0.994	0.794
Notes 1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced 2. Background population is Flamborough and Filey Coast SPA breeding adults (103,070 individuals), adult age class annual mortality rate of 14.6% (Horswill and Robinson, 2015) 3. After 40 years of operation				

1501. The PVA investigating the population-level effects of potential collision impacts for SEP and DEP in-combination with other projects produced a median CGR of 0.994 and a CPS of 0.794. Without the impacts of SEP and DEP included, the CGR was 0.995 and the CPS 0.798, and without SEP and DEP, and any tier 4 projects (i.e. East Anglia ONE North and TWO, and Hornsea Project Four), the median CGR was 0.996 and the CPS 0.859.

1502. The CGR presented indicates that the annual growth rate of the population compared with the baseline, unimpacted scenario would be reduced by 0.6% due to the predicted in-combination impacts. The median CPS indicates that after 40 years of operation of SEP and DEP, along with all other OWFs included in the in-combination assessment (**Table 9-105**), the impacted population would be 20.6% smaller than the unimpacted scenario.

1503. The counterfactuals calculated from the model outputs should be interpreted according to the number of precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The use of consented OWF designs in the CRM;
- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary; and
- The Flamborough and Filey Coast SPA kittiwake population is modelled as a closed population, with no emigration or immigration occurring.

1504. The collision impacts predicted at SEP and DEP, in-combination with other projects, will not prevent the majority of the Conservation Objectives from being met. However, the kittiwake population of the Flamborough and Filey Coast SPA is in unfavourable conservation status, and has a "restore" Conservation Objective (to 83,700 breeding pairs). Whilst there is no agreed threshold beyond which an effect could or should be considered significant, the median CGR represents a relatively small change to the growth rate. However, the Flamborough and Filey Coast SPA breeding kittiwake qualifying feature is of unfavourable conservation status if the population trend presented in **Plate 9-4** is correct. Further reduction of the population growth rate, and to the population at the end of the impacted period, will make it more challenging for FCS to be achieved. In the event that the suggestion of Coulson (2011), that the 1987 count was mistakenly recorded as breeding pairs when it was actually breeding adults that were counted (**Plate 9-5**), the population trend is more stable. However, without any collision effects at any OWFs factored in, it would still take several hundred years for the population to reach the levels apparently recorded in the 1986 count based on the trajectory of the trendline in **Plate 9-5**.

1505. The PVA produced indicates that kittiwake mortality levels due to the impacts from OWFs may already be at, or close to, a level where an adverse effect on the integrity of the Flamborough and Filey Coast SPA might be expected. The contribution of SEP and DEP to Flamborough and Filey Coast SPA kittiwake mortality is small in the context of the overall in-combination impact of OWF collision; 1.7% of all predicted Flamborough and Filey Coast SPA kittiwake mortality due to OWF impacts are due to DEP, and 0.2% due to SEP. However, despite the impacts being small, they contribute to the current situation, which is that the population is unable to be restored due to existing impacts. This situation is reflected in information presented in recent OWF Examinations, such as Hornsea Project Three, Norfolk Vanguard, and Norfolk Boreas.

1506. **It is concluded that an adverse effect on the integrity of the Flamborough and Filey Coast SPA cannot be ruled out as a result of predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other OWFs.**

9.15.3.3 Guillemot

9.15.3.3.1 Status

1507. The Flamborough and Filey Coast SPA breeding guillemot population was cited as 41,607 pairs or 83,214 breeding adults, for the period 2008 to 2011 (Natural England, 2018b). The most recent count (in 2017) was 60,877 pairs or 121,754 breeding adults (Aitken *et al*., 2017), which is used as the reference population for the remainder of the assessment. It is clear that the population of guillemot at the Flamborough and Filey Coast SPA has increased between designation and 2017 (Aitken *et al.*, 2017; JNCC, 2022), and has increased almost threefold since 1986 (**Plate 9-6**). The average annual increase in the population between 1987 and 2017 was 3.8%, and 4.6% between 2008 and 2017.

1508. The baseline mortality of this population is 7,427 adult birds per year based on an adult population of 121,754 individuals and the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

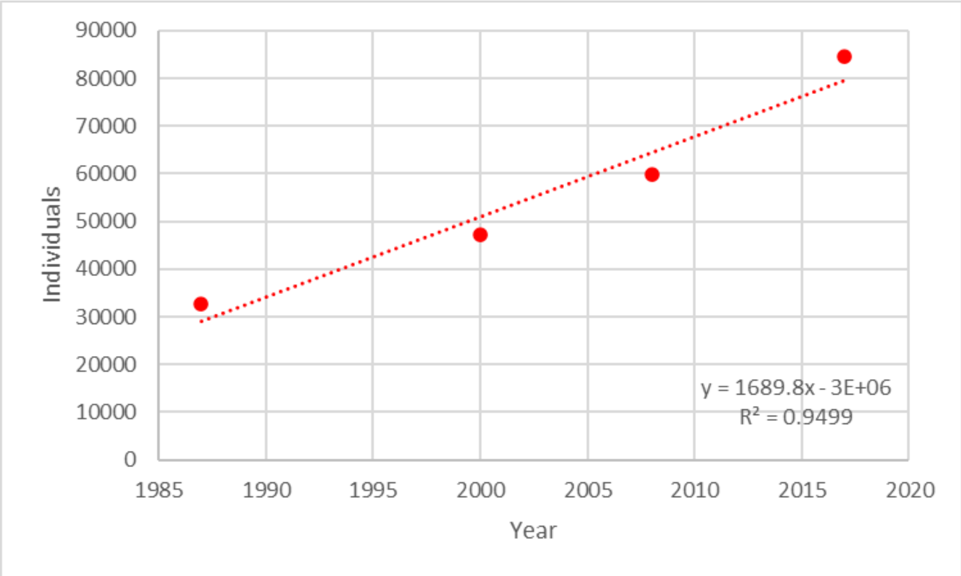

Plate 9-6: Guillemot Counts (Individuals) at the Flamborough and Filey Coast SPA between 1986 and 2017 Included in the SMP Database (JNCC, 2022), with Linear Trendline. Note that these Values have Not Been Corrected to Estimate the Number of Birds Not at the Colony at the Time of the Count, so Do Not Match the Values Given in the Text

1509. Supplementary advice on the conservation objectives were added for qualifying features in 2020 (Natural England, 2020). For guillemot, these are:

- Maintain the size of the breeding population at a level which is above 41,607 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent;
- Maintain safe passage of birds moving between nesting and feeding areas;
- Restrict the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed;
- Restrict predation and disturbance caused by native and non-native predators;

- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System;
- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised;
- Maintain the extent, distribution and availability of suitable breeding habitat which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at: current extent;
- Maintain the distribution, abundance and availability of key food and prey items (e.g. sandeel, herring, sprat) at preferred sizes;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels;
- Maintain water quality and specifically mean winter dissolved inorganic nitrogen (DIN) at a concentration equating to High Ecological Status (specifically mean winter DIN is <12µM for coastal waters), avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.15.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1510. SEP and DEP are situated 112km and 116km respectively from the Flamborough and Filey Coast SPA boundary at the nearest point. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum foraging range is 338km (Woodward *et al*., 2019). Excluding data from breeding guillemots at Fair Isle, where reduced prey availability was considered to be causing substantially increased foraging ranges during the breeding season, the mean maximum foraging range decreases to 55.7km (±39.7km) and the maximum to 135km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

1511. SEP and DEP are therefore beyond the mean maximum foraging range of guillemots from the Flamborough and Filey Coast SPA, but within mean maximum foraging range plus one standard deviation, and the maximum foraging range. The latter two measurements are considered to be poor indicators of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity.

1512. Modelled at-sea distributions from tracking data collected during the breeding season from breeding adult birds (Cleasby *et al*., 2020, 2018; Wakefield *et al*., 2017), suggest that SEP and DEP are outside the home foraging range (i.e. beyond the 95% utilisation distribution) of guillemots from the Flamborough and Filey Coast SPA. This information does not mean that breeding adult guillemots from the Flamborough and Filey Coast SPA will not be present at SEP and DEP during the breeding season. However, it does suggest that the majority of guillemots recorded on site during the breeding season are unlikely to be breeding adults from the SPA.

1513. SEP and DEP are not within foraging range of breeding guillemots from any other SPAs so it seems likely based on the above foraging range and utilisation distributions that the birds recorded at SEP and DEP during the breeding season are non-breeding adults and sub-adult birds which have not yet reached breeding age. This may include birds from Flamborough and Filey Coast SPA and other breeding colonies.

1514. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 4.4% of birds present are considered to be breeding adults from the Flamborough and Filey Coast SPA. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.15.3.3.3 Potential Effects on the Qualifying Feature

1515. The guillemot qualifying feature of the Flamborough and Filey Coast SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects.

9.15.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.15.3.3.4.1 Operational Phase Displacement / Barrier Effects

1516. Population estimates of guillemot at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-107**, **Table 9-108** and **Table 9-109** respectively.

1517. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017).

1518. The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. Whilst it is true that guillemots and razorbills tend to be displaced by OWFs they do not avoid them completely, and displacement rates vary between sites (MacArthur Green, 2019c). On average it was concluded that densities within OWFs are around half of the density found in the habitats around the OWF. At some OWFs there is also displacement of birds from a buffer zone surrounding it. The size of the buffer zone varies between OWFs and is generally less than 2km, with auk density increasing across the buffer zone as distance from turbines increases, up to the density in the wider area. Another recent review (APEM, 2022) suggested that the current displacement rates suggested by the SNCBs for guillemot and razorbill (0.300 to 0.700) did not account for the quality of or confidence in the studies which were used to inform this position, and that studies where no significant effects were recorded were not accounted for during the provision of the advice. APEM (2022) suggested that in the case of Hornsea Project Four, an evidence-based displacement rate of 0.500 was appropriate. However, the study also recognised that larger displacement effects are possible.

1519. Mortality due to displacement could arise due to increased energy costs and/or decreased energy intake, if displacement results in increased flying time to avoid OWFs, and/or increased bird densities and competition for prey in areas of unimpacted habitat outside the OWF. Given that UK OWFs in the North Sea represent a very small proportion of the available foraging habitat for guillemots and razorbills within UK North Sea waters, the increase in density of auks outside OWFs due to displacement is likely to be negligible (MacArthur Green, 2019c). It is considered unlikely that the mortality rate due to displacement would be as high as the empirically estimated 6.1% annual mortality for adult guillemots that occurs due to the combination of 'natural' factors and anthropogenic activities (Horswill and Robinson, 2015). Indeed, it may be much lower; MacArthur Green (2019c) recommended precautionary rates of 50% displacement for guillemot and 1% mortality of displaced birds based on a review of available evidence. Modelling undertaken by APEM (2022) found that in the case of Hornsea Project Four, a mortality rate of 1% for displaced auks was considered to be precautionary, and that this may be an overestimate given that Hornsea Project Four is located towards the upper end of the mean maximum foraging range for guillemot from the Flamborough and Filey Coast SPA. As SEP and DEP are beyond the mean maximum range of birds from this colony, it is anticipated that a mortality rate of 1% represents a highly precautionary estimate.

1520. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult guillemots belonging to the Flamborough and Filey Coast SPA population is presented in **Table 9-107** (DEP), **Table 9-108** (SEP) and **Table 9-109** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots belonging to the Flamborough and Filey Coast SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-107: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 1,078 (nb) 1,078 (year round)	3 - 75 (5)	0.04 - 1.02 (0.07)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 655 (nb) 655 (year round)	2 - 46 (3)	0.03 - 0.62 (0.04)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 344 (nb) 344 (year round)	1 - 24 (2)	0.01 - 0.32 (0.02)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Flamborough and Filey Coast SPA breeding adults. For non-breeding season, assumes 4.4% of birds are Flamborough and Filey Coast SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Flamborough and Filey Coast SPA breeding adults (121,754 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-108: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,437 (year round)	0 (b) 69 (nb) 69 (year round)	0 - 5 (0)	0.00 - 0.07 (0.00)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 48 (nb) 48 (year round)	0 - 3 (0)	0.00 - 0.04 (0.00)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 29 (nb) 29 (year round)	0 - 2 (0)	0.00 - 0.03 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
2. For breeding season (Mar-Jul), assumes 0% of birds are Flamborough and Filey Coast SPA breeding adults. For non-breeding season, assumes 4.4% of birds are Flamborough and Filey Coast SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Flamborough and Filey Coast SPA breeding adults (121,754 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-109: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 1,147 (nb) 1,147 (year round)	3 - 80 (6)	0.05 - 1.08 (0.08)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 703 (nb) 703 (year round)	2 - 49 (4)	0.03 - 0.66 (0.05)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 373 (nb) 373 (year round)	1 - 26 (2)	0.02 - 0.35 (0.03)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are Flamborough and Filey Coast SPA breeding adults. For non-breeding season, assumes 4.4% of birds are Flamborough and Filey Coast SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Flamborough and Filey Coast SPA breeding adults (121,754 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

1521. Based on the mean peak abundances, the annual total of guillemots from the Flamborough and Filey Coast SPA at risk of displacement from SEP and DEP is 703 birds (**Table 9-109**); 655 at DEP (**Table 9-107**) and 48 at SEP (**Table 9-108**).

At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 2.0 to 45.9 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.1 to 3.3 birds due to displacement from SEP.

1522. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.62% due to impacts at DEP, and 0.04% due to impacts at SEP (0.66% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the Flamborough and Filey Coast SPA breeding adult guillemot population would increase by 0.07% due to impacts at DEP (5.4 birds), <0.01% due to impacts at SEP (0.3 birds), and 0.08% due to the impacts of SEP and DEP together (5.7 birds).

1523. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1524. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered. Mortality rate increases of just over 1% are predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside the highest recommended displacement and mortality rates. The probability of this occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, displacement and mortality rates of 0.700 and 10% are much higher than evidence suggests will actually be the case.

1525. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

1526. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same

irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.15.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.15.3.3.5.1 Operational Phase Displacement/Barrier Effects

1527. Seasonal and annual population estimates of breeding adult guillemots of the Flamborough and Filey Coast SPA at all OWFs included in the in-combination assessment are presented in **Table 9-110**. This information was taken from the latest numbers presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a). The Hornsea Project Four ES Chapter has been published since the publication of the above document. However, relevant representations of Natural England (Natural England, 2021) indicate that they consider that the importance of the Hornsea Project Four site to Flamborough and Filey Coast SPA guillemot during August and September has not been accounted for in the assessment. For this reason, the estimated guillemot mortality for displacement due to Hornsea Project Four is taken from the PEIR. This assessment will be updated as further information becomes available.

1528. The estimated annual total of breeding adult guillemots from Flamborough and Filey Coast SPA at risk of displacement from all OWFs within the UK North Sea BDMPS combined is 43,281 (**Table 9-110**). Of this total, SEP and DEP contribute 0.1% and 1.5% respectively. Using displacement rates of 0.300 to 0.700 and mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017), the number of Flamborough and Filey Coast SPA birds predicted to die each year would be between 132 to 3,079 (**Table 9-111**).

1529. The estimated increase in mortality of Flamborough and Filey Coast SPA breeding adult guillemot due to in-combination displacement impacts is between 1.78% and 41.46%. Increases in the existing mortality rate of greater than 1% could be detectable against natural variation.

Table 9-110: Seasonal and Annual Population Estimates of All Guillemots at SEP, DEP and Other OWFs Included in the In-Combination Assessment, and Breeding Adult Birds Apportioned to Flamborough and Filey Coast SPA

Tier	OWF	Seasonal population at risk of displacement[1]					
		Breeding		Non-breeding		Total	
		Total	FFC	Total	FFC	Total	FFC
1	Beatrice	13610.0	0.0	2755.0	121.2	16365.0	121.2
1	Beatrice Demonstrator	No estimate available					
1	Blyth Demonstration Project	1220.0	0.0	1321.0	58.1	2541.0	58.1
1	Dudgeon	334.0	0.0	542.0	23.8	876.0	23.8
1	East Anglia ONE	274.0	0.0	640.0	28.2	914.0	28.2
1	European Offshore Wind Deployment Centre	547.0	0.0	225.0	9.9	772.0	9.9
1	Galloper	305.0	0.0	593.0	26.1	898.0	26.1
1	Greater Gabbard	345.0	0.0	548.0	24.1	893.0	24.1
1	Gunfleet Sands	0.0	0.0	363.0	16.0	363.0	16.0
1	Hornsea Project One	9836.0	4554.1	8097.0	356.3	17933.0	4910.4
1	Humber Gateway	99.0	99.0	138.0	6.1	237.0	105.1
1	Hywind	249.0	0.0	2136.0	94.0	2385.0	94.0
1	Kentish Flats	0.0	0.0	3.0	0.1	3.0	0.1
1	Kentish Flats Extension	0.0	0.0	4.0	0.2	4.0	
1	Kincardine	632.0	0.0	0.0	0.0	632.0	0.0
1	Lincs & LID	582.0	0.0	814.0	35.8	1396.0	35.8
1	London Array	192.0	0.0	377.0	16.6	569.0	16.6
1	Race Bank	361.0	0.0	708.0	31.2	1069.0	31.2
1	Rampion	10887.0	0.0	15536.0	683.6	26423.0	683.6
1	Scroby Sands	No estimate available					
1	Sheringham Shoal	390.0	0.0	715.0	31.5	1105.0	31.5

Tier	OWF	Seasonal population at risk of displacement[1]					
		Breeding		Non-breeding		Total	
		Total	FFC	Total	FFC	Total	FFC
1	Teesside	267.0	267.0	901.0	39.6	1168.0	306.6
1	Thanet	18.0	0.0	124.0	5.5	142.0	5.5
1	Westermost Rough	347.0	347.0	486.0	21.4	833.0	368.4
3	Hornsea Project Two	7735.0	3581.3	13164.0	579.2	20899.0	4160.5
2	Triton Knoll	425.0	425.0	746.0	32.8	1171.0	457.8
3	Dogger Bank Creyke Beck A	5407.0	1892.5	6142.0	270.2	11549.0	2162.7
3	Dogger Bank Creyke Beck B	9479.0	3317.7	10621.0	467.3	20100.0	3785.0
3	Dogger Bank Teesside A	3283.0	1149.1	2268.0	99.8	5551.0	1248.9
3	Dogger Bank Teesside B	5211.0	1823.9	3701.0	162.8	8912.0	1986.7
3	East Anglia THREE	1744.0	0.0	2859.0	125.8	4603.0	125.8
3	Firth of Forth Alpha	13606.0	0.0	4688.0	206.3	18294.0	206.3
3	Firth of Forth Bravo	11118.0	0.0	4112.0	180.9	15230.0	180.9
3	Hornsea Project Three	13374.0	0.0	17772.0	782.0	31146.0	782.0
3	Inch Cape	4371.0	0.0	3177.0	139.8	7548.0	139.8
3	Methil	25.0	0.0	0.0	0.0	25.0	0.0
3	Moray Firth (EDA)	9820.0	0.0	547.0	24.1	10367.0	24.1
3	Moray West	24426.0	0.0	38174.0	1679.7	62600.0	1679.7
3	Neart na Gaoithe	1755.0	0.0	3761.0	165.5	5516.0	165.5
3	Norfolk Boreas	7767.0	0.0	13777.0	606.2	21544.0	606.2
3	Norfolk Vanguard	4320.0	0.0	4776.0	210.2	9096.0	210.2
3	East Anglia ONE North	4183.0	0.0	1888.0	83.1	6071.0	83.1
3	East Anglia TWO	2077.0	0.0	1675.0	73.7	3752.0	73.7

Tier	OWF	Seasonal population at risk of displacement[1]					
		Breeding		Non-breeding		Total	
		Total	FFC	Total	FFC	Total	FFC
Total (all projects above)		**170621**	**17457**	**170874**	**7519**	**341495**	**24975**
5	*Hornsea 4 (PEIR)*	*15245.0*	*15245.0*	*69555.0*	*3060.4*	*84800.0*	*18305.4*
5	*DEP*	*3839.0*	*0.0*	*14887.0*	*655.0*	*18726.0*	*655.0*
5	*SEP*	*1094.5*	*0.0*	*1085.0*	*47.7*	*2179*	*47.7*
Total (all projects)		**190800**	**32702**	**256401**	**11282**	**447200**	**43983**

Notes

1. The preferred standard is the OWF plus a 2km buffer, however the buffer zones included in this assessment varied between 0-4km depending on the data available, see **Appendix 11.2 Supplementary Information to Inform the Offshore Ornithology Cumulative Impact Assessment** (document reference 6.3.11.2) for further details and sources of seasonal populations for other OWFs besides SEP and DEP.

Table 9-111: In-Combination Displacement Matrix for Guillemot from Flamborough and Filey Coast SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	44	88	132	176	220	440	880	1319	2199	3519	4398
	20	88	176	264	352	440	880	1759	2639	4398	7037	8797
	30	132	264	396	528	660	1319	2639	3958	6597	10556	13195
	40	176	352	528	704	880	1759	3519	5278	8797	14075	17593
	50	220	440	660	880	1100	2199	4398	6597	10996	17593	21992
	60	264	528	792	1056	1319	2639	5278	7917	13195	21112	26390
	70	308	616	924	1232	1539	3079	6158	9236	15394	24630	30788
	80	352	704	1056	1407	1759	3519	7037	10556	17593	28149	35186
	90	396	792	1188	1583	1979	3958	7917	11875	19792	31668	39585
	100	440	880	1319	1759	2199	4398	8797	13195	21992	35186	43983

1530. PVAs examining the effect of the mortality rates generated by the in-combination displacement assessment at the population level have been produced (**Table 9-112**).

1531. Displacement and mortality rates covering the entire range recommended by the SNCBs have been considered. CGR and CPS have been produced from the model outputs and are presented. These measure changes in annual growth rate and population size at the end of the impacted period relative to the unimpacted scenario, which in this case is 40 years. These outputs are favoured due to their relatively high tolerance for misspecification of input parameters, which is common in population modelling (Jitlal *et al*., 2017).

1532. The increase in existing mortality rate due to the predicted impact is also presented. This is a PVA input and was calculated by adding the predicted mortality to existing mortality, dividing the resultant total by the starting population to calculate a new mortality rate, and subtracting the original mortality rate from the new mortality rate to obtain the difference between the two.

Table 9-112: PVA Outputs for Breeding Adult Flamborough and Filey Coast SPA Guillemots Incorporating Mean Displacement Impacts of SEP and DEP In-Combination with Other Projects

Displacement rate	Mortality rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
0.300	1%	132	0.0010837344	0.999	0.952
	2%	264	0.0021674688	0.998	0.905
	5%	660	0.0054186721	0.994	0.779
	10%	1319	0.0108373442	0.988	0.606
0.400	1%	176	0.0014449792	0.998	0.936
	2%	352	0.0028899584	0.997	0.875
	5%	880	0.0072248961	0.992	0.717
	10%	1759	0.0144497922	0.984	0.512
0.500	1%	220	0.0018062240	0.998	0.920
	2%	440	0.0036124481	0.996	0.847
	5%	1100	0.0090311201	0.990	0.659
	10%	2199	0.0180622403	0.980	0.433
0.600	1%	264	0.0021674688	0.998	0.905
	2%	528	0.0043349377	0.995	0.819
	5%	1319	0.0108373442	0.988	0.606
	10%	2639	0.0216746883	0.976	0.365
0.700	1%	308	0.0025287136	0.997	0.890
	2%	616	0.0050574273	0.994	0.792
	5%	1539	0.0126435682	0.986	0.557
	10%	3079	0.0252871364	0.972	0.308

Notes
1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is Flamborough and Filey Coast SPA breeding adults (121,754 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)
3. After 40 years of operation

1533. The PVA investigating the population-level effects of potential displacement impacts for SEP and DEP in-combination with other projects produced a wide range of median CGR and CPS values depending on the displacement and mortality rates used to estimate the magnitude of the impact.

1534. At the upper end of the displacement and mortality rates examined (0.700 displacement and 10% mortality of displaced birds), the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.972 and a CPS of 0.308. At the lower end of the displacement and mortality rates examined (0.300 displacement and 1% mortality of displaced birds), the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.999 and a CPS of 0.952. Using the evidence-based displacement and mortality rates of 0.500 displacement and 1% mortality of displaced birds, the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.998 and a CPS of 0.920.

1535. The counterfactuals calculated from the model outputs should be interpreted according to the level of precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The use of mean peak abundance estimates in displacement modelling may result in estimates of displaced birds being unrealistically high;
- The upper range of displacement rates considered may be overestimated;
- The mortality rates assumed for displaced birds may be overestimated;
- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary; and
- The Flamborough and Filey Coast SPA guillemot population is modelled as a closed population, with no emigration or immigration occurring.

1536. The impacts predicted at SEP and DEP, in-combination with other projects, will not prevent the majority of the Conservation Objectives from being met. However, there is potential for the Conservation Objective for the guillemot population size of the Flamborough and Filey Coast SPA not being met due to the predicted impacts. This is to maintain the size of the breeding population at a level which is above 41,607 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

1537. The guillemot population of the Flamborough and Filey Coast SPA increased on average by 3.8% annually between 1986 and 2017. Between 2008 and 2017, the annual growth rate increased to 4.6%. Whilst this is no guarantee of the future population trend of the colony, it might be the case that scenarios where the CGR is sufficiently low may result in a reduction in the growth rate of the colony, rather than recent trends reversing, and the population going into decline. The Conservation Objective for population size could therefore be met despite the predicted in-combination impacts.

1538. The percentage reduction in growth rate resulting from each of the median CGRs presented in **Table 9-112** is presented in **Table 9-113**. This assumes that the Flamborough and Filey Coast SPA guillemot population would continue to increase at a rate of 3.8% annual growth for the next 40 years, as it did between 1986 and 2017. In this scenario, none of the 20 impact scenarios presented in **Table 9-112** would cause the population to decline. Instead, the growth rate would decrease in all scenarios.

Table 9-113: Percentage Reduction of the Breeding Adult Guillemot Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 3.8%, which is the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red.

	0.300	0.400	0.500	0.600	0.700
1%	2.6%	5.3%	5.3%	5.3%	7.9%
2%	5.3%	7.9%	10.5%	13.2%	15.8%
5%	15.8%	21.1%	26.3%	31.6%	36.8%
10%	31.6%	42.1%	52.6%	63.2%	73.7%

1539. There is no guarantee that the Flamborough and Filey Coast guillemot population would continue to increase at a rate of 3.8% annual growth for the next 40 years, as it did between 1986 and 2017. Three further population trend scenarios have therefore been considered. These are situations where the future population growth of the colony is half (i.e. 1.90%), a quarter (i.e. 0.95%), and an eighth (i.e. 0.48%) of the growth rate recorded at the colony between 1986 and 2017.

1540. The percentage reduction in growth rate resulting from each of the median CGRs presented in **Table 9-112** is presented in **Table 9-114**, **Table 9-115** and **Table 9-116** respectively for each scenario.

1541. Assuming a future growth rate of 1.90%, three of the 20 impact scenarios presented in **Table 9-112** would cause the population to decline. These involve displacement rates of 0.500 and above, and mortality rates of 10%. Assuming a future growth rate of 0.95%, eight of the 20 impact scenarios presented in **Table 9-112** would cause the population to decline. These involve all scenarios where the mortality of displaced birds is assumed to be 10%, and scenarios where mortality rates of 5%, in conjunction with displacement rates of 0.500 and above were assumed. Assuming a future growth rate of 0.48%, twelve of the 20 impact scenarios presented in **Table 9-112** would cause the population to decline. These involve all scenarios where the mortality of displaced birds is assumed to be 5% and 10%, and scenarios where mortality rates of 2%, in conjunction with displacement rates of 0.600 and above were assumed.

Table 9-114: Percentage Reduction of the Breeding Adult Guillemot Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 1.90%, which is Half of the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red.

	0.300	0.400	0.500	0.600	0.700
1%	5.3%	10.5%	10.5%	10.5%	15.8%
2%	10.5%	15.8%	21.1%	26.3%	31.6%
5%	31.6%	42.1%	52.6%	63.2%	73.7%
10%	63.2%	84.2%	105.3%	126.3%	147.4%

Table 9-115: Percentage Reduction of the Breeding Adult Guillemot Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 0.95%, which is a Quarter of the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red.

	0.300	0.400	0.500	0.600	0.700
1%	10.5%	21.1%	21.1%	21.1%	31.6%
2%	21.1%	31.6%	42.1%	52.6%	63.2%
5%	63.2%	84.2%	105.3%	126.3%	147.4%
10%	126.3%	168.4%	210.5%	252.6%	294.7%

Table 9-116: Percentage Reduction of the Breeding Adult Guillemot Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 0.48%, which is an Eighth of the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red.

	0.300	0.400	0.500	0.600	0.700
1%	21.1%	42.1%	42.1%	42.1%	63.2%
2%	42.1%	63.2%	84.2%	105.3%	126.3%
5%	126.3%	168.4%	210.5%	252.6%	294.7%
10%	252.6%	336.8%	421.1%	505.3%	589.5%

1542. In conclusion, even in scenarios where the growth rate of the Flamborough and Filey Coast SPA guillemot colony is considerably reduced from levels recorded between 1986 and 2017, the application of appropriately precautionary levels of displacement and mortality of displaced birds indicate that a slowing of the population growth rate, rather than a population decline, is likely as a result of in-combination displacement effects. This is particularly true when evidence-based displacement and mortality rates of 0.500 and 1% respectively are used to predict population level effects. Whilst the CPSs generated from the PVA outputs in **Table 9-112** suggest a large change in population at the end of the operational period, this is somewhat inevitable over the length of the operational phase, even when the predicted annual impacts appear smaller. The colony would remain at a size greater than the 41,607 pairs or 83,214 adults required by the population size Conservation Objective.

1543. The displacement impacts predicted at SEP and DEP, in-combination with other projects, will not prevent all of the other Conservation Objectives from being met.

1544. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

9.15.3.4 Razorbill

9.15.3.4.1 Status

1545. The Flamborough and Filey Coast SPA breeding razorbill population was 10,570 pairs or 21,140 breeding adults, for the period 2008 to 2012 (Natural England, 2018b). The most recent count (in 2017) was 20,253 pairs or 40,506 breeding adults (Aitken *et al*., 2017), which is used as the reference population for the remainder of the assessment. Using the published annual mortality rate of 10.5% (Horswill and Robinson, 2015), 4,253 birds per year would be expected to die each year.

1546. The average annual increase in the population between 1987 and 2017 was 5.8%, and 9.7% between 2008 and 2017. It is clear that the population of razorbill at the Flamborough and Filey Coast SPA has increased between designation and 2017 (Aitken *et al.*, 2017; JNCC, 2022), and has increased almost fourfold since 1986 (**Plate 9-7**).

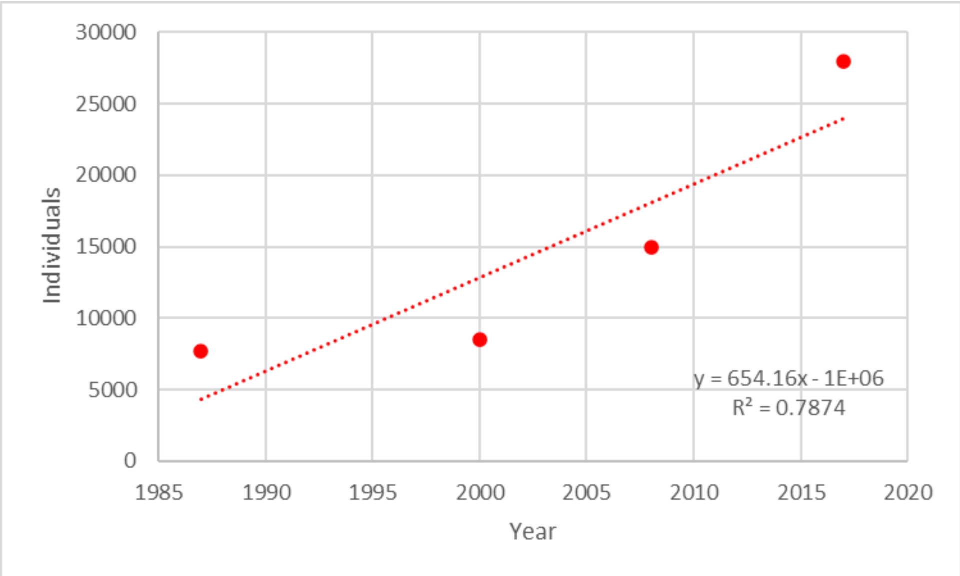

Plate 9-7: Razorbill Counts (Individuals) at the Flamborough and Filey Coast SPA between 1987 and 2017 Included in the SMP Database (JNCC, 2022), with Linear Trendline. Note That These Values have not been Corrected to Estimate the Number of Birds not at the Colony at the Time of the Count, so Do Not Match the Values Given in the Text

1547. Supplementary advice on the conservation objectives were added for qualifying features in 2020 (Natural England, 2020). For razorbill, these are:

- Maintain the size of the breeding population at a level which is above 10,570 breeding pairs whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent;
- Maintain safe passage of birds moving between nesting and feeding areas;
- Restrict the frequency, duration and / or intensity of disturbance affecting roosting, nesting, foraging, feeding, moulting and/or loafing birds so that they are not significantly disturbed;

- Restrict predation and disturbance caused by native and non-native predators;
- Maintain concentrations and deposition of air pollutants at below the site-relevant Critical Load or Level values given for this feature of the site on the Air Pollution Information System;
- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat through management or other measures (whether within and/or outside the site boundary as appropriate) and ensure these measures are not being undermined or compromised;
- Maintain the extent, distribution and availability of suitable breeding habitat which supports the feature for all necessary stages of its breeding cycle (courtship, nesting, feeding) at: current extent;
- Maintain the distribution, abundance and availability of key food and prey items (e.g. sandeel, herring, sprat) at preferred sizes;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain the dissolved oxygen (DO) concentration at levels equating to High Ecological Status (specifically ≥ 5.7mg per litre (at 35 salinity) for 95% of the year), avoiding deterioration from existing levels
- Maintain water quality and specifically mean winter dissolved inorganic nitrogen (DIN) at a concentration equating to High Ecological Status (specifically mean winter DIN is <12µM for coastal waters), avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. concentrations of suspended sediment, plankton and other material) across the habitat.

9.15.3.4.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1548. SEP and DEP are situated 112km and 116km respectively from the Flamborough and Filey Coast SPA boundary at the nearest point. The mean maximum foraging range of razorbill is 88.7km (±75.9km) and the maximum foraging range is 313km. When data from breeding razorbills at Fair Isle is excluded, where reduced prey availability was considered to be causing substantially increased foraging ranges during the breeding season, the mean maximum foraging range decreases to 73.8km (±48.4km) and the maximum foraging range to 191km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of razorbill from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 48.5km (±35.0km) based on data from three sites. The updated review of Woodward *et al*. (2019), based on 16 sites, gives a larger mean maximum foraging range.

1549. SEP and DEP are therefore beyond the mean maximum foraging range of razorbills from the Flamborough and Filey Coast SPA, but within the mean maximum foraging range plus one standard deviation, and the maximum foraging range. The latter two measurements are considered to be poor indicators of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity.

1550. Modelled at-sea distributions derived from tracking data during the breeding season from breeding adult birds (Cleasby *et al*., 2020, 2018; Wakefield *et al*., 2017) indicate that SEP and DEP are outside the home foraging range (i.e. beyond the 95% utilisation distribution) of razorbills from the Flamborough and Filey Coast SPA. This information does not mean that breeding adult razorbills from the Flamborough and Filey Coast SPA will not be present at SEP and DEP during the breeding season. However, it does suggest that the majority of razorbills recorded on site during the breeding season are unlikely to be breeding adults from the SPA.

1551. SEP and DEP are not within foraging range of breeding razorbills from any other SPAs. It therefore seems likely based on the above foraging range and utilisation distributions that the majority of birds recorded at SEP and DEP during the breeding season are non-breeding adults and sub-adult birds which have not yet reached breeding age. This may include birds from the Flamborough and Filey Coast SPA and other breeding colonies.

1552. Outside the breeding season breeding razorbills are assumed to range widely and to mix with razorbills of all ages from breeding colonies in the UK and further afield. The relevant background population is considered to be the UK North Sea and Channel BDMPS, consisting of 591,874 individuals during autumn and spring passage periods (August to October and January to March), and 218,622 individuals during winter (November and December) (Furness, 2015).

1553. During autumn and spring migration, 100% of the SPA breeding adults (20,002 individuals based on the 2008 population estimate) are assumed to be present in the BDMPS, representing 3.4% of the BDMPS population (591,874 individuals of all ages). During the winter season, 30% of the SPA breeding adults (6,001 individuals based on the 2008 population estimate) are assumed to be present in the BDMPS, representing 2.7% of the BDMPS population (218,622 individuals of all ages). These percentages (i.e. 3.4% and 2.7%) are the proportions of birds present at SEP and DEP that are presumed to originate from the Flamborough and Filey Coast SPA during the relevant seasons.

9.15.3.4.3 Potential Effects on the Qualifying Feature

1554. The razorbill qualifying feature of the Flamborough and Filey Coast SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects.

9.15.3.4.4 Potential Effects of SEP and DEP in Isolation and Together

9.15.3.4.4.1 Operational Phase Displacement/Barrier Effects

1555. Population estimates of razorbill at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-117**, **Table 9-118** and **Table 9-119** respectively.

1556. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017).

1557. The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. Whilst it is true that guillemots and razorbills tend to be displaced by OWFs they do not avoid them completely, and displacement rates vary between sites (MacArthur Green, 2019c). On average it was concluded that densities within OWFs are around half of the density found in the habitats around the OWF. At some OWFs there is also displacement of birds from a buffer zone surrounding it. The size of the buffer zone varies between OWFs and is generally less than 2km, with auk density increasing across the buffer zone as distance from turbines increases, up to the density in the wider area. Another recent review (APEM, 2022) suggested that the current displacement rates suggested by the SNCBs for guillemot and razorbill (0.300 to 0.700) did not account for the quality of or confidence in the studies which were used to inform this position, and that studies where no significant effects were recorded were not accounted for during the provision of the advice. APEM (2022) suggested that in the case of Hornsea Project Four, an evidence-based displacement rate of 0.500 was appropriate. However, the study also recognised that larger displacement effects are possible.

1558. Mortality due to displacement could arise due to increased energy costs and/or decreased energy intake, if displacement results in increased flying time to avoid OWFs, and/or increased bird densities and competition for prey in areas of unimpacted habitat outside the OWF. Given that UK OWFs in the North Sea represent a very small proportion of the available foraging habitat for guillemots and razorbills within UK North Sea waters, the increase in density of auks outside OWFs due to displacement is likely to be negligible (MacArthur Green, 2019c). It is considered unlikely that the mortality rate due to displacement would be as high as the empirically estimated 6.1% annual mortality for adult guillemots that occurs due to the combination of ‘natural’ factors and anthropogenic activities (Horswill and Robinson, 2015). Indeed, it may be much lower; MacArthur Green (2019c) recommended precautionary rates of 50% displacement for guillemot and 1% mortality of displaced birds based on a review of available evidence. Modelling undertaken by APEM (2022) found that in the case of Hornsea Project Four, a mortality rate of 1% for displaced auks was considered to be precautionary, and that this may be an overestimate given that Hornsea Project Four is located towards the upper end of the mean maximum foraging range for guillemot from the Flamborough and Filey Coast SPA. As SEP and DEP are beyond the mean maximum range of birds from this colony, it is anticipated that a mortality rate of 1% represents a highly precautionary estimate.

1559. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult razorbills belonging to the Flamborough and Filey Coast SPA population is presented in **Table 9-117** (DEP), **Table 9-118** (SEP) and **Table 9-119** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult razorbills belonging to the Flamborough and Filey Coast SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-117: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Razorbills at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	6,857 (b) 1,469 (aut) 1,348 (win) 652 (spr) 10,326 (year round)	0 (b) 50 (aut) 36 (win) 22 (spr) 108 (year round)	0 - 8 (1)	0.01 - 0.18 (0.01)
Mean	3,741 (b) 923 (aut) 845 (win) 320 (spr) 5,829 (year round)	0 (b) 31 (aut) 23 (win) 11 (spr) 65 (year round)	0 - 5 (0)	0.00 - 0.11 (0.01)
Lower 95% CI	1,266 (b) 518 (aut) 450 (win) 85 (spr) 2,319 (year round)	0 (b) 18 (aut) 12 (win) 3 (spr) 33 (year round)	0 - 2 (0)	0.00 - 0.05 (0.01)

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For breeding season (Apr-Jul), assumes 0% of birds are Flamborough and Filey Coast SPA breeding adults. For autumn migration and spring migration seasons, assumes 3.4% of birds are Flamborough and Filey Coast SPA breeding adults. For winter season, assumes 2.7% of birds are Flamborough and Filey Coast SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Flamborough and Filey Coast SPA breeding adults (40,506 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)

Table 9-118: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Razorbills at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,245 (b) 421 (aut) 1,112 (win) 300 (spr) 3,078 (year round)	0 (b) 14 (aut) 30 (win) 10 (spr) 55 (year round)	0 - 4 (0)	0.00 - 0.09 (0.01)
Mean	759 (b) 316 (aut) 686 (win) 144 (spr) 1,905 (year round)	0 (b) 11 (aut) 19 (win) 5 (spr) 34 (year round)	0 - 2 (0)	0.00 - 0.06 (0.00)
Lower 95% CI	326 (b) 206 (aut) 339 (win) 26 (spr) 897 (year round)	0 (b) 7 (aut) 9 (win) 1 (spr) 17 (year round)	0 - 1 (0)	0.00 - 0.03 (0.00)

Notes

1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For breeding season (Apr-Jul), assumes 0% of birds are Flamborough and Filey Coast SPA breeding adults. For autumn migration and spring migration seasons, assumes 3.4% of birds are Flamborough and Filey Coast SPA breeding adults. For winter season, assumes 2.7% of birds are Flamborough and Filey Coast SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Flamborough and Filey Coast SPA breeding adults (40,506 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)

Table 9-119: Predicted Operational Phase Displacement and Mortality of Flamborough and Filey Coast SPA Breeding Adult Razorbills at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	8,101 (b) 1,890 (aut) 2,460 (win) 951 (spr) 13,402 (year round)	0 (b) 64 (aut) 66 (win) 32 (spr) 163 (year round)	1 - 11 (1)	0.01 - 0.27 (0.02)
Mean	4,500 (b) 1,239 (aut)	0 (b) 42 (aut)	0 - 7 (0)	0.01 - 0.16 (0.01)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	1,531 (win) 464 (spr) 7,734 (year round)	41 (win) 16 (spr) 99 (year round)		
Lower 95% CI	1,591 (b) 724 (aut) 789 (win) 111 (spr) 3,214 (year round)	0 (b) 25 (aut) 21 (win) 4 (spr) 50 (year round)	0 - 3 (0)	0.00 - 0.08 (0.01)

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For breeding season (Apr-Jul), assumes 0% of birds are Flamborough and Filey Coast SPA breeding adults. For autumn migration and spring migration seasons, assumes 3.4% of birds are Flamborough and Filey Coast SPA breeding adults. For winter season, assumes 2.7% of birds are Flamborough and Filey Coast SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Flamborough and Filey Coast SPA breeding adults (40,506 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)

1560. Based on the mean peak abundances, the annual total of razorbills from the Flamborough and Filey Coast SPA at risk of displacement from SEP and DEP is 99 birds (**Table 9-119**); 65 at DEP (**Table 9-117**) and 34 at SEP (**Table 9-118**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 0.2 to 4.6 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.1 to 2.4 birds due to displacement from SEP.

1561. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.11% due to impacts at DEP, and 0.06% due to impacts at SEP (0.16% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the Flamborough and Filey Coast SPA breeding adult razorbill population would increase by 0.01% due to impacts at DEP (0.3 birds), <0.01% due to impacts at SEP (0.2 birds), and 0.01% due to the impacts of SEP and DEP together (0.5 birds).

1562. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 12.6% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1563. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak or upper 95% CIs for mean peak abundance estimate assessments are considered.

1564. **It is concluded that predicted razorbill mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

1565. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.15.3.4.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.15.3.4.5.1 Operational Phase Displacement/Barrier Effects

1566. Seasonal and annual population estimates of breeding adult razorbill of the Flamborough and Filey Coast SPA at all OWFs included in the in-combination assessment are presented in **Table 9-120**. This information was taken from the latest numbers presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a). The Hornsea Project Four ES Chapter has been published since the publication of the above document. However, relevant representations of Natural England (Natural England, 2021) indicate that they consider that the importance of the Hornsea Project Four site to Flamborough and Filey Coast SPA razorbill during August and September has not been accounted for in the assessment. For this reason, the estimated razorbill mortality for displacement due to Hornsea Project Four is taken from the PEIR. This assessment will be updated as further information becomes available.

1567. The estimated annual total of breeding adult razorbills from Flamborough and Filey Coast SPA at risk of displacement from all OWFs within the UK North Sea BDMPS combined is 7,166 (**Table 9-120**). Of this total, SEP and DEP contribute 0.5% and 1.0% respectively. Using displacement rates of 0.300 to 0.700 and mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017), the number of Flamborough and Filey Coast SPA birds predicted to die each year would be between 21 to 502 (**Table 9-121**).

1568. The estimated increase in mortality of Flamborough and Filey Coast SPA breeding adult razorbill due to in-combination displacement impacts is between 0.51% and 11.79%. Increases in the existing mortality rate of greater than 1% could be detectable against natural variation.

Table 9-120: Seasonal and Annual Population Estimates of All Razorbills at SEP, DEP and Other OWFs Included in the In-Combination Assessment, and Breeding Adult Birds Apportioned to Flamborough and Filey Coast SPA

Tier	OWF	Seasonal population at risk of displacement[1]									
		Breeding		Autumn migration		Winter		Spring migration		Total	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	Beatrice	873.0	0.0	833.0	28.3	555.0	15.0	833.0	28.3	3094.0	72.0
1	Beatrice Demonstrator	No estimate available									
1	Blyth Demonstration Project	121.0	0.0	91.0	3.1	61.0	1.6	91.0	3.1	364.0	8.0
1	Dudgeon	256.0	0.0	346.0	11.8	745.0	20.1	346.0	11.8	1693.0	44.0
1	East Anglia ONE	16.0	0.0	26.0	0.9	155.0	4.2	336.0	11.4	533.0	17.0
1	European Offshore Wind Deployment Centre	161.0	0.0	64.0	2.2	7.0	0.2	26.0	0.9	258.0	3.0
1	Galloper	44.0	0.0	43.0	1.5	106.0	2.8	394.0	13.4	587.0	18.0
1	Greater Gabbard	0.0	0.0	0.0	0.0	387.0	10.5	84.0	2.8	471.0	13.0
1	Gunfleet Sands	0.0	0.0	0.0	0.0	30.0	0.8	0.0	0.0	30.0	1.0
1	Hornsea Project One	1109.0	534.5	4812.0	163.6	1518.0	41.0	1803.0	61.3	9242.0	800.0
1	Humber Gateway	27.0	0.0	20.0	0.7	13.0	0.4	20.0	0.7	80.0	2.0
1	Hywind	30.0	0.0	719.0	24.4	10.0	0.3	-	-	759.0	25.0
1	Kentish Flats	No estimate available									
1	Kentish Flats Extension	No estimate available									
1	Kincardine	22.0	0.0	-	0.0	-	0.0	-	-	22.0	0.0
1	Lincs & LID	45.0	0.0	34.0	1.1	22.0	0.6	34.0	1.1	134.0	3.0

Tier	OWF	Seasonal population at risk of displacement[1]									
		Breeding		Autumn migration		Winter		Spring migration		Total	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
1	London Array	14.0	0.0	20.0	0.7	14.0	0.4	20.0	0.7	68.0	2.0
1	Race Bank	28.0	0.0	42.0	1.4	28.0	0.8	42.0	1.4	140.0	4.0
1	Rampion	630.0	0.0	66.0	2.2	1244.0	33.6	3327.0	113.1	5267.0	149.0
1	Scroby Sands	No estimate available									
1	Sheringham Shoal	106.0	0.0	1343.0	45.7	211.0	5.7	30.0	1.0	1690.0	52.0
1	Teesside	16.0	0.0	61.0	2.1	2.0	0.1	20.0	0.7	99.0	3.0
1	Thanet	3.0	0.0	0.0	0.0	14.0	0.4	21.0	0.7	37.0	1.0
1	Westermost Rough	91.0	91.0	121.0	4.1	152.0	4.1	91.0	3.1	455.0	102.0
2	Triton Knoll	40.0	0.0	254.0	8.6	855.0	23.1	117.0	4.0	1265.0	36.0
3	Dogger Bank Creyke Beck A	1250.0	375.0	1576.0	53.6	1728.0	46.7	4149.0	141.1	8703.0	616.0
3	Dogger Bank Creyke Beck B	1538.0	461.4	2097.0	71.3	2143.0	57.9	5119.0	174.0	10897.0	765.0
3	Dogger Bank Teesside A	834.0	250.2	310.0	10.6	959.0	25.9	1919.0	65.2	4022.0	352.0
3	Dogger Bank Teesside B	1153.0	345.9	592.0	20.1	1426.0	38.5	2953.0	100.4	6125.0	505.0
3	East Anglia THREE	1807.0	0.0	1122.0	38.1	1499.0	40.5	1524.0	51.8	5952.0	130.0
3	Firth of Forth Alpha	5876.0	0.0	-	-	1103.0	29.8	-	-	6979.0	30.0
3	Firth of Forth Bravo	3698.0	0.0	-	-	1272.0	34.3	-	-	4970.0	34.0
3	Hornsea Project Three	630.0	0.0	2020.0	69.0	3649.0	99.0	2105.0	72.0	8404.0	240.0
3	Hornsea Project Two	2511.0	1210.3	4221.0	143.5	720.0	19.4	1668.0	56.7	9119.0	1430.0
3	Inch Cape	1436.0	0.0	2870.0	97.6	651.0	17.6	-	-	4957.0	115.0

Tier	OWF	Seasonal population at risk of displacement[1]									
		Breeding		Autumn migration		Winter		Spring migration		Total	
		Total	FFC	Total	FFC	Total	FFC	Total	FFC	Total	FFC
3	Methil	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.0	0.0
3	Moray Firth (EDA)	2423.0	0.0	1103.0	37.5	30.0	0.8	168.0	5.7	3724.0	44.0
3	Moray West	2808.0	0.0	3544.0	120.5	184.0	5.0	3585.0	121.9	10121.0	247.0
3	Neart na Gaoithe	331.0	0.0	5492.0	186.7	508.0	13.7	-	-	6331.0	200.0
3	Norfolk Boreas	630.0	0.0	263.0	8.9	1065.0	28.8	345.0	11.7	2303.0	49.0
3	Norfolk Vanguard	879.0	0.0	866.0	29.5	839.0	22.7	924.0	31.4	3508.0	84.0
3	East Anglia ONE North	403.0	0.0	85.0	2.9	54.0	1.5	207.0	7.0	749.0	11.0
3	East Anglia TWO	281.0	0.0	44.1	1.5	136.4	3.7	230.0	7.8	692.0	13.0
Total (all projects above)		**32124**	**3268**	**35100**	**1194**	**24095**	**652**	**32531**	**1106**	**123848**	**6220**
5	*Hornsea 4 (PEIR)*	*580.0*	*580.0*	*5960.0*	*202.6*	*685.0*	*18.5*	*1361.0*	*46.3*	*8586.0*	*847.4*
5	*DEP*	*3741.0*	*0.0*	*923.0*	*31.4*	*845.0*	*22.8*	*320.0*	*10.9*	*5829.0*	*68.7*
5	*SEP*	*759.0*	*0.0*	*315.5*	*10.7*	*685.5*	*18.5*	*144.0*	*4.9*	*1904.0*	*37.9*
Total (all projects)		**37204**	**3848**	**42299**	**1438**	**26311**	**712**	**37204**	**1168**	**140167**	**7166**

Notes
1. The preferred standard is the OWF plus a 2km buffer, however the buffer zones included in this assessment varied between 0-4km depending on the data available, see **Appendix 11.2 Supplementary Information to Inform the Offshore Ornithology Cumulative Impact Assessment** (document reference 6.3.11.2) for further details and sources of seasonal populations for other OWFs besides SEP and DEP. Dashes indicate no data available for a given OWF.

Table 9-121: In-Combination Displacement Matrix for Razorbill from Flamborough and Filey Coast SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	7	14	21	29	36	72	143	215	358	573	717
	20	14	29	43	57	72	143	287	430	717	1147	1433
	30	21	43	64	86	107	215	430	645	1075	1720	2150
	40	29	57	86	115	143	287	573	860	1433	2293	2866
	50	36	72	107	143	179	358	717	1075	1792	2866	3583
	60	43	86	129	172	215	430	860	1290	2150	3440	4300
	70	50	100	150	201	251	502	1003	1505	2508	4013	5016
	80	57	115	172	229	287	573	1147	1720	2866	4586	5733
	90	64	129	193	258	322	645	1290	1935	3225	5160	6449
	100	72	143	215	287	358	717	1433	2150	3583	5733	7166

1569. PVAs examining the effect of the mortality rates generated by the in-combination displacement assessment at the population level have been produced (**Table 9-122**).

1570. Displacement and mortality rates covering the entire range recommended by the SNCBs have been considered. CGR and CPS have been produced from the model outputs and are presented. These measure changes in annual growth rate and population size at the end of the impacted period relative to the unimpacted scenario, which in this case is 40 years. These outputs are favoured due to their relatively high tolerance for misspecification of input parameters, which is common in population modelling (Jitlal *et al*., 2017).

1571. The increase in existing mortality rate due to the predicted impact is also presented. This is a PVA input and was calculated by adding the predicted mortality to existing mortality, dividing the resultant total by the starting population to calculate a new mortality rate, and subtracting the original mortality rate from the new mortality rate to obtain the difference between the two.

Table 9-122: PVA Outputs for Breeding Adult Flamborough and Filey Coast SPA Razorbills Incorporating Mean Displacement Impacts of SEP and DEP In-Combination with Other Projects

Displacement rate	Mortality rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
0.300	1%	22	0.0005313287	0.999	0.975
	2%	43	0.0010626574	0.999	0.950
	5%	108	0.0026566435	0.997	0.879
	10%	215	0.0053132869	0.994	0.773
0.400	1%	29	0.0007084383	0.999	0.966
	2%	57	0.0014168765	0.998	0.934
	5%	143	0.0035421913	0.996	0.842
	10%	287	0.0070843826	0.992	0.709
0.500	1%	36	0.0008855478	0.999	0.959
	2%	72	0.0017710956	0.998	0.917
	5%	179	0.0044277391	0.995	0.807
	10%	359	0.0088554782	0.990	0.650
0.600	1%	43	0.0010626574	0.999	0.950
	2%	86	0.0021253148	0.997	0.902
	5%	215	0.0053132869	0.994	0.773
	10%	430	0.0106265738	0.987	0.596
0.700	1%	50	0.0012397669	0.999	0.942
	2%	100	0.0024795339	0.997	0.886
	5%	251	0.0061988347	0.993	0.740
	10%	502	0.0123976695	0.985	0.546

Notes
1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is Flamborough and Filey Coast SPA breeding adults (40,506 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)
3. After 40 years of operation

1572. The PVA investigating the population-level effects of potential displacement impacts for SEP and DEP in-combination with other projects produced a wide range of median CGR and CPS values depending on the displacement and mortality rates used to estimate the magnitude of the impact.

1573. At the upper end of the displacement and mortality rates examined (0.700 displacement and 10% mortality of displaced birds), the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.985 and a CPS of 0.546. At the lower end of the displacement and mortality rates examined (0.300 displacement and 1% mortality of displaced birds), the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.999 and a CPS of 0.975. Using the evidence-based displacement and mortality rates of 0.500 displacement and 1% mortality of displaced birds, the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.999 and a CPS of 0.959.

1574. The counterfactuals calculated from the model outputs should be interpreted according to the level of precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The use of mean peak abundance estimates in displacement modelling may result in estimates of displaced birds being unrealistically high;
- The upper range of displacement rates considered may be overestimated;
- The mortality rates assumed for displaced birds may be overestimated;
- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary; and
- The Flamborough and Filey Coast SPA razorbill population is modelled as a closed population, with no emigration or immigration occurring.

1575. The impacts predicted at SEP and DEP, in-combination with other projects, will not prevent the majority of the Conservation Objectives from being met. However, there is potential for the Conservation Objective for the razorbill population size of the Flamborough and Filey Coast SPA not being met due to the predicted impacts. This is to maintain the size of the breeding population at a level which is above 10,570 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

1576. The razorbill population of the Flamborough and Filey Coast SPA increased on average by 5.8% annually between 1986 and 2017. Between 2008 and 2017, the annual growth rate increased to 9.7%. Whilst this is no guarantee of the future population trend of the colony, it might be the case that scenarios where the CGR is sufficiently low may result in a reduction in the growth rate of the colony, rather than recent trends reversing, and the population going into decline. The Conservation Objective for population size could therefore be met despite the predicted in-combination impacts.

1577. The percentage reduction in growth rate resulting from each of the median CGRs presented in **Table 9-122** is presented in **Table 9-123**. This assumes that the Flamborough and Filey Coast razorbill population would continue to increase at a rate of 5.8% annual growth for the next 40 years, as it did between 1986 and 2017. In this scenario, none of the 20 impact scenarios presented in **Table 9-122** would cause the population to decline. Instead, the growth rate would decrease in all scenarios.

Table 9-123: Percentage Reduction of the Breeding Adult Razorbill Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 5.8%, which is the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red

	0.300	0.400	0.500	0.600	0.700
1%	1.7%	1.7%	1.7%	1.7%	1.7%
2%	1.7%	3.4%	3.4%	5.2%	5.2%
5%	5.2%	6.9%	8.6%	10.3%	12.1%
10%	10.3%	13.8%	17.2%	22.4%	25.9%

1578. There is no guarantee that the Flamborough and Filey Coast razorbill population would continue to increase at a rate of 5.8% annual growth for the next 40 years, as it did between 1986 and 2017. Three further population trend scenarios have therefore been considered. These are situations where the future population growth of the colony is half (i.e. 2.90%), a quarter (i.e. 1.45%), and an eighth (i.e. 0.73%) of the growth rate recorded at the colony between 1986 and 2017.

1579. The percentage reduction in growth rate resulting from each of the median CGRs presented in **Table 9-122** is presented in **Table 9-124**, **Table 9-125** and **Table 9-126** respectively for each scenario.

1580. Assuming a future growth rate of 2.90%, none of the 20 impact scenarios presented in **Table 9-122** would cause the population to decline. Assuming a future growth rate of 1.45%, one of the 20 impact scenarios presented in **Table 9-122** would cause the population to decline; the scenario where the mortality of displaced birds is assumed to be 10% in conjunction with a displacement rate of 0.500. Assuming a future growth rate of 0.73%, four of the 20 impact scenarios presented in **Table 9-122** would cause the population to decline. These involve all scenarios where the mortality of displaced birds is assumed to be 10%, in conjunction with displacement rates of 0.400 and above were assumed.

Table 9-124: Percentage Reduction of the Breeding Adult Razorbill Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 2.90%, which is Half of the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red

	0.300	0.400	0.500	0.600	0.700
1%	3.4%	3.4%	3.4%	3.4%	3.4%
2%	3.4%	6.9%	6.9%	10.3%	10.3%
5%	10.3%	13.8%	17.2%	20.7%	24.1%
10%	20.7%	27.6%	34.5%	44.8%	51.7%

Table 9-125: Percentage Reduction of Breeding Adult Razorbill at the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 1.45%, which is a Quarter of the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red

	0.300	0.400	0.500	0.600	0.700
1%	6.9%	6.9%	6.9%	6.9%	6.9%
2%	6.9%	13.8%	13.8%	20.7%	20.7%
5%	20.7%	27.6%	34.5%	41.4%	48.3%
10%	41.4%	55.2%	69.0%	89.7%	103.4%

Table 9-126: Percentage Reduction of the Breeding Adult Razorbill Population Growth Rate of the Flamborough and Filey Coast SPA due to In-Combination Displacement Impacts. Assumes Baseline Growth Rate of 0.73%, which is an Eighth of the Average Annual Growth Rate Recorded between 1986 and 2017. Scenarios which would Result in Reduction in Colony Population are Shaded Red

	0.300	0.400	0.500	0.600	0.700
1%	13.8%	13.8%	13.8%	13.8%	13.8%
2%	13.8%	27.6%	27.6%	41.4%	41.4%
5%	41.4%	55.2%	69.0%	82.8%	96.6%
10%	82.8%	110.3%	137.9%	179.3%	206.9%

1581. In conclusion, even in scenarios where the growth rate of the Flamborough and Filey Coast SPA razorbill colony is considerably reduced from levels recorded between 1986 and 2017, the application of appropriately precautionary levels of displacement and mortality of displaced birds indicate that a slowing of the population growth rate, rather than a population decline, is likely as a result of in-combination displacement effects. Whilst the CPSs generated from the PVA outputs in **Table 9-122** suggest a large change in population at the end of the operational period, this is somewhat inevitable over the length of the operational phase, even when the predicted annual impacts appear smaller. The colony would remain at a size greater than the 20,253 pairs or 40,506 adults required by the population size Conservation Objective.

1582. The displacement impacts predicted at SEP and DEP, in-combination with other projects, will not prevent all of the other Conservation Objectives from being met.

1583. **It is concluded that predicted razorbill mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Flamborough and Filey Coast SPA.**

9.16 Coquet Island SPA

9.16.1 Description of Designation

1584. Coquet Island is located 1km off the coast of Northumberland. It is a small, flat-topped island with a plateau extent of approximately seven hectares. The island consists of sandy soil and peat over a soft sandstone base. Low cliffs of up to 3.7m high result from earlier quarrying. Surrounding the island is a rocky upper shore and intertidal. There is a sandy beach on the southwest of the island and the southeast corner is shingle and rock.

9.16.2 Conservation Objectives

1585. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.16.3 Appropriate Assessment

1586. The qualifying features of this SPA screened into the Appropriate Assessment are listed in **Table 5-2**. These are breeding Arctic tern, breeding common tern, and breeding Sandwich tern.

9.16.3.1 Arctic Tern

9.16.3.1.1 Status

1587. The SPA breeding population at classification was 1,230 pairs or 2,460 breeding adults, for the period 2010 to 2014 (Natural England, 2017a). The most recent count is 1,155 pairs, or 2,310 breeding adults, in 2019 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 377 breeding adult birds per year based on the published adult mortality rate of 16.3% (Horswill and Robinson, 2015).

9.16.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1588. The mean maximum foraging range of Arctic tern is 25.7km (±14.8km) and the maximum foraging range is 46km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Arctic tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 24.2km (±6.3km) based on data from four sites. The updated review of Woodward *et al*. (2019), based on five studies at nine sites, gives a smaller mean maximum foraging range.

1589. The Coquet Island SPA is located approximately 280km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1590. During the pre and post breeding periods, breeding Arctic terns from the Coquet Island SPA migrate through UK waters. The relevant reference population is the UK

North Sea and Channel BDMPS, consisting of 163,930 individuals during autumn migration (July to early September) and spring migration (late April to May) (Furness, 2015). During these seasons it is estimated that 1.5% of birds present are breeding adults from the Coquet Island SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.16.3.1.3 Potential Effects on the Qualifying Feature

1591. The Arctic tern qualifying feature of the Coquet Island SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.16.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.16.3.1.4.1 Collision Risk

1592. Information to inform the Appropriate Assessment for collision risk on breeding adult Arctic terns belonging to the Coquet Island SPA population is presented in **Table 9-127**. Collision estimates are presented by month. The avoidance rate used was 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1593. Based on the mean collision rates, the annual total of breeding adult Arctic terns from the Coquet Island SPA at risk of collision at SEP and DEP together is <0.01. This would increase the existing mortality of the SPA breeding population by <0.01%.

Table 9-127: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Arctic Tern at SEP and DEP Apportioned to Coquet Island SPA

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.
2. For autumn migration season (Jul-Sept) and spring migration season (Apr-May), assumes 1.5% of adult birds are Coquet Island SPA breeders (Furness 2015). For breeding season (May-Aug), assumes 0% of adult birds are Coquet Island SPA breeders

1594. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is <0.01% due to the collision impacts of SEP and DEP together.

1595. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Coquet Island SPA.**

1596. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.16.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.16.3.1.5.1 Collision Risk

1597. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Arctic tern population of the Coquet Island SPA are extremely small (i.e. virtually zero) (**Table 9-127**). Potential in-combination effects of OWF collision on Arctic tern have not been investigated quantitatively. However, the low flight heights that are generally favoured by this species (“Corrigendum,” 2014; Johnston *et al*., 2014), particularly during migration (Hedenström and Åkesson, 2016), indicate that the possibility of a substantial cumulative impact on this species is unlikely. During the breeding season, only a single OWF demonstrator site is within mean maximum foraging range plus one standard deviation of this SPA. Whilst birds were present in small numbers, quantitative assessment was not performed, and potential mortality is anticipated to be very low.

1598. Outside the breeding season, there is potential for other OWFs to impact this qualifying feature during the spring and autumn migration seasons. However, a review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. As approximately just 1.5% of migration season impacts on this species would be apportioned to this SPA population (Furness, 2015), it is considered unlikely that in-combination effects on this qualifying feature will occur to the level where an adverse effect on the integrity of the site would be possible.

1599. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Coquet Island SPA.**

9.16.3.2 Sandwich Tern

9.16.3.2.1 Status

1600. The SPA breeding population at classification was 1,300 pairs or 2,600 breeding adults, for the period 2010 to 2014 (Natural England, 2017a). The most recent count is 1,652 pairs in 2019, or 3,304 breeding adults (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 337 breeding adult birds per year based on the published adult mortality rate of 10.2% (Horswill and Robinson, 2015).

9.16.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1601. The mean maximum foraging range of Sandwich tern is 34.3km (±23.2km), and the maximum foraging range is 54km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Sandwich tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 49km (±7.1km) based on data from two sites. The updated review of Woodward *et al.* (2019), based on five sites, gives a smaller mean maximum foraging range. However, it was noted by the recent review that clear differences in data collected using different methods (i.e. boat tracking versus tagged birds) means that the confidence level in the data was changed from “high” to “moderate”.

1602. The Coquet Island SPA is located approximately 280km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1603. Outside the breeding season breeding Sandwich terns are assumed to range widely and to mix with birds of all ages from breeding colonies in the UK and further afield. The relevant background population is considered to be the UK North Sea and Channel BDMPS, consisting of 38,051 individuals during autumn migration (July to September), and spring migration (March to May) (Furness, 2015).

1604. Estimates of the proportion of Sandwich terns present at SEP and DEP during the autumn and spring migration seasons which originate from the Coquet Island SPA are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS (Furness 2015). During both autumn and spring migration seasons, breeding adult Sandwich terns from the Coquet Island SPA make up 5.1% of the total BDMPS population. The same percentage of impacts are therefore attributable to birds from this SPA during these times of year.

9.16.3.2.3 Potential Effects on the Qualifying Feature

1605. The Sandwich tern qualifying feature of the Coquet Island SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.16.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.16.3.2.4.1 Operational Phase Displacement/Barrier Effects

1606. Population estimates of Sandwich tern at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-128**, **Table 9-129** and **Table 9-130** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult Sandwich tern belonging to the Coquet Island SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

1607. Displacement rates of 0.000 to 0.500 are considered to be appropriate for this species based on a review of available evidence (Cook *et al.*, 2014; Green *et al.*, 2019, 2018; Harwood *et al.*, 2018; Krijgsveld *et al.*, 2011; Scragg *et al.*, 2016; Thaxter *et al.*, 2018). A maximum mortality rate of 1% of displaced birds is considered to be appropriate, based on the existing mortality of adult birds of 0.102 (Horswill and Robinson, 2015), and low energy expenditure predictions of a closely related species (common tern) due to barrier effects by OWFs (Masden *et al.*, 2010).

Table 9-128: Predicted Operational Phase Displacement and Mortality of Coquet Island SPA Breeding Adult Sandwich Terns at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	346 (breeding) 132 (autumn) 0 (spring)	0 (breeding) 7 (autumn) 0 (spring)	0 - 0	0.00 - 0.01
Mean	179 (breeding) 45 (autumn) 0 (spring)	0 (breeding) 2 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Lower 95% CI	62 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0 - 0	0.00 - 0.00

Notes
1. For breeding season (Apr-Aug), assumes 0% of adult birds are Coquet Island SPA breeders. For autumn and spring migration seasons (September and March), assumes 5.1% of adult birds are Coquet Island SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
3. Background population is Coquet Island SPA breeding adults (3,304 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-129: Predicted Operational Phase Displacement and Mortality of Coquet Island SPA Breeding Adult Sandwich Terns at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	139 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Mean	77 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Lower 95% CI	25 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Notes 1. For breeding season (Apr-Aug), assumes 0% of adult birds are Coquet Island SPA breeders. For autumn and spring migration seasons (September and March), assumes 5.1% of adult birds are Coquet Island SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Coquet Island SPA breeding adults (3,304 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-130: Predicted Operational Phase Displacement and Mortality of Coquet Island SPA Breeding Adult Sandwich Terns at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	485 (breeding) 132 (autumn) 0 (spring)	0 (breeding) 7 (autumn) 0 (spring)	0 - 0	0.00 - 0.01
Mean	255 (breeding) 45 (autumn) 0 (spring)	0 (breeding) 2 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Lower 95% CI	86 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Notes				

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
1. For breeding season (Apr-Aug), assumes 0% of adult birds are Coquet Island SPA breeders. For autumn and spring migration seasons (September and March), assumes 5.1% of adult birds are Coquet Island SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Coquet Island SPA breeding adults (3,304 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

1608. Based on the mean peak abundances, the annual total of Sandwich terns from the Coquet Island SPA at risk of displacement from SEP and DEP together is two birds, both of which would occur at DEP. At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 0.01 SPA breeding adults would be predicted to die each year due to displacement from DEP. The combined mean displacement mortality from SEP and DEP would increase annual mortality within this population by <0.01% (**Table 9-130**). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peak abundances are used as inputs to the assessment, since the maximum predicted mortality increase that could occur on this basis represents a 0.01% increase to baseline mortality.

1609. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Coquet Island SPA.**

1610. The confidence in the assessment is high for several reasons. Firstly, despite not being available in large quantities, the evidence used to set the displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.16.3.2.4.2 Collision Risk

1611. Collision risk predictions for Coquet Island SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-131**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-132**. Outputs are based on Option 1 of the Band Model, avoidance rates of 0.980, and the flight height distribution of Harwood (2021). These parameters were agreed with Natural England during the Expert Topic Group (ETG) process. Nocturnal activity was set at 2% of daytime activity, based on an assessment of Sandwich tern tracking data from the Scolt Head population. Further information on this, detailed methodology and information on other input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1612. For DEP, the mean annual collision estimate increases the annual baseline mortality by <0.01%, and the predicted increase in the annual baseline mortality is 0.02% for the annual upper 95% CI output. For SEP, the mean and upper 95% CI output increases the annual baseline mortality by <0.01%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. These are very low collision rates which would be further reduced if correction for birds displaced by OWFs were included in the calculations. Whilst there is uncertainty around the level of macro-avoidance (i.e. displacement) that will actually occur, evidence indicates that this will be greater than zero (Cook *et al.*, 2014; Green *et al.*, 2019, 2018; Harwood *et al.*, 2018; Krijgsveld *et al.*, 2011; Scragg *et al.*, 2016; Thaxter *et al.*, 2018).

1613. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Coquet Island SPA.**

1614. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

Table 9-131: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP Apportioned to Coquet Island SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.00	0.00	0.00	0.09
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

Table 9-132: Predicted Annual Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP Apportioned to Coquet Island SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	0.02 (0.00 - 0.07)	0.00 (0.00 - 0.02)
SEP	0.00 (0.00 - 0.01)	0.00 (0.00 - 0.00)
SEP and DEP	0.02 (0.00 - 0.09)	0.01 (0.00 - 0.03)
Notes 1. Background population is Coquet Island SPA breeding adults (3,304 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)		

9.16.3.2.4.3 Combined Displacement/Barrier Effects and Collision Risk

1615. It was demonstrated in the Appropriate Assessment for Sandwich terns of the North Norfolk Coast SPA that when considering combined displacement and collision mortality, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Section 9.4.3.1.4.3**). The worst case scenario for combined operational phase displacement and collision for Coquet Island SPA Sandwich terns is therefore presented in **Table 9-132**. The annual mortality predicted and consequent increase in baseline annual mortality of the population is very small, far less than the 1% level at which effects may be detectable.

1616. **It is concluded that predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Coquet Island SPA.**

9.16.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.16.3.2.5.1 Operational Phase Displacement

1617. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Sandwich tern population of the Coquet Island SPA are extremely small, with a mean predicted annual mortality rate of <0.01 bird (**Table 9-130**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination operational phase OWF displacement effect on this qualifying feature.

1618. During the breeding season, only a single OWF demonstrator site is within mean maximum foraging range plus one standard deviation of this SPA. Whilst birds were present in small numbers, quantitative displacement assessment was not performed, and potential mortality is anticipated to be very low. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. During passage periods, it is anticipated that displacement impacts will result in very low mortality rates. This is because the increase in energetic expenditure of displacement will be lower than in the breeding season, when little or no impact on survival has also been predicted for some seabirds unless the OWF causing the effect is located close to the breeding colony (Searle *et al.*, 2017, 2014).

1619. Furthermore, as just 3.5% of total Sandwich tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1620. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF displacement on breeding Sandwich tern of the Coquet Island SPA, no such assessment has been performed. However, the information presented still provides relatively high confidence that mortality levels due to this impact are very low.

1621. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Coquet Island SPA.**

9.16.3.2.5.2 Collision Risk

1622. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Sandwich tern population of the Coquet Island SPA are extremely small, with a mean predicted annual mortality rate of <0.01 bird (**Table 9-132**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature.

1623. During the breeding season, only a single OWF demonstrator site is within mean maximum foraging range plus one standard deviation of this SPA. Whilst birds were present in small numbers, quantitative assessment was not performed, and potential mortality is therefore anticipated to be very low. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. However, the low flight heights that are generally used by this species during passage periods ("Corrigendum," 2014; Johnston *et al*., 2014), indicate that the possibility of a substantial in-combination collision impact on this species during these seasons is unlikely. Furthermore, as just 3.5% of total Sandwich tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1624. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF collision on breeding Sandwich tern of the Coquet Island SPA, no such assessment has been performed. However, the information presented provides relatively high confidence that mortality levels due to this impact are very low.

1625. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Coquet Island SPA.**

9.16.3.2.5.3 Combined Displacement and Collision Risk

1626. It was demonstrated in the Appropriate Assessment for Sandwich terns of the North Norfolk Coast SPA that when considering combined displacement and collision mortality, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Section 9.4.3.1.4.3**). The worst case scenario for combined operational phase displacement and collision for Coquet Island SPA Sandwich terns is therefore presented in **Table 9-132**. The annual mortality predicted and consequent increase in baseline annual mortality of the population is very small, far less than the 1% level at which effects may be detectable.

1627. **It is concluded that predicted Sandwich tern mortality due to combined displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Coquet Island SPA.**

9.16.3.3 Common Tern

9.16.3.3.1 Status

1628. The SPA breeding population at classification was 1,189 pairs or 2,378 breeding adults, for the period 2010 to 2014 (Natural England, 2017a). The most recent count is 1,652 pairs, or 3,304 breeding adults, in 2019 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 387 breeding adult birds per year based on the published adult mortality rate of 11.7% (Horswill and Robinson, 2015).

9.16.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1629. The mean maximum foraging range of common tern is 18.0km (±8.9km) and the maximum foraging range is 30km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of common tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 15.2km (±11.2km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on data from 16 studies, gives a larger mean maximum foraging range.

1630. The Coquet Island SPA is located approximately 280km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1631. During the pre and post breeding periods, breeding common terns from the Coquet Island SPA migrate through UK waters. The relevant reference population is the UK North Sea and Channel BDMPS, consisting of 144,911 individuals during autumn migration (late July to early September) and spring migration (April to May) (Furness, 2015). During these seasons it is estimated that 1.0% of birds present are breeding adults from the Coquet Island SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.16.3.3.3 Potential Effects on the Qualifying Feature

1632. The common tern qualifying feature of the Coquet Island SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.16.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.16.3.3.4.1 Collision Risk

1633. Information to inform the Appropriate Assessment for collision risk on breeding adult common terns belonging to the Coquet Island SPA population is presented in **Table 9-133**. Collision estimates are presented by month. The avoidance rate used was 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1634. Based on the mean collision rates, the annual total of breeding adult common terns from the Coquet Island SPA at risk of collision at SEP and DEP together is 0.01. This would increase the existing mortality of the SPA breeding population by <0.01%.

Table 9-133: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Common Tern at SEP and DEP Apportioned to Coquet Island SPA

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.06
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.
2. For autumn migration season (Jul-Sept) and spring migration season (Apr-May), assumes 1.0% of adult birds are Coquet Island SPA breeders (Furness 2015). For breeding season (May-Aug), assumes 0% of adult birds are Coquet Island SPA breeders

1635. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.07% due to the collision impacts of SEP and DEP together.

1636. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 36 flying birds were observed across DEP (of which 29 were within DEP-N, and seven within DEP-S). When corrected for the different survey transect lengths in both regions of DEP this means that encounter rate was 32.2% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not materially impact the predicted increases in annual mortality presented above.

1637. **It is concluded that predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Coquet Island SPA.**

1638. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.16.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.16.3.3.5.1 Collision Risk

1639. The predicted impacts of SEP and DEP in isolation and together on the breeding adult common tern population of the Coquet Island SPA are extremely small, with a mean predicted annual mortality rate of 0.01 bird (**Table 9-133**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. During the breeding season, only a single OWF demonstrator site is within mean maximum foraging range plus one standard deviation of this SPA. Whilst birds were present in small numbers, quantitative assessment was not performed, and potential mortality is therefore anticipated to be very low.

1640. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. However, the low flight heights that are generally used by this species during passage periods ("Corrigendum," 2014; Hedenström and Åkesson, 2016; Johnston *et al.*, 2014), indicate that the possibility of a substantial in-combination collision impact on this species during these seasons is unlikely. Furthermore, as just 1.0% of total common tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1641. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF collision on breeding common tern of the Coquet Island SPA, no such assessment has been performed. However, the information presented provides relatively high confidence that mortality levels due to this impact are very low. have not been investigated quantitatively.

1642. **It is concluded that predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Coquet Island SPA.**

9.17 Farne Islands SPA

9.17.1 Description of Designation

1643. The Farne Islands are a group of low-lying islands situated between 2km and 6km off the coast of Northumberland in northeast England. The islands are important nesting areas for a range of seabirds, especially terns, gulls and auks. Seabirds breeding at the SPA feed outside it in nearby waters, as well as more distantly in the North Sea.

9.17.2 Conservation Objectives

1644. The SPA's conservation objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

- The extent and distribution of the habitats of the qualifying features;
- The structure and function of the habitats of the qualifying features;
- The supporting processes on which the habitats of the qualifying features rely;
- The populations of each of the qualifying features; and
- The distribution of qualifying features within the site.

9.17.3 Appropriate Assessment

1645. The qualifying features of this SPA screened into the Appropriate Assessment are listed in **Table 5-2**. These are breeding Arctic tern, breeding Sandwich tern, breeding guillemot, and two named components of the seabird assemblage (kittiwake and puffin).

9.17.3.1 Arctic Tern

9.17.3.1.1 Status

1646. The SPA breeding population at classification was 2,003 pairs or 4,006 breeding adults, for the period 2010 to 2014 (Natural England, 2017a). The most recent count was 1,416 pairs, or 2,832 breeding adults, in 2019 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 462 breeding adult birds per year based on the published adult mortality rate of 16.3% (Horswill and Robinson, 2015).

9.17.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1647. The mean maximum foraging range of Arctic tern is 25.7km (±14.8km) and the maximum foraging range is 46km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Arctic tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 24.2km (±6.3km) based on data from four sites. The updated review of Woodward *et al.* (2019), based on five studies at nine sites, gives a smaller mean maximum foraging range.

1648. The Farne Islands SPA is located approximately 310km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1649. During the pre and post breeding periods, breeding Arctic terns from the Farne Islands SPA migrate through UK waters. The relevant reference population is the UK North Sea and Channel BDMPS, consisting of 163,930 individuals during autumn migration (July to early September) and spring migration (late April to May) (Furness, 2015). During these seasons it is estimated that 2.3% of birds present are breeding adults from the Farne Islands SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.17.3.1.3 Potential Effects on the Qualifying Feature

1650. The Arctic tern qualifying feature of the Farne Islands SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.17.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.17.3.1.4.1 Collision Risk

1651. Information to inform the Appropriate Assessment for collision risk on breeding adult Arctic terns belonging to the Farne Islands SPA population is presented in **Table 9-134**. Collision estimates are presented by month. The avoidance rate used was 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1652. Based on the mean collision rates, the annual total of breeding adult Arctic terns from the Farne Islands SPA at risk of collision at SEP and DEP together is 0.01. This would increase the existing mortality of the SPA breeding population by <0.01%.

Table 9-134: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Arctic Tern at SEP and DEP Apportioned to Farne Islands SPA

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.
2. For autumn migration season (Jul-Sept) and spring migration season (Apr-May), assumes 2.3% of adult birds are Farne Islands SPA breeders (Furness 2015). For breeding season (May-Aug), assumes 0% of adult birds are Farne Islands SPA breeders

1653. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.01% due to the collision impacts of SEP and DEP together.

1654. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

1655. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.17.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.17.3.1.5.1 Collision Risk

1656. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Arctic tern population of the Farne Islands SPA are extremely small (i.e. virtually zero) (**Table 9-134**). Potential in-combination effects of OWF collision on Arctic tern have not been investigated quantitatively. However, the low flight heights that are generally favoured by this species ("Corrigendum," 2014; Johnston *et al.*, 2014), particularly during migration (Hedenström and Åkesson, 2016), indicate that the possibility of a substantial cumulative impact on this species is unlikely.

1657. During the breeding season, no OWFs are within mean maximum foraging range plus one standard deviation of this SPA, therefore no breeding season impacts on this qualifying feature are predicted. Outside the breeding season, there is potential for other OWFs to impact this qualifying feature during the spring and autumn migration seasons. However, a review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. As approximately just 2.3% of migration season impacts on this species would be apportioned to this SPA population (Furness, 2015), it is considered unlikely that in-combination effects on this qualifying feature will occur to the level where an adverse effect on the integrity of the site would be possible.

1658. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.2 Sandwich Tern

9.17.3.2.1 Status

1659. The SPA breeding population at classification was 862 pairs or 1,724 breeding adults, for the period 2010 to 2014 (Natural England, 2017b). The most recent count is 417 pairs in 2019 (JNCC, 2022), equivalent to 834 breeding adults. This is used as the reference population for the assessment. The baseline mortality of this population is 85 breeding adult birds per year based on the published adult mortality rate of 10.2% (Horswill and Robinson, 2015).

9.17.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1660. The mean maximum foraging range of Sandwich tern is 34.3km (±23.2km), and the maximum foraging range is 54km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Sandwich tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 49km (±7.1km) based on data from two sites. The updated review of Woodward *et al.* (2019), based on five sites, gives a smaller mean maximum foraging range. However, it was noted by the recent review that clear differences in data collected using different methods (i.e. boat tracking versus tagged birds) means that the confidence level in the data was changed from "high" to "moderate".

1661. The Farne Islands SPA is located approximately 310km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1662. Outside the breeding season breeding Sandwich terns are assumed to range widely and to mix with birds of all ages from breeding colonies in the UK and further afield. The relevant background population is considered to be the UK North Sea and Channel BDMPS, consisting of 38,051 individuals during autumn migration (July to September), and spring migration (March to May) (Furness, 2015).

1663. Estimates of the proportion of Sandwich terns present at SEP and DEP during the autumn and spring migration seasons which originate from the Farne Islands SPA are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS (Furness 2015). During both autumn and spring migration seasons, breeding adult Sandwich terns from the Farne Islands SPA make up 4.3% of the total BDMPS population. The same percentage of impacts are therefore attributable to birds from this SPA during these times of year.

9.17.3.2.3 Potential Effects on the Qualifying Feature

1664. The Sandwich tern qualifying feature of the Farne Islands SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.17.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.17.3.2.4.1 Operational Phase Displacement/Barrier Effects

1665. Population estimates of Sandwich tern at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-135**, **Table 9-136** and **Table 9-137** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult Sandwich tern belonging to the Farne Islands SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

1666. Displacement rates of 0.000 to 0.500 are considered to be appropriate for this species based on a review of available evidence (Cook *et al*., 2014; Green *et al*., 2019, 2018; Harwood *et al*., 2018; Krijgsveld *et al*., 2011; Scragg *et al*., 2016; Thaxter *et al*., 2018). A maximum mortality rate of 1% of displaced birds is considered to be appropriate, based on the existing mortality of adult birds of 0.102 (Horswill and Robinson, 2015), and low energy expenditure predictions of a closely related species (common tern) due to barrier effects by OWFs (Masden *et al.*, 2010).

Table 9-135: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Sandwich Terns at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	346 (breeding) 132 (autumn) 0 (spring)	0 (breeding) 6 (autumn) 0 (spring)	0 - 0	0.00 - 0.03
Mean	179 (breeding) 45 (autumn) 0 (spring)	0 (breeding) 2 (autumn) 0 (spring)	0 - 0	0.00 - 0.01
Lower 95% CI	62 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Notes 1. For breeding season (Apr-Aug), assumes 0% of adult birds are Farne Islands SPA breeders. For autumn and spring migration seasons (September and March), assumes 4.3% of adult birds are Farne Islands SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Farne Islands SPA breeding adults (834 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-136: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Sandwich Terns at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	139 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Mean	77 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Lower 95% CI	25 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0

Notes
1. For breeding season (Apr-Aug), assumes 0% of adult birds are Farne Islands SPA breeders. For autumn and spring migration seasons (September and March), assumes 4.3% of adult birds are Farne Islands SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Farne Islands SPA breeding adults (834 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-137: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Sandwich Terns at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	485 (breeding) 132 (autumn) 0 (spring)	0 (breeding) 6 (autumn) 0 (spring)	0 - 0	0.00 - 0.03
Mean	255 (breeding) 45 (autumn) 0 (spring)	0 (breeding) 2 (autumn) 0 (spring)	0 - 0	0.00 - 0.01
Lower 95% CI	86 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0 - 0	0.00 - 0.00

Notes
1. For breeding season (Apr-Aug), assumes 0% of adult birds are Farne Islands SPA breeders. For autumn and spring migration seasons (September and March), assumes 4.3% of adult birds are Farne Islands SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Farne Islands SPA breeding adults (834 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

1667. Based on the mean peak abundances, the annual total of Sandwich terns from the Farne Islands SPA at risk of displacement from SEP and DEP together is two birds, both of which would occur at DEP. At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 0.01 SPA breeding adults would be predicted to die each year due to displacement from DEP. The combined displacement mortality from SEP and DEP would increase annual mortality within this population by 0.01% (**Table 9-137**). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peak abundances are used as inputs to the assessment, since the maximum predicted mortality increase that could occur on this basis represents a 0.03% increase to baseline mortality.

1668. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

1669. The confidence in the assessment is high for several reasons. Firstly, despite not being available in large quantities, the evidence used to set the displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.17.3.2.4.2 Collision Risk

1670. Collision risk predictions for Farne Islands SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-138**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-139**. Outputs are based on Option 1 of the Band Model, avoidance rates of 0.980, and the flight height distribution of Harwood (2021). These parameters were agreed with Natural England during the Expert Topic Group (ETG) process. Nocturnal activity was set at 2% of daytime activity, based on an assessment of Sandwich tern tracking data from the Scolt Head population. Further information on this, detailed methodology and information on other input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1671. For DEP, the mean annual collision estimate increases the annual baseline mortality by 0.01%, and the predicted increase in the annual baseline mortality is 0.07% for the annual upper 95% CI output. For SEP, the mean collision rate increases the annual baseline mortality by <0.01%, and the upper 95% CI collision rate by 0.01%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. These are very low collision rates which would be further reduced if correction for birds displaced by OWFs were included in the calculations. Whilst there is uncertainty around the level of macro-avoidance (i.e. displacement) that will actually occur, evidence indicates that this will be greater than zero (Cook *et al*., 2014; Green *et al*., 2019, 2018; Harwood *et al*., 2018; Krijgsveld *et al*., 2011; Scragg *et al*., 2016; Thaxter *et al*., 2018).

1672. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

1673. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

Table 9-138: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP Apportioned to Farne Islands SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.06
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
SEP and DEP	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.02

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

Table 9-139: Predicted Annual Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP Apportioned to Farne Islands SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase
DEP	0.01 (0.00 - 0.06)	0.01 (0.00 - 0.07)
SEP	0.00 (0.00 - 0.01)	0.00 (0.00 - 0.01)
SEP and DEP	0.02 (0.00 - 0.07)	0.02 (0.00 - 0.09)
Notes 1. Background population is Farne Islands SPA breeding adults (854 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)		

9.17.3.2.4.3 Combined Displacement/Barrier Effects and Collision Risk

1674. It was demonstrated in the Appropriate Assessment for Sandwich terns of the North Norfolk Coast SPA that when considering combined displacement and collision mortality, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Section 9.4.3.1.4.3**). The worst case scenario for combined operational phase displacement and collision for Farne Islands SPA Sandwich terns is therefore presented in **Table 9-138**. The annual mortality predicted and consequent increase in baseline annual mortality of the population is very small, far less than the 1% level at which effects may be detectable.

1675. **It is concluded that predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.17.3.2.5.1 Operational Phase Displacement

1676. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Sandwich tern population of the Farne Islands SPA are extremely small, with a mean predicted annual mortality rate of up to 0.01 birds (**Table 9-137**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination operational phase OWF displacement effect on this qualifying feature.

1677. During the breeding season, no OWFs are within mean maximum foraging range plus one standard deviation of this SPA, therefore no breeding season impacts on this qualifying feature are predicted. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. During passage periods, it is anticipated that displacement impacts will result in very low mortality rates. This is because the increase in energetic expenditure of displacement will be lower than in the breeding season, when little or no impact on survival has also been predicted for some seabirds unless the OWF causing the effect is located close to the breeding colony (Searle *et al.*, 2017, 2014).

1678. Furthermore, as just 4.3% of total Sandwich tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1679. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF displacement on breeding Sandwich tern of the Farne Islands SPA, no such assessment has been performed. However, the information presented still provides relatively high confidence that mortality levels due to this impact are very low.

1680. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.2.5.2 Collision Risk

1681. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Sandwich tern population of the Farne Islands SPA are extremely small, with a mean predicted annual mortality rate of 0.02 birds (**Table 9-139**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature.

1682. During the breeding season, no OWFs are within mean maximum foraging range plus one standard deviation of this SPA, therefore no breeding season impacts on this qualifying feature are predicted. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. However, the low flight heights that are generally used by this species during passage periods ("Corrigendum," 2014; Johnston *et al*., 2014), indicate that the possibility of a substantial in-combination collision impact on this species during these seasons is unlikely. Furthermore, as just 4.3% of total Sandwich tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1683. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF collision on breeding Sandwich tern of the Farne Islands SPA, no such assessment has been performed. However, the information presented provides relatively high confidence that mortality levels due to this impact are very low. have not been investigated quantitatively.

1684. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.2.5.3 Combined Displacement and Collision Risk

1685. It was demonstrated in the Appropriate Assessment for Sandwich terns of the North Norfolk Coast SPA that when considering combined displacement and collision mortality, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Section 9.4.3.1.4.3**). The worst case scenario for combined operational phase displacement and collision for Farne Islands SPA Sandwich terns is therefore presented in **Table 9-132**. The annual mortality predicted and consequent increase in baseline annual mortality of the population is very small, far less than the 1% level at which effects may be detectable.

1686. **It is concluded that predicted Sandwich tern mortality due to combined displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.3 Guillemot

9.17.3.3.1 Status

1687. The SPA breeding population at classification was 32,875 pairs (65,750 breeding adults) for the period 2010 to 2014 (Natural England, 2017b). The most recent published count was 64,042 individuals in 2019 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 3,907 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson (2015).

9.17.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1688. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum foraging range recorded is 338km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al*. (2019), based on 16 sites, gives a smaller mean maximum foraging range.

1689. The Farne Islands SPA is located approximately 310km from SEP and DEP. While at the outer limit of the maximum foraging range recorded by Woodward *et al*. (2019), this distance considerably exceeds the mean maximum foraging range plus one standard deviation for this species. The maximum foraging range is a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1690. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and beyond. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 3.7% of birds present are considered to be breeding adults from the Farne Islands SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

9.17.3.3.3 Potential Effects on the Qualifying Feature

1691. Guillemot from the Farne Islands SPA have been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects.

9.17.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.17.3.3.4.1 Operational Phase Displacement/Barrier Effects

1692. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-140**, **Table 9-141** and **Table 9-142** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides an overview of how information from Furness (2015), in conjunction with the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots present at SEP and DEP that belong to the SPA population. An estimated annual mortality for the population due to operational phase displacement is provided, along with the increase in existing annual mortality of the relevant background population that would occur through such an impact.

1693. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to this population. The full ranges of recommended displacement and mortality effects are considered by the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-140: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 907 (nb) 907 (year round)	3 - 63 (5)	0.07 - 1.63 (0.12)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 551 (nb) 551 (year round)	2 - 39 (3)	0.04 - 0.99 (0.07)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 290 (nb) 290 (year round)	1 - 20 (1)	0.02 - 0.52 (0.04)
Notes				

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are Farne Islands SPA breeding adults. For non-breeding season, assumes 3.7% of birds are Farne Islands SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Farne Islands SPA breeding adults (64,042 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-141: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,437 (year round)	0 (b) 58 (nb) 58 (year round)	0 - 4 (0)	0.00 - 0.10 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 40 (nb) 40 (year round)	0 - 3 (0)	0.00 - 0.07 (0.01)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 24 (nb) 24 (year round)	0 - 2 (0)	0.00 - 0.04 (0.00)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are Farne Islands SPA breeding adults. For non-breeding season, assumes 3.7% of birds are Farne Islands SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Farne Islands SPA breeding adults (64,042 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-142: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 965 (nb) 965 (year round)	3 - 68 (5)	0.07 - 1.73 (0.12)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 591 (nb) 591 (year round)	2 - 41 (3)	0.05 - 1.06 (0.08)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 314 (nb) 314 (year round)	1 - 22 (2)	0.02 - 0.56 (0.04)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Farne Islands SPA breeding adults. For non-breeding season, assumes 3.7% of birds are Farne Islands SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Farne Islands SPA breeding adults (64,042 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

1694. Based on the mean peak abundances, the annual total of guillemots from the Farne Islands SPA at risk of displacement from SEP and DEP is 591 birds (**Table 9-142**); 551 at DEP (**Table 9-140**) and 40 at SEP (**Table 9-141**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 1.7 to 38.6 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.1 to 2.8 birds due to displacement at SEP.

1695. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 0.99% due to impacts at DEP and 0.07% due to impacts at SEP (1.06% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.07% due to impacts at DEP (2.8 birds), 0.01% due to impacts at SEP (0.2 birds) and 0.08% due to the impacts of SEP and DEP together (3.0 birds).

1696. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1697. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under almost any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered. Mortality rate increases of over 1% are predicted for mean peak abundance estimate assessments only when a displacement rate of 0.700 and a mortality rate of 10% is considered. These displacement and mortality rates are much higher than evidence suggests will actually be the case. Use of the evidence-based displacement (0.500) and mortality rate (1%) would result in a mortality increase of significantly less than 1%

1698. Increases of over 1% are also predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside a 10% mortality rate for displaced birds. The probability of this occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, mortality rates for displaced birds of 10% are much higher than evidence suggests will actually be the case, and use of the evidence-based displacement (0.500) and mortality rate (1%) would again result in a mortality increase of significantly less than 1%.

1699. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

1700. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.17.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.17.3.3.5.1 Operational Phase Displacement / Barrier Effects

1701. The only OWF within mean maximum foraging range of breeding guillemot from the Farne Islands SPA is the Blyth Demonstrator site. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a) indicates that 1,220 birds could be at risk of displacement. It is presumed on a precautionary basis that all birds potentially at risk of displacement and barrier effects at Blyth Demonstrator site are breeding adults from the Farne Islands SPA. In-combination displacement and mortality rates of birds belonging to the Farne Islands SPA during the breeding season are presented in **Table 9-143**.

Table 9-143: In-Combination Displacement Matrix for Guillemot from Farne Islands SPA (Breeding Season) from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	1	2	4	5	6	12	24	37	61	98	122
	20	2	5	7	10	12	24	49	73	122	195	244
	30	4	7	11	15	18	37	73	110	183	293	366
	40	5	10	15	20	24	49	98	146	244	390	488
	50	6	12	18	24	31	61	122	183	305	488	610
	60	7	15	22	29	37	73	146	220	366	586	732
	70	9	17	26	34	43	85	171	256	427	683	854
	80	10	20	29	39	49	98	195	293	488	781	976
	90	11	22	33	44	55	110	220	329	549	878	1098
	100	12	24	37	49	61	122	244	366	610	976	1220

1702. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 9,487 are estimated to belong to the Farne Islands SPA, assuming 3.7% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015). Potential displacement and mortality of breeding adult birds belonging to the Farne Islands SPA during the non-breeding season are presented in **Table 9-144**.

Table 9-144: In-Combination Displacement Matrix for Guillemot from Farne Islands SPA (Non-Breeding Season) from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

Displacement (%)	Mortality (%)										
	1	2	3	4	5	10	20	30	50	80	100
10	9	19	28	38	47	95	190	285	474	759	949
20	19	38	57	76	95	190	379	569	949	1518	1897
30	28	57	85	114	142	285	569	854	1423	2277	2846
40	38	76	114	152	190	379	759	1138	1897	3036	3795
50	47	95	142	190	237	474	949	1423	2372	3795	4744
60	57	114	171	228	285	569	1138	1708	2846	4554	5692
70	66	133	199	266	332	664	1328	1992	3320	5313	6641
80	76	152	228	304	379	759	1518	2277	3795	6072	7590
90	85	171	256	342	427	854	1708	2561	4269	6831	8538
100	95	190	285	379	474	949	1897	2846	4744	7590	9487

1703. The year round potential displacement and mortality of breeding adult birds belonging to the Farne Islands SPA are presented in **Table 9-145**.

Table 9-145: In-Combination Displacement Matrix for Guillemot from Farne Islands SPA (Year Round) from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

Displacement (%)	Mortality (%)										
	1	2	3	4	5	10	20	30	50	80	100
10	11	21	32	43	54	107	214	321	535	857	1071
20	21	43	64	86	107	214	428	642	1071	1713	2141
30	32	64	96	128	161	321	642	964	1606	2570	3212
40	43	86	128	171	214	428	857	1285	2141	3426	4283
50	54	107	161	214	268	535	1071	1606	2677	4283	5354
60	64	128	193	257	321	642	1285	1927	3212	5139	6424
70	75	150	225	300	375	749	1499	2248	3747	5996	7495
80	86	171	257	343	428	857	1713	2570	4283	6852	8566
90	96	193	289	385	482	964	1927	2891	4818	7709	9636
100	107	214	321	428	535	1071	2141	3212	5354	8566	10707

1704. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 749 breeding adult SPA birds would be lost to displacement annually. This would increase the existing mortality within the SPA population (3,907 breeding adult birds per year) by 19.19%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 54 birds. This would increase the existing mortality within this population by 1.37%.

1705. PVAs examining the effect of the mortality rates generated by the in-combination displacement assessment at the population level have been produced (**Table 9-146**).

1706. Displacement and mortality rates covering the entire range recommended by the SNCBs have been considered. CGR and CPS have been produced from the model outputs and are presented. These measure changes in annual growth rate and population size at the end of the impacted period relative to the unimpacted scenario, which in this case is 40 years. These outputs are favoured due to their relatively high tolerance for misspecification of input parameters, which is common in population modelling (Jitlal *et al*., 2017).

1707. The increase in existing mortality rate due to the predicted impact is also presented. This is a PVA input and was calculated by adding the predicted mortality to existing mortality, dividing the resultant total by the starting population to calculate a new mortality rate, and subtracting the original mortality rate from the new mortality rate to obtain the difference between the two.

Table 9-146: PVA Outputs for Breeding Adult Farne Islands SPA Guillemots Incorporating Mean Displacement Impacts of SEP and DEP In-Combination with Other Projects

Displacement rate	Mortality rate	Annual mortality	Increase in existing mortality rate[1,2]	Median CGR[3]	Median CPS[3]
0.300	1%	32	0.0005015615	0.999	0.977
	2%	64	0.0010031230	0.999	0.955
	5%	161	0.0025078074	0.997	0.891
	10%	321	0.0050156148	0.994	0.793
0.400	1%	43	0.0006687486	0.999	0.970
	2%	86	0.0013374973	0.998	0.940
	5%	214	0.0033437432	0.996	0.857
	10%	428	0.0066874863	0.992	0.734
0.500	1%	54	0.0008359358	0.999	0.962
	2%	107	0.0016718716	0.998	0.926
	5%	268	0.0041796790	0.995	0.825
	10%	535	0.0083593579	0.991	0.679
0.600	1%	64	0.0010031230	0.999	0.955
	2%	128	0.0020062459	0.998	0.912
	5%	321	0.0050156148	0.994	0.793
	10%	642	0.0100312295	0.989	0.629
0.700	1%	75	0.0011703101	0.999	0.947
	2%	150	0.0023406202	0.997	0.898
	5%	375	0.0058515505	0.993	0.763
	10%	749	0.0117031011	0.987	0.581

Notes
1. This is a key input into PVA, and is provided to ten decimal places to enable the model to be reproduced
2. Background population is Farne Islands SPA breeding adults (64,042 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)
3. After 40 years of operation

1708. The PVA investigating the population-level effects of potential displacement impacts for SEP and DEP in-combination with other projects produced a wide range of median CGR and CPS values depending on the displacement and mortality rates used to estimate the magnitude of the impact.

1709. At the upper end of the displacement and mortality rates examined (0.700 displacement and 10% mortality of displaced birds), the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.987 and a CPS of 0.581. At the lower end of the displacement and mortality rates examined (0.300 displacement and 1% mortality of displaced birds), the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.999 and a CPS of 0.977. Using the evidence-based displacement and mortality rates of 0.500 displacement and 1% mortality of displaced birds, the median CGR when impacts from all OWFs in Tiers 1-5 (including SEP and DEP) were included was 0.999 and a CPS of 0.962.

1710. The counterfactuals calculated from the model outputs should be interpreted according to the level of precautionary assumptions made both within the PVAs themselves, and the processes that were undertaken to produce the inputs into the PVAs. These include:

- The use of mean peak abundance estimates in displacement modelling may result in estimates of displaced birds being unrealistically high;
- The upper range of displacement rates considered may be overestimated;
- The mortality rates assumed for displaced birds may be overestimated;
- The PVA does not incorporate density dependence, which means the outputs of the model are likely to be precautionary; and
- The Farne Islands SPA guillemot population is modelled as a closed population, with no emigration or immigration occurring.

1711. The impacts predicted at SEP and DEP, in-combination with other projects, will not prevent the majority of the Conservation Objectives from being met. However, there is potential for the Conservation Objective for the guillemot population size of the Farne Islands SPA not being met due to the predicted impacts. This is to maintain or restore the size of the breeding population.

1712. The guillemot population of the Farne Islands SPA increased on average by 4.0% annually between 1990 and 2019. Between 2008 and 2017, the average annual growth rate decreased to 2.5%, though most of this was due to a large increase between 2018 (49,972 individuals) and 2019 (64,042 individuals). The 2021 count of 62,936 individuals indicates that the short term population trend is relatively stable. Whilst this is no guarantee of the future population trend of the colony, it might be the case that scenarios where the CGR is sufficiently low may result in a reduction in the growth rate of the colony, rather than recent trends reversing, and the population going into decline. The Conservation Objective for population size could therefore be met despite the predicted in-combination impacts.

1713. The level of mortality predicted in the breeding guillemot population of the Farne Islands SPA due to in-combination OWF displacement is considered to be relatively modest where evidence-based displacement and mortality rates are used. In such a case (50% displacement and 1% mortality of displaced birds), the annual growth rate would change by less than 0.1%. This is considerably less than the average annual growth rate over the medium and short term at the colony. Whilst the use of higher displacement and mortality rates results in population level impacts which would potentially represent an adverse effect on the integrity of the qualifying feature, it is not considered appropriate to rely on these outputs to draw conclusions. This is because the assessment already includes a great deal of precautionary assumptions, and there is no evidence for mortality rates due to OWF displacement being at the higher levels considered by the PVA.

1714. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.4 Kittiwake

9.17.3.4.1 Status

1715. Kittiwake is listed as a named component of the breeding seabird assemblage of this SPA.

1716. The SPA breeding population at classification was cited as 8,241 pairs or 16,482 breeding adults, for the period 2010 to 2014 (Natural England, 2017b). The most recent count is 4,402 apparently occupied nests, or 8,804 breeding adults in 2019 (JNCC, 2022). The baseline mortality of this population is 1,285 breeding adult birds per year based on the published adult mortality rate of 14.6% (Horswill and Robinson, 2015).

9.17.3.4.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1717. SEP and DEP are located approximately 310km from the Farne Islands SPA boundary at the nearest point. The mean maximum foraging range of kittiwake is 156.1km (±144.5km), and the maximum foraging range is 770km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of kittiwake from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 60.0km (±23.3km) based on data from six studies. The updated review of Woodward *et al.* (2019), based on 19 studies at 37 sites, gives a substantially larger mean maximum foraging range.

1718. SEP and DEP are therefore beyond the mean maximum foraging range plus one standard deviation from the Farne Islands SPA, but within the maximum foraging range. The latter measurement is a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. SEP and DEP are within the mean maximum foraging range of kittiwakes from the Flamborough and Filey Coast SPA. Foraging areas of kittiwakes from different colonies often tend not to overlap (Cleasby *et al*., 2020, 2018; Wakefield *et al*., 2017). This further increases the likelihood that birds from the Farne Islands SPA will not occur at SEP and DEP during the breeding season. This is the assumption made by the assessment.

1719. Outside the breeding season breeding kittiwakes, including those from the Farne Islands SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with kittiwakes of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea BDMPS. This consists of 829,937 individuals during the autumn migration season (August to December), and 627,816 individuals during the spring migration season (January to April) (Furness, 2015).

1720. During the autumn migration season, 60% of the Farne Islands SPA breeding adults are assumed to be present in the BDMPS, representing 0.5% of the BDMPS population (829,937 individuals of all ages). During this season, 1,609 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 487 birds were able to be assigned to an age class. 400 birds (82.1% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Farne Islands SPA is 0.4% (i.e. 0.005 x 0.821).

1721. 60% of SPA breeding adults are also assumed to be present in the BDMPS during the spring migration season, representing 0.7% of the BDMPS population (627,816 individuals of all ages). During this season, 63 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 23 birds were able to be assigned to an age class. 21 birds (91.3% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Farne Islands SPA is 0.6% (i.e. 0.006 x 0.913).

9.17.3.4.3 Potential Effects on the Qualifying Feature

1722. The kittiwake qualifying feature of the Farne Islands SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.17.3.4.4 Potential Effects of SEP and DEP in Isolation and Together

9.17.3.4.4.1 Collision Risk

1723. Information to inform the Appropriate Assessment for collision risk on breeding adult kittiwakes belonging to the Farne Islands SPA population is presented in **Table 9-147**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-148**. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1724. Based on the mean collision rates, the annual total of breeding adult kittiwakes from the Farne Islands SPA at risk of collision at DEP is 0.03, with no collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.03 Farne Islands SPA breeding adult kittiwakes. This would increase the existing mortality of the SPA breeding population by <0.01%.

1725. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 205 flying birds were observed across DEP (of which 158 were within DEP-N, and 47 within DEP-S). When corrected for the different survey transect lengths in both regions of DEP, this means that encounter rate was 26.5% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

Table 9-147: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Farne Islands SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.03
	Density	95% UCI	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.01	0.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
	Avoidance Rate	-2 SD	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.03
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.03
	Density	95% UCI	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.01	0.09
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.04
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
	Avoidance Rate	-2 SD	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.04
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.03
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02

Notes

1. For autumn migration season (Sept-Dec), assumes 0.5% of adult birds are Farne Islands SPA breeders (Furness 2015), combined with 82.1% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Jan-Feb), assumes 0.7% of adult birds are Farne Islands SPA breeders, combined with 91.3% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Aug), assumes 0% of adult birds are Farne Islands SPA breeders

Table 9-148: Predicted Annual Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Farne Islands SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase[1]
DEP	0.03 (0.00 - 0.07)	0.00 (0.00 - 0.01)
SEP	0.00 (0.00 - 0.02)	0.00 (0.00 - 0.00)
SEP and DEP	0.03 (0.00 - 0.09)	0.00 (0.00 - 0.01)
Notes 1. Background population is Farne Islands SPA breeding adults (8,804 individuals), adult age class annual mortality rate of 14.6% (Horswill and Robinson, 2015)		

1726. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.01% due to the collision impacts of SEP and DEP together.

1727. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

1728. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.17.3.4.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.17.3.4.5.1 Collision Risk

1729. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus the predicted impacts of SEP and DEP, indicates that during the autumn migration season, 1,587 collisions are predicted between kittiwakes belonging to the UK North Sea and Channel BDMPS and OWFs in the North Sea. The corresponding value for the spring migration season is 1,204 birds. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-105**). Of the collisions predicted during the autumn migration season, 7.9 are estimated to involve breeding adult birds from the Farne

Islands SPA, assuming 0.5% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015). The corresponding number of collisions for the spring migration season, based on the assumption that 0.7% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015), is also 7.9. In total therefore, 15.8 collisions per year are predicted for breeding adults of the Farne Islands SPA due to in-combination collision risk of OWFs in the North Sea. This would increase the existing mortality within this population by 1.2%. It is possible that this level of mortality could be detectable against background mortality.

1730. The predicted impacts of SEP and DEP in isolation and together on the breeding adult kittiwake population of the Farne Islands SPA are extremely small, with a mean predicted annual mortality rate of 0.03 birds (**Table 9-148**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature.

1731. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.17.3.5 Puffin

9.17.3.5.1 Status

1732. Puffin is listed as a named component of the breeding seabird assemblage of this SPA.

1733. The SPA breeding population at classification was 76,798 individuals (Natural England, 2017b). The most recent published count was 87,504 individuals in 2018 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 8,225 adult birds per year based on this reference population and the published adult mortality rate of 9.4% (Horswill and Robinson, 2015).

9.17.3.5.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1734. The mean maximum foraging range of puffin is 137.1km (±128.3km) and the maximum foraging range is 383km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of puffin from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 105.4km (±46.0km) based on data from eight studies. The updated review of Woodward *et al.* (2019), based on five studies across seven breeding sites, therefore gives an increased mean maximum foraging range.

1735. SEP and DEP are located approximately 310km from the Farne Islands SPA boundary at the nearest point. This means that puffins from this SPA are beyond the mean maximum foraging range for this species, but within the maximum recorded foraging range for this species. However, this measurement is considered to be a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1736. Outside the breeding season, breeding puffins from the SPA are assumed to range widely and to mix with puffins of all age classes from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 231,957 individuals (mid-August to March) (Furness, 2015). During the non-breeding season, it is estimated that 17.2% of birds present are considered to be breeding adults from the Farne Islands SPA. This is based on the SPA adult population as a proportion of the UK North Sea and Channel BDMPS, and impacts are apportioned accordingly.

9.17.3.5.3 Potential effects on the qualifying feature

1737. The puffin qualifying feature of the Farne Islands SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects during the non-breeding season.

9.17.3.5.4 Potential Effects of SEP and DEP in Isolation and Together

9.17.3.5.4.1 Operational Phase Displacement/Barrier Effects

1738. Population estimates of puffin at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-149**, **Table 9-150** and **Table 9-151** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult puffins belonging to the Farne Islands SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

1739. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA with respect to other auk species (**Section 9.15.3.3.4.1**) is also relevant to this population. The full range of recommended displacement and mortality effects are considered by the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1% respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-149: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Puffins at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 58 (nb) 58 (year round)	0 (b) 10 (nb) 10 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 22 (nb) 22 (year round)	0 (b) 4 (nb) 4 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Farne Islands SPA breeding adults. For non-breeding season, assumes 17.2% of birds are Farne Islands SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Farne Islands SPA breeding adults (87,504 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)

Table 9-150: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Puffins at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 23 (nb) 23 (year round)	0 (b) 4 (nb) 4 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 11 (nb) 11 (year round)	0 (b) 2 (nb) 2 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Farne Islands SPA breeding adults. For non-breeding season, assumes 17.2% of birds are Farne Islands SPA breeding adults.

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Farne Islands SPA breeding adults (87,504 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)				

Table 9-151: Predicted Operational Phase Displacement and Mortality of Farne Islands SPA Breeding Adult Puffins at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 80 (nb) 80 (year round)	0 (b) 14 (nb) 14 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 32 (nb) 32 (year round)	0 (b) 6 (nb) 6 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Apr-early Aug), assumes 0% of birds are Farne Islands SPA breeding adults. For non-breeding season, assumes 17.2% of birds are Farne Islands SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Farne Islands SPA breeding adults (87,504 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)				

1740. Based on the mean peak abundances, the annual total of puffins from the Farne Islands SPA at risk of displacement from SEP and DEP is 6 birds (**Table 9-151**); 4 at DEP (**Table 9-149**) and 2 at SEP (**Table 9-150**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, less than one (0.02 - 0.39) SPA breeding adult would be predicted to die each year due to displacement from SEP and DEP together. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by <0.01% due to impacts at SEP and DEP together.

1741. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when either the mean peak abundance estimate assessments, or those using the upper 95% CI of mean peak abundance are considered.

1742. **It is concluded that predicted puffin mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Farne Islands SPA.**

1743. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.17.3.5.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.17.3.5.5.1 Operational Phase Displacement / Barrier Effects

1744. An unpublished Appropriate Assessment for a proposed OWF in Scottish waters indicates that approximately 247 breeding adult puffins from the Farne Islands SPA are at risk of displacement from existing or proposed developments in Scottish Waters during the breeding season. The OWFs contributing to this impact during this season are Inch Cape and Seagreen. Two OWFs within English waters, Blyth Demonstrator and Teesside, are within the mean maximum foraging range of puffins breeding at the Farne Islands SPA. The digital aerial surveys conducted for the Blyth Demonstrator site (APEM, 2011; Natural Power, 2012) estimates that 84 puffins were present at the Blyth Demonstrator site. Post construction monitoring of the Teesside OWF (Ecology Consulting, 2016) indicated that the peak count of puffin within the OWF and 2km buffer recorded during baseline surveys was 53 birds. It is not known which season this count occurred within, but it is included in breeding season totals on a precautionary basis. At these OWFs, it is presumed that 100% of birds present during the breeding season belong to the breeding adult population of the Farne Islands SPA. The total number of breeding adult Farne Islands SPA puffin at risk of displacement during the breeding season is therefore 384.

1745. The cumulative impact assessment presented in the Hornsea Project Four OWF assessment (APEM, 2021), plus impacts from SEP and DEP, indicates that during the non-breeding season, 45,017 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. Of the birds at risk of displacement, 7,756 are estimated to belong to the Farne Islands SPA, assuming 17.2% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

1746. Puffin was screened out of the EIA for SEP and DEP due to the low abundance of this species in the SEP and DEP wind farm sites and 2km buffers. In total, two and four birds from the breeding adult population of the Farne Islands SPA were present at SEP and DEP respectively year round.

1747. This brings the number of breeding adult puffins belonging the Farne Islands SPA population at risk of cumulative operational OWF displacement to 8,146 individuals.

1748. Displacement and mortality rates of birds belonging to the Farne Islands SPA are presented in **Table 9-152**.

Table 9-152: In-Combination Year Round Displacement Matrix for Puffin from Farne Islands SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**50**	**80**	**100**
Displacement (%)	**10**	8	16	24	33	41	81	163	244	407	652	815
	20	16	33	49	65	81	163	326	489	815	1303	1629
	30	24	49	73	98	122	244	489	733	1222	1955	2444
	40	33	65	98	130	163	326	652	978	1629	2607	3258
	50	41	81	122	163	204	407	815	1222	2037	3258	4073
	60	49	98	147	196	244	489	978	1466	2444	3910	4888
	70	57	114	171	228	285	570	1140	1711	2851	4562	5702
	80	65	130	196	261	326	652	1303	1955	3258	5213	6517
	90	73	147	220	293	367	733	1466	2199	3666	5865	7331
	100	81	163	244	326	407	815	1629	2444	4073	6517	8146

1749. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 570 breeding adult SPA birds would be lost to displacement annually. This would increase the mortality within this population by 6.93%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 41 birds. This would increase the mortality within this population by 0.50%.

1750. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used. Mortality rate increases in the SPA population of over 1% are predicted if the mortality rates of displaced birds are assumed to be 2% in conjunction with displacement rates of 60% or more, 3% in conjunction with displacement rates of 40% or more, and if mortality rates of displaced birds of 4% or more are used in conjunction with displacement rates of 30% to 70%. However, the potential for mortality rates of greater than 1% is not supported by existing evidence, or expert opinion.

1751. **It is concluded that predicted puffin mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Farne Islands SPA.**

9.18 St Abbs Head to Fast Castle SPA

9.18.1 Description of Designation

1752. St Abb's Head to Fast Castle SPA comprises an area of sea cliffs and coastal strip stretching over 10km along the Berwickshire Coast north of St Abbs.

9.18.2 Conservation Objectives

1753. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.18.3 Appropriate Assessment

1754. Breeding guillemot is the only qualifying features of this SPA screened into the Appropriate Assessment (**Table 5-2**).

9.18.3.1 Guillemot

9.18.3.1.1 Status

1755. The SPA breeding population at classification was 31,750 individuals (SNH, 2009a). The most recent published count was 42,905 individuals in 2018 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 2,617 adult birds per year based on an adult population of 42,905 individuals and the published adult mortality rate of 0.061 (Horswill and Robinson, 2015).

9.18.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1756. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al*. (2019), based on 16 sites, gives a smaller mean maximum foraging range.

1757. The St Abbs Head to Fast Castle SPA is located approximately 350km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1758. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 4.1% of birds present are considered to be breeding adults from the St Abbs Head and Fast Castle SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.18.3.1.3 Potential Effects on the Qualifying Feature

1759. The guillemot qualifying feature of the St Abbs Head to Fast Castle SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects during the non-breeding season.

9.18.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.18.3.1.4.1 Operational Phase Displacement/Barrier Effects

1760. Population estimates of guillemot at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-153**, **Table 9-154** and **Table 9-155** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots belonging to the St Abbs Head to Fast Castle SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

1761. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to this population. The full range of recommended displacement and mortality effects are considered by the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1% respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-153: Predicted Operational Phase Displacement and Mortality of St Abbs Head to Fast Castle SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 1,005 (nb) 1,005 (year round)	3 - 70 (5)	0.12 - 2.69 (0.19)
Mean	3.839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 610 (nb) 610 (year round)	2 - 43 (3)	0.07 - 1.63 (0.12)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 321 (nb) 321 (year round)	1 - 22 (2)	0.04 - 0.86 (0.06)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are St Abbs Head to Fast Castle SPA breeding adults. For non-breeding season, assumes 4.1% of birds are St Abbs Head to Fast Castle SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is St Abbs Head to Fast Castle SPA breeding adults (42,905 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-154: Predicted Operational Phase Displacement and Mortality of St Abbs Head to Fast Castle SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,437 (year round)	0 (b) 64 (nb) 64 (year round)	0 - 5 (0)	0.01 - 0.17 (0.01)
Mean	1,095 (b) 1,085 (nb) 1,194 (year round)	0 (b) 44 (nb) 44 (year round)	0 - 3 (0)	0.01 - 0.12 (0.01)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 27 (nb) 27 (year round)	0 - 2 (0)	0.00 - 0.07 (0.01)

Notes
1. Breeding season = b, non-breeding season = nb

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
2. For breeding season (Mar-Jul), assumes 0% of birds are St Abbs Head to Fast Castle SPA breeding adults. For non-breeding season, assumes 4.1% of birds are St Abbs Head to Fast Castle SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is St Abbs Head to Fast Castle SPA breeding adults (42,905 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-155: Predicted Operational Phase Displacement and Mortality of St Abbs Head to Fast Castle SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 1,069 (nb) 1,069 (year round)	3 - 75 (5)	0.12 - 2.86 (0.20)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 655 (nb) 655 (year round)	2 - 46 (3)	0.08 - 1.75 (0.13)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 348 (nb) 348 (year round)	1 - 24 (2)	0.04 - 0.93 (0.07)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are St Abbs Head to Fast Castle SPA breeding adults. For non-breeding season, assumes 4.1% of birds are St Abbs Head to Fast Castle SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is St Abbs Head to Fast Castle SPA breeding adults (42,905 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

1762. Based on the mean peak abundances, the annual total of guillemots from the St Abbs Head to Fast Castle SPA at risk of displacement from SEP and DEP together is 655 birds (**Table 9-155**); 610 at DEP (**Table 9-153**) and 44 at SEP (**Table 9-154**).

At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 1.8 to 42.7 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.1 to 3.1 birds due to displacement from SEP.

1763. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 1.63% due to impacts at DEP, and 0.12% due to impacts at SEP (1.75% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the St Abbs Head to Fast Castle SPA breeding adult guillemot population would increase by 0.19% due to impacts at DEP (5.0 birds), 0.01% due to impacts at SEP (0.3 birds), and 0.20% due to the impacts of SEP and DEP together (5.3 birds).

1764. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1765. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered. Mortality rate increases of over 1% are predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside the highest recommended displacement and mortality rates. The probability of this occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, displacement and mortality rates of 0.700 and 10% are much higher than evidence suggests will actually be the case.

1766. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the St Abbs Head to Fast Castle SPA.**

1767. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same

irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

1768. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, impacts from SEP and DEP on this SPA qualifying feature are in fact zero.

9.18.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.18.3.1.5.1 Operational Phase Displacement / Barrier Effects

1769. The Appropriate Assessment for the Neart na Gaoithe OWF (Pelagica Environmental Consultancy and Cork Ecology, 2018) indicated that approximately 2,615 adults from the St Abbs Head to Fast Castle SPA are at risk of displacement during the breeding season. The OWFs contributing to this impact during this season are Neart na Gaoithe and Seagreen.

1770. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 10,512 are estimated to belong to the St Abbs Head to Fast Castle SPA, assuming 4.1% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

1771. In total therefore, 13,127 birds from the St Abbs Head to Fast Castle SPA are at risk of in-combination OWF displacement throughout the year. Annual displacement and mortality of breeding adult birds belonging to the St Abbs Head to Fast Castle SPA are presented in **Table 9-156**.

Table 9-156: In-Combination Displacement Matrix for Guillemot from St Abbs Head to Fast Castle SPA Year Round from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	13	26	39	53	66	131	263	394	656	1050	1313
	20	26	53	79	105	131	263	525	788	1313	2100	2625
	30	39	79	118	158	197	394	788	1181	1969	3150	3938
	40	53	105	158	210	263	525	1050	1575	2625	4201	5251
	50	66	131	197	263	328	656	1313	1969	3282	5251	6564
	60	79	158	236	315	394	788	1575	2363	3938	6301	7876
	70	92	184	276	368	459	919	1838	2757	4594	7351	9189
	80	105	210	315	420	525	1050	2100	3150	5251	8401	10502
	90	118	236	354	473	591	1181	2363	3544	5907	9451	11814
	100	131	263	394	525	656	1313	2625	3938	6564	10502	13127

1772. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 919 breeding adult SPA birds would be lost to displacement each year. This would increase the mortality within this population by 35.11%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual season in-combination displacement mortality would be 66 birds. This would increase the mortality within this population by 2.51%.

1773. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

1774. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this in-combination impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

1775. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of St Abbs Head to Fast Castle SPA.**

9.19 Forth Islands SPA

9.19.1 Description of Designation

1776. The Forth Islands SPA consists of a series of islands supporting the main seabird colonies in the Firth of Forth. The seaward extension extends approximately 2km to include the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.19.2 Conservation Objectives

1777. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.19.3 Appropriate Assessment

1778. The qualifying species screened into the Appropriate Assessment are breeding gannet, breeding lesser black-backed gull, and breeding puffin (**Table 5-2**).

9.19.3.1 Gannet

9.19.3.1.1 Status

1779. The SPA breeding population at classification was 21,600 pairs or 43,200 breeding adults (SNH, 2018a). The most recent available count is 75,259 pairs, or 150,518 breeding adults, in 2014 (JNCC, 2022). The latter estimate is considered the best available evidence for the gannet population of this designated site. Using the published adult mortality rate of 8.1% (Horswill and Robinson (2015)), 12,192 birds would be expected to die annually from the breeding adult population of 150,518 individuals.

9.19.3.1.2 Functional linkage and seasonal apportionment of potential effects

1780. Forth Islands SPA is located approximately 380km from SEP and DEP. The mean maximum foraging range of gannet is 315.2km (±194.2km), and the maximum foraging range is 709km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of gannet from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 229.4km (±124.3km) based on data from seven studies. The updated review of Woodward *et al*. (2019), based on data from 21 studies, gives a considerably larger mean maximum foraging range.

1781. This means that breeding adult gannets from this SPA are beyond the mean maximum foraging range for this species from SEP and DEP but within the mean-maximum (plus one standard deviation) and maximum recorded foraging ranges. However, data presented by Wakefield *et al*. (2013) indicate that gannets breeding at the Forth Islands SPA are unlikely to occur within SEP and DEP during the breeding season, due to the distance from SEP and DEP and the fact that the foraging ranges of gannets from different breeding colonies tend not to overlap (the assumption therefore is that 100% of foraging breeding adult birds present at SEP and DEP during the breeding season are from the Flamborough and Filey Coast SPA (**Section 9.15.3.1**)). No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at Forth Islands SPA.

1782. Outside the breeding season, breeding gannets, including those from Forth Islands SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with gannets of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea and Channel BDMPS. This consists of 456,299 individuals during autumn migration (September to November), and 248,385 individuals during spring migration (December to March) (Furness, 2015).

1783. During autumn migration, 100% of Forth Islands SPA breeding adults are thought to be present in the BDMPS, representing 24.3% of the total BDMPS population (456,299 individuals of all ages). During this season, 458 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 182 birds were able to be assigned to an age class. 170 birds (93.4% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Forth Islands SPA is 22.7% (i.e. 0.243 x 0.934).

1784. During spring migration, 70% of Forth Islands SPA breeding adults are thought to be present in the BDMPS, representing 31.3% of the BDMPS population (248,385 individuals of all ages). During this season, 28 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 21 birds were able to be assigned to an age class. 20 birds (95.2% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Forth Islands SPA is 29.8% (i.e. 0.313 x 0.952).

9.19.3.1.3 Potential Effects on the Qualifying Feature

1785. The gannet qualifying feature of Forth Islands SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.19.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.19.3.1.4.1 Operational Phase Displacement/Barrier Effects

1786. Following statutory guidance (UK SNCBs, 2017), abundance estimates for gannet for DEP and its 2km buffer, and SEP and its 2km buffer have been used to produce displacement matrices. Based on the recommended displacement rate of Cook *et al.* (2018) and the findings of Skov *et al.* (2018), displacement rates of 0.600 to 0.800 are considered. These rates appear to be broadly in line with recent research on gannet displacement by OWFs (Peschko *et al*., 2021).

1787. The mortality rate of displaced birds due to displacement is assumed to be a maximum of 1%. This value has been selected firstly because gannet is known to possess high habitat flexibility (Furness and Wade, 2012). This suggests that displaced birds will readily find alternative habitats including foraging areas. Secondly, no evidence of displacement-induced mortality has been identified, which means there is limited justification for setting predicted mortality rates at a higher level.

1788. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult gannets belonging to the Forth Islands SPA population is presented in **Table 9-157** (DEP), **Table 9-158** (SEP) and **Table 9-159** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult gannets belonging to the Forth Islands SPA population by season. An estimated annual mortality for the population is provided, along with the increase of existing mortality within the breeding adult SPA population that would occur due to such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-157: Predicted Operational Phase Displacement and Mortality of Forth Islands SPA Breeding Adult Gannets at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year-round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	554 (autumn) 103 (spring) 692 (breeding) 1,349 (year round)	126 (autumn) 31 (spring) 0 (breeding) 156 (year round)	1 – 1	0.01 - 0.01
Mean	343 (autumn) 47 (spring) 417 (breeding) 807 (year round)	78 (autumn) 14 (spring) 0 (breeding) 92 (year round)	1 - 1	0.00 - 0.01
Lower 95% CI	186 (autumn) 10 (spring) 180 (breeding) 376 (year round)	42 (autumn) 3 (spring) 0 (breeding) 45 (year round)	0 - 0	0.00 - 0.00

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year-round mortality range[2]	Year round% background mortality annual increase range[3]

Notes
1. For autumn migration season (Oct-Nov), assumes 24.3% of adult birds are Forth Islands SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 31.3% of adult birds are Forth Islands SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Forth Islands SPA breeders.

2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds

3. Background population is Forth Islands SPA breeding adults (150,518 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

Table 9-158: Predicted Operational Phase Displacement and Mortality of Forth Islands SPA Breeding Adult Gannets at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year-round mortality range[2]	Year-round% background mortality annual increase range[3]
Upper 95% CI	426 (autumn) 31 (spring) 47 (breeding) 504 (year round)	97 (autumn) 9 (spring) 0 (breeding) 106 (year round)	1 – 1	0.01 - 0.01
Mean	295 (autumn) 11 (spring) 23 (breeding) 329 (year round)	67 (autumn) 3 (spring) 0 (breeding) 70 (year round)	0 - 1	0.00 - 0.00
Lower 95% CI	193 (autumn) 0 (spring) 3 (breeding) 196 (year round)	44 (autumn) 0 (spring) 0 (breeding) 44 (year round)	0 - 0	0.00 - 0.00

Notes
1. For autumn migration season (Oct-Nov), assumes 24.3% of adult birds are Forth Islands SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 31.3% of adult birds are Forth Islands SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Forth Islands SPA breeders.

2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds

3. Background population is Forth Islands SPA breeding adults (150,518 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

Table 9-159: Predicted Operational Phase Displacement and Mortality of Forth Islands SPA Breeding Adult Gannets at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year-round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	980 (autumn) 133 (spring) 739 (breeding) 1,852 (year round)	222 (autumn) 40 (spring) 0 (breeding) 262 (year round)	2 - 2	0.01 - 0.02
Mean	638 (autumn) 57 (spring) 440 (breeding) 1,135 (year round)	145 (autumn) 17 (spring) 0 (breeding) 162 (year round)	1 - 1	0.01 - 0.01
Lower 95% CI	378 (autumn) 10 (spring) 183 (breeding) 571 (year round)	86 (autumn) 3 (spring) 0 (breeding) 89 (year round)	1 - 1	0.00 - 0.01

Notes
1. For autumn migration season (Oct-Nov), assumes 24.3% of adult birds are Forth Islands SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 31.3% of adult birds are Forth Islands SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Forth Islands SPA breeders.

2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds

3. Background population is Forth Islands SPA breeding adults (150,518 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

1789. Based on the mean peak abundances, the annual total of breeding adult gannets from Forth Islands SPA at risk of displacement from DEP is 92, 70 from SEP, and 162 for SEP and DEP together. At displacement rates of 0.600 to 0.800 and a maximum mortality rate of 1% for displaced birds, 0.97 to 1.29 SPA breeding adults would be predicted to die each year due to displacement from both OWFs (**Table 9-159**). The combined displacement mortality of SEP and DEP would increase the existing mortality of the SPA breeding population by 0.01%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

1790. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 22.0% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1791. **It is concluded that predicted gannet mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Forth Islands SPA.**

1792. The confidence in the assessment is high for several reasons. Firstly, the evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.19.3.1.4.2 Collision Risk

1793. Information to inform the Appropriate Assessment for collision risk on breeding adult gannets belonging to the Forth Islands SPA population is presented in **Table 9-160**. An estimated monthly and annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). The methodology and input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1794. Based on the mean collision rates, the annual total of breeding adult gannets from Forth Islands SPA at risk of collision at DEP is 0.71, with 0.15 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.86 Forth Islands SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.01%. Using an evidence-based nocturnal activity factor of 8% (Furness *et al.*, 2018), which has been calculated more recently than the value of 25% recommended for use in CRM by Natural England (originally estimated by Garthe and Hüppop (2004)), reduces the mean collision rate to 0.12 and 0.57 birds per year for SEP and DEP respectively. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peaks are used as an input into the assessment, since the maximum predicted mortality increase that could occur is 0.02%.

1795. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 59 flying birds were observed across DEP (of which 41 were within DEP-N, and 18 within DEP-S). This means that encounter rate was 14.0% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

1796. **It is concluded that predicted gannet mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Forth Islands SPA.**

1797. The confidence in the assessment is high. The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

1798. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

Table 9-160: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Gannet at SEP and DEP Apportioned to Forth Islands SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.34	0.06	0.71
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	0.68	0.24	1.96
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.62	0.11	1.28
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.14	0.02	0.28
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.41	0.07	0.83
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.28	0.05	0.58
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.27	0.05	0.57
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.15
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.00	0.34
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.00	0.27
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.06
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.00	0.18
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.12
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.12

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.49	0.06	0.86
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.03	1.02	0.24	2.29
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.90	0.11	1.55
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.19	0.02	0.34
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.58	0.07	1.01
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.40	0.05	0.70
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.25	0.39	0.05	0.69

Notes
1. For autumn migration season (Oct-Nov), assumes 24.3% of adult birds are Forth Islands SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Dec-Feb), assumes 31.3% of adult birds are Forth Islands SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Sept), assumes 0% of adult birds are Forth Islands SPA breeders

9.19.3.1.4.3 Combined Displacement/Barrier Effects and Collision Risk

1799. The combined displacement and collision rates for breeding adult gannet from Forth Islands SPA for SEP and DEP in isolation and together are presented in **Table 9-161**.

Table 9-161: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Forth Islands SPA Breeding Adult Gannets at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population

Site	Annual displacement mortality[1]	Annual collision mortality	Annual displacement and collision mortality	% annual mortality increase[2]
DEP	0.64 (0.31 - 1.09)	0.71 (0.00 - 1.96)	1.35 (0.31 - 3.05)	0.01 (0.00 - 0.03)
SEP	0.49 (0.31 - 0.74)	0.15 (0.00 - 0.34)	0.64 (0.31 - 1.08)	0.01 (0.00 - 0.01)
SEP and DEP	1.13 (0.62 - 1.83)	0.86 (0.00 - 2.29)	1.99 (0.62 - 4.12)	0.02 (0.01 - 0.03)

Notes
1. Assumes displacement rates of 0.700 and mortality rate of 1% of displaced birds

2. Background population is Forth Islands SPA breeding adults (150,518 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

1800. Based on the mean combined displacement and collision rates, the annual mortality of breeding adult gannets from Forth Islands SPA at DEP is 1.35, and 0.64 at SEP. This gives a combined total annual displacement and collision mortality rate for SEP and DEP together of 1.99 Forth Islands SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.02%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates are likely in a typical year of impacts due to SEP and DEP. The use of upper 95% CI outputs does not alter the conclusions of the assessment.

1801. **It is concluded that predicted gannet mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Forth Islands SPA.**

1802. The confidence in the assessment is high, for the reasons provided in the individual displacement and collision assessments.

9.19.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

1803. Whilst some OWFs in Scottish waters (particularly in the Moray Firth) are situated within mean maximum foraging range of gannets from the Forth Islands SPA, the evidence from Wakefield *et al.* (2013) indicates that there would be no use of SEP and DEP by breeding gannets from the SPA during the breeding season, hence there is no risk of SEP and DEP contributing to in-combination impacts during the breeding season. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

9.19.3.1.5.1 Operational Phase Displacement/Barrier Effects

1804. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn and spring migration seasons respectively, 22,374 and 5,728 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-98**). Of the birds at risk of displacement, 7,230 are estimated to belong to the breeding adult population of Forth Islands SPA, assuming 24.3% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the autumn migration season, and 31.3% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the spring migration season (Furness, 2015). Displacement and mortality rates of birds belonging to Forth Islands SPA are presented in **Table 9-162**.

Table 9-162: In-Combination Displacement Matrix for Gannet from Forth Islands SPA and from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
Displacement (%)		1	2	3	4	5	10	20	30	50	80	100
	10	7	14	22	29	36	72	145	217	361	578	723
	20	14	29	43	58	72	145	289	434	723	1157	1446
	30	22	43	65	87	108	217	434	651	1084	1735	2169
	40	29	58	87	116	145	289	578	868	1446	2314	2892
	50	36	72	108	145	181	361	723	1084	1807	2892	3615
	60	43	87	130	174	217	434	868	1301	2169	3470	4338
	70	51	101	152	202	253	506	1012	1518	2530	4049	5061
	80	58	116	174	231	289	578	1157	1735	2892	4627	5784
	90	65	130	195	260	325	651	1301	1952	3253	5205	6507
	100	72	145	217	289	361	723	1446	2169	3615	5784	7230

1805. Assuming a displacement rate of 0.600 to 0.800, and a mortality rate of 1% of displaced birds, 43 to 58 SPA birds would be lost to displacement each non-breeding season. This would increase the existing mortality within the SPA population (12,192 breeding adult birds per year) by 0.36% to 0.47%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable change in mortality rate is predicted due to operational phase OWF displacement impacts.

1806. **It is concluded that predicted gannet mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Forth Islands SPA**.

9.19.3.1.5.2 Collision risk

1807. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn and spring migration seasons respectively, 836 and 333 birds belonging to the UK North Sea and Channel BDMPS are predicted to die due to collision with OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-100**).

1808. These collision rates are based largely on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than their consent allows. These will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

1809. Of the birds predicted to die annually due to in-combination collision impacts, 307 are estimated to belong to the breeding adult population of Forth Islands SPA. This assumes that 24.3% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the autumn migration season, and 31.3% of birds of the total relevant BDMPS belong to the breeding population of this SPA (Furness, 2015) during the spring migration season. This would increase the existing mortality within the SPA population (12,192 breeding adult birds per year) by 2.52%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to collision risk.

1810. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of Forth Islands SPA are small, with a mean predicted annual mortality rate of 0.86 birds (**Table 9-161**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay, the conservation objectives for the SPA being met.

1811. **It is concluded that predicted gannet mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Forth Islands SPA.**

1812. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

9.19.3.1.5.3 Combined Displacement/Barrier Effects and Collision Risk

1813. The predicted annual in-combination breeding adult Forth Islands SPA gannet mortality from collision and displacement at OWFs screened into the Appropriate Assessment is between 350 and 365 birds, depending on whether a displacement rate of 0.600 to 0.800 is used in calculations. This represents an increase in existing annual mortality of 2.87% to 2.99%, assuming an existing mortality of 12,192 breeding adult birds per year. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to collision risk.

1814. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of Forth Islands SPA are small, with a mean predicted annual mortality rate of 1.99 birds (**Table 9-161**). Based on the size of the population, and recent population trends, it is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay, the conservation objectives for the SPA being met.

1815. **It is concluded that predicted gannet mortality due to the combined impacts of operational phase displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Forth Islands SPA.**

1816. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

9.19.3.2 Lesser black-backed gull

9.19.3.2.1 Status

1817. The SPA breeding population at classification was 1,500 pairs or 3,000 breeding adults (SNH, 2018a). Furness (2015) gives a breeding population of 1,608 breeding pairs or 3,216 adults for 2005 to 2009. This is used as the reference population for the assessment. The baseline mortality of this population is 370 adult birds per year based on this reference population and the published adult mortality rate of 11.5% (Horswill and Robinson, 2015).

9.19.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1818. SEP and DEP are situated approximately 380km from the Forth Islands SPA. The mean maximum foraging range of lesser black-backed gull is 127km (±109km) and the maximum foraging range is 533km. The mean maximum breeding season foraging range of lesser black-backed gull from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 141km (±51km) based on data from three sites. The updated review of Woodward *et al*. (2019), based on 18 sites, gives a smaller mean maximum foraging range.

1819. SEP and DEP are therefore beyond the mean maximum foraging range plus one standard deviation of breeding adult lesser black-backed gull from the Forth Islands SPA. Whilst they are within the maximum foraging range, this measurement is considered to be a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. As a result, no impacts on this qualifying feature due to SEP and DEP are predicted during the breeding season.

1820. During the pre and post breeding periods, breeding lesser black-backed gulls from the Forth Islands SPA migrate through UK waters, whilst some birds remain in the UK during the winter. The relevant reference population is considered to be the UK North Sea and Channel BDMPS. This consists of 209,007 individuals during autumn migration (September to October), 39,314 individuals during winter (November to February) and 197,483 individuals during spring migration (March) (Furness, 2015).

1821. Estimates of the proportion of lesser black-backed gulls present at SEP and DEP which originate from this SPA during the non-breeding season (and therefore the proportion of predicted mortalities from the SPA population) are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS during the season at which it is largest. During autumn migration, winter, and spring migration, 1.5%, 4.1%, and 1.6% of impacts are considered to affect birds from the SPA respectively (Furness, 2015).

9.19.3.2.3 Potential Effects on the Qualifying Feature

1822. The lesser black-backed gull qualifying feature of Forth Islands SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.19.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.19.3.2.4.1 Collision Risk

1823. Information to inform the Appropriate Assessment for collision risk on breeding adult lesser black-backed gulls belonging to the Forth Islands SPA population is presented in **Table 9-163**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-164**. The avoidance rate used was 0.995, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1824. Based on the mean collision rates, the annual total of breeding adult lesser black-backed gulls from the Forth Islands SPA at risk of collision at DEP is 0.01, and zero at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.01 Forth Islands SPA breeding adult lesser black-backed gulls. This would increase the existing mortality of the SPA breeding population by 0.002%.

Table 9-163: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Lesser Black-Backed Gull at SEP and DEP Apportioned to Forth Islands SPA

Site	Variable		J[2]	F[2]	M[3]	A[4]	M[4]	J[4]	J[4]	A[4]	S[1]	O[1]	N[2]	D[2]	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.04	0.05
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable		J[2]	F[2]	M[3]	A[4]	M[4]	J[4]	J[4]	A[4]	S[1]	O[1]	N[2]	D[2]	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.04	0.05
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. For autumn migration season (Sept-Oct), assumes 1.5% of birds present are Forth Islands SPA breeders (Furness 2015)

2. For winter season (Nov-Feb), assumes 4.1% of birds present are Forth Islands SPA breeders (Furness 2015)

3. For spring migration season (Mar), assumes 1.5% of birds present are Forth Islands SPA breeders (Furness 2015)

4. For breeding season (Apr-Aug), assumes 0% of birds present are Forth Islands SPA breeders based on relevant information in published literature

1825. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.01% due to the collision impacts of SEP and DEP together.

1826. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. The small sample size of flying birds recorded across DEP as a whole (16 birds) means that any differences in encounter rate between DEP and DEP-N are highly unlikely to be statistically significant for this species. Therefore, the collision rates presented here are a reasonable representation of the worst case scenario for DEP.

1827. **It is concluded that predicted lesser black-backed gull mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Forth Islands SPA.**

1828. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.19.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.19.3.2.5.1 Collision Risk

1829. The predicted impacts of SEP and DEP in isolation and together on the breeding adult lesser black-backed gull population of the Forth Islands SPA are extremely small (i.e. virtually zero) (**Table 9-163**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature.

1830. No quantitative assessment of in-combination collision risk for lesser black-backed gull has been carried out. It should be noted that the Appropriate Assessment for the Neart Na Gaoithe OWF (Pelagica Environmental Consultancy and Cork Ecology, 2018) did not assess Forth Islands SPA lesser black-backed gull, following advice from Scottish Ministers in 2017.

1831. **It is concluded that predicted lesser black-backed gull mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Forth Islands SPA.**

9.19.3.3 Puffin

9.19.3.3.1 Status

1832. The Forth Islands SPA breeding puffin population was 14,000 pairs or 28,000 breeding adults at classification (SNH, 2018a). Furness (2015) gives a breeding population of 62,231 breeding pairs or 124,462 adults for 2008 to 2010. This is used as the reference population for the assessment. The baseline mortality of this population is 11,699 adult birds per year based on this reference population and the published adult mortality rate of 9.4% (Horswill and Robinson, 2015).

9.19.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1833. The mean maximum foraging range of puffin is 137.1km (±128.3km) and the maximum foraging range is 383km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of puffin from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 105.4km (±46.0km) based on data from eight studies. The updated review of Woodward *et al.* (2019), based on five studies across seven breeding sites, therefore gives an increased mean maximum foraging range.

1834. SEP and DEP are located approximately 380km from the Forth Islands SPA boundary at the nearest point. This means that puffins from this SPA are beyond the mean maximum foraging range plus one standard deviation for this species, but within the maximum recorded foraging range for this species. However, this measurement is considered to be a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1835. Outside the breeding season, breeding puffins from the SPA are assumed to range widely and to mix with puffins of all age classes from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 231,957 individuals (mid-August to March) (Furness, 2015). During the non-breeding season, it is estimated that 26.8% of birds present are considered to be breeding adults from the Forth Islands SPA. This is based on the SPA adult population as a proportion of the UK North Sea and Channel BDMPS, and impacts are apportioned accordingly.

9.19.3.3.3 Potential Effects on the Qualifying Feature

1836. The puffin qualifying feature of the Forth Islands SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects during the non-breeding season.

9.19.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.19.3.3.4.1 Operational Phase Displacement/Barrier Effects

1837. Population estimates of puffin at SEP, DEP and SEP and DEP by biologically relevant season are provided in **Table 9-164**, **Table 9-165** and **Table 9-166** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult puffins belonging to the Forth Islands SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

1838. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA with respect to other auk species (**Section 9.15.3.3.4.1**) is also relevant to this population. The full range of recommended displacement and mortality effects are considered by the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1% respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-164: Predicted Operational Phase Displacement and Mortality of Forth Islands SPA Breeding Adult Puffins at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 58 (nb) 58 (year round)	0 (b) 15 (nb) 15 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 22 (nb) 22 (year round)	0 (b) 6 (nb) 6 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Forth Islands SPA breeding adults. For non-breeding season, assumes 26.8% of birds are Forth Islands SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Forth Islands SPA breeding adults (124,462 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)

Table 9-165: Predicted Operational Phase Displacement and Mortality of Forth Islands SPA Breeding Adult Puffins at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 23 (nb) 23 (year round)	0 (b) 6 (nb) 6 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 11 (nb) 11 (year round)	0 (b) 3 (nb) 3 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Forth Islands SPA breeding adults. For non-breeding season, assumes 26.8% of birds are Forth Islands SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Forth Islands SPA breeding adults (124,462 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)

Table 9-166: Predicted Operational Phase Displacement and Mortality of Forth Islands SPA Breeding Adult Puffins at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 80 (nb) 80 (year round)	0 (b) 21 (nb) 21 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 32 (nb) 32 (year round)	0 (b) 9 (nb) 9 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Forth Islands SPA breeding adults. For non-breeding season, assumes 26.8% of birds are Forth Islands SPA breeding adults.

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Forth Islands SPA breeding adults (124,462 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)				

1839. Based on the mean peak abundances, the annual total of puffins from the Forth Islands SPA at risk of displacement from SEP and DEP is nine birds (**Table 9-166**); six at DEP (**Table 9-164**) and three at SEP (**Table 9-165**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, less than one (0.03 - 0.60) SPA breeding adult would be predicted to die each year due to displacement from SEP and DEP together. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.01% due to impacts at SEP and DEP together.

1840. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when either the mean peak abundance estimate assessments, or those using the upper 95% CI of mean peak abundance are considered.

1841. **It is concluded that predicted puffin mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Forth Islands SPA.**

1842. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.19.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.19.3.3.5.1 Operational Phase Displacement/Barrier Effects

1843. An unpublished Appropriate Assessment for a proposed OWF in Scottish waters indicates that approximately 7,845 breeding adult puffins from the Forth Islands SPA are at risk of displacement from existing or proposed developments in Scottish

Waters during the breeding season. The OWFs contributing to this impact during this season are Inch Cape, Neart Na Gaoithe, Seagreen, Kincardine and Hywind. The Blyth Demonstrator OWF is within the mean maximum foraging range of puffins breeding at the Forth Islands SPA, but it is assumed that 100% of birds recorded at that OWF during the breeding season are from the breeding adult population of the Farne Islands SPA (**Section 9.17.3.5.5.1**).

1844. The cumulative impact assessment presented in the Hornsea Project Four OWF (APEM, 2021), plus impacts from SEP and DEP, indicates that during the non-breeding season, 45,017 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. Of the birds at risk of displacement, 12,077 are estimated to belong to the Forth Islands SPA, assuming 26.8% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

1845. Puffin was screened out of the EIA for SEP and DEP due to the low abundance of this species in the SEP and DEP wind farm sites and 2km buffers. In total, three and six birds from the breeding adult population of the Forth Islands SPA were present at SEP and DEP respectively year round.

1846. This brings the number of breeding adult puffins belonging the Forth Islands SPA population at risk of cumulative operational OWF displacement to 19,931 individuals.

1847. Displacement and mortality rates of birds belonging to the Forth Islands SPA are presented in **Table 9-167**.

Table 9-167: In-Combination Year Round Displacement Matrix for Puffin from Forth Islands SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

	Mortality (%)										
Displacement (%)	1	2	3	4	5	10	20	30	50	80	100
10	20	40	60	80	100	199	399	598	997	1594	1993
20	40	80	120	159	199	399	797	1196	1993	3189	3986
30	60	120	179	239	299	598	1196	1794	2990	4783	5979
40	80	159	239	319	399	797	1594	2392	3986	6378	7972
50	100	199	299	399	498	997	1993	2990	4983	7972	9966
60	120	239	359	478	598	1196	2392	3588	5979	9567	11959
70	140	279	419	558	698	1395	2790	4186	6976	11161	13952
80	159	319	478	638	797	1594	3189	4783	7972	12756	15945
90	179	359	538	718	897	1794	3588	5381	8969	14350	17938
100	199	399	598	797	997	1993	3986	5979	9966	15945	19931

1848. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 1,395 breeding adult SPA birds would be lost to displacement annually. This would increase the mortality within this population by 11.93%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 100 birds. This would increase the mortality within this population by 0.85%.

1849. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used. Mortality rate increases in the SPA population of over 1% are predicted if the mortality rates of displaced birds are assumed to be 1% in conjunction with displacement rates of 0.600 or more, and if mortality rates of displaced birds of 2% or more are used in conjunction with displacement rates of 0.300 to 0.700.

1850. It is concluded **that predicted puffin mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Forth Islands SPA.**

9.20 Imperial Dock Lock, Leith, SPA

9.20.1 Description of Designation

1851. The Imperial Dock Lock, Leith SPA is a man-made structure at the mouth of the Imperial Dock in the heart of the Port of Leith, Edinburgh.

9.20.2 Conservation Objectives

1852. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.20.3 Appropriate Assessment

1853. The only qualifying species screened into the Appropriate Assessment from this SPA is breeding common tern (**Table 5-2**).

9.20.3.1 Common Tern

9.20.3.1.1 Status

1854. The SPA breeding population at classification was 558 pairs or 1,116 breeding adults, for the period 1997 to 2001 (SNH, 2004). The most recent count is 246 pairs, or 492 breeding adults, in 2019 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 58 breeding adult birds per year based on the published adult mortality rate of 11.7% (Horswill and Robinson, 2015).

9.20.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1855. The mean maximum foraging range of common tern is 18.0km (±8.9km) and the maximum foraging range is 30km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of common tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 15.2km (±11.2km) based on data from six sites. The updated review of Woodward *et al*. (2019), based on data from 16 studies, gives a larger mean maximum foraging range.

1856. The Imperial Dock Lock, Leith SPA is located approximately 430km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1857. During the pre and post breeding periods, breeding common terns from the Imperial Dock Lock, Leith SPA migrate through UK waters. The relevant reference population is the UK North Sea and Channel BDMPS, consisting of 144,911 individuals during autumn migration (late July to early September) and spring migration (April to May) (Furness, 2015). During these seasons it is estimated that 0.8% of birds present are breeding adults from the Imperial Dock Lock, Leith SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.20.3.1.3 Potential Effects on the Qualifying Feature

1858. The common tern qualifying feature of the Imperial Dock Lock, Leith SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.20.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.20.3.1.4.1 Collision Risk

1859. Information to inform the Appropriate Assessment for collision risk on breeding adult common terns belonging to the Imperial Dock Lock, Leith SPA population is presented in **Table 9-168**. Collision estimates are presented by month. The avoidance rate used was 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1860. Based on the mean collision rates, the annual total of breeding adult common terns from the Imperial Dock Lock, Leith SPA at risk of collision at SEP and DEP together is 0.01. This would increase the existing mortality of the SPA breeding population by 0.02%.

Table 9-168: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Common Tern at SEP and DEP Apportioned to Imperial Dock Lock, Leith SPA

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.02	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.06
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.02	0.02	0.01	0.00	0.01	0.02	0.00	0.00	0.00	0.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.
2. For autumn migration season (Jul-Sept) and spring migration season (Apr-May), assumes 1.0% of adult birds are Imperial Dock Lock, Leith SPA breeders (Furness 2015). For breeding season (May-Aug), assumes 0% of adult birds are Imperial Dock Lock, Leith SPA breeders

1861. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.10% due to the collision impacts of SEP and DEP together.

1862. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 36 flying birds were observed across DEP (of which 29 were within DEP-N, and seven within DEP-S). When corrected for the different survey transect lengths in both regions of DEP this means that encounter rate was 32.2% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not materially impact the predicted increases in annual mortality presented above.

1863. **It is concluded that predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Imperial Dock Lock, Leith SPA.**

1864. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.20.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.20.3.1.5.1 Collision Risk

1865. The predicted impacts of SEP and DEP in isolation and together on the breeding adult common tern population of the Imperial Dock Lock, Leith SPA are extremely small, with 0.01 collisions predicted annually (**Table 9-168**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature.

1866. During the breeding season, no OWFs are within mean maximum foraging range of this SPA. Therefore no impacts are predicted.

1867. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. However, the low flight heights that are generally used by this species during passage periods ("Corrigendum," 2014; Hedenström and Åkesson, 2016; Johnston *et al.*, 2014), indicate that the possibility of a substantial in-combination collision impact on this species during these seasons is unlikely. Furthermore, as just 0.8% of total common tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1868. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF collision on breeding common tern of the Imperial Dock Lock, Leith SPA, no such assessment has been performed. However, the information presented provides relatively high confidence that mortality levels due to this impact are very low.

1869. **It is concluded that predicted common tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Imperial Dock Lock, Leith SPA.**

9.21 Fowlsheugh SPA

9.21.1 Description of Designation

1870. Fowlsheugh SPA, located 4km south of Stonehaven on the east coast of Aberdeenshire in north-east Scotland, is a stretch of sheer cliffs between 30m and 60m high. Large numbers of seabirds nest on the cliffs.

1871. The seaward extension of the SPA extends 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.21.2 Conservation Objectives

1872. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.21.3 Appropriate Assessment

1873. The qualifying species screened into the Appropriate Assessment are breeding kittiwake and breeding guillemot (**Table 5-2**).

9.21.3.1 Kittiwake

9.21.3.1.1 Status

1874. The SPA breeding population at classification was cited as 36,650 pairs or 73,300 breeding adults (Natural England, 2017b). The most recent count is 14,039 breeding pairs, or 28,078 breeding adults in 2018 (JNCC, 2022), which is used as the reference population for the assessment. The baseline mortality of this population is 4,099 breeding adult birds per year based on the published adult mortality rate of 14.6% (Horswill and Robinson, 2015).

9.21.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1875. SEP and DEP are located approximately 450km from Fowlsheugh SPA boundary at the nearest point. The mean maximum foraging range of kittiwake is 156.1km (±144.5km), and the maximum foraging range is 770km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of kittiwake from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 60.0km (±23.3km) based on data from six studies. The updated review of Woodward *et al*. (2019), based on 19 studies at 37 sites, gives a substantially larger mean maximum foraging range.

1876. SEP and DEP are therefore beyond the mean maximum foraging range plus one standard deviation from Fowlsheugh SPA, but within the maximum foraging range. The latter measurement is a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. SEP and DEP are within the mean maximum foraging range of kittiwakes from the Flamborough and Filey Coast SPA. Foraging areas of kittiwakes from different colonies often tend not to overlap (Cleasby *et al*., 2020, 2018; Wakefield *et al*., 2017). This further increases the likelihood that birds from the Fowlsheugh SPA will not occur at SEP and DEP during the breeding season. This is the assumption made by the assessment.

1877. Outside the breeding season breeding kittiwakes, including those from Fowlsheugh SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with kittiwakes of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea BDMPS. This consists of 829,937 individuals during the autumn migration season (August to December), and 627,816 individuals during the spring migration season (January to April) (Furness, 2015).

1878. During the autumn migration season, 60% of Fowlsheugh SPA breeding adults are assumed to be present in the BDMPS, representing 1.3% of the BDMPS population (829,937 individuals of all ages). During this season, 1,609 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 487 birds were able to be assigned to an age class. 400 birds (82.1% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from Fowlsheugh SPA is 1.1% (i.e. 0.013 x 0.821).

1879. 60% of SPA breeding adults are also assumed to be present in the BDMPS during the spring migration season, representing 1.8% of the BDMPS population (627,816 individuals of all ages). During this season, 63 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 23 birds were able to be assigned to an age class. 21 birds (91.3% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the spring migration season that are breeding adult birds from the Fowlsheugh SPA is 1.6% (i.e. 0.018 x 0.913).

9.21.3.1.3 Potential Effects on the Qualifying Feature

1880. The kittiwake qualifying feature of the Fowlsheugh SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.21.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.21.3.1.4.1 Collision Risk

1881. Information to inform the Appropriate Assessment for collision risk on breeding adult kittiwakes belonging to the Fowlsheugh SPA population is presented in **Table 9-169**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-170**. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1882. Based on the mean collision rates, the annual total of breeding adult kittiwakes from the Fowlsheugh SPA at risk of collision at DEP is 0.07, with 0.01 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.09 Fowlsheugh SPA breeding adult kittiwakes. This would increase the existing mortality of the SPA breeding population by 0.01%.

1883. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 205 flying birds were observed across DEP (of which 158 were within DEP-N, and 47 within DEP-S). When corrected for the different survey transect lengths in both regions of DEP, this means that encounter rate was 26.5% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

Table 9-169: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Fowlsheugh SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
DEP	Mean	-	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.01	0.07
	Density	95% UCI	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.03	0.01	0.01	0.19
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.01	0.09
		95% LCI	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.05
	Avoidance Rate	-2 SD	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	0.01	0.09
		+2 SD	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.06
	Noct. Act.	EB	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.00	0.01	0.06
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.02	0.06
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
SEP and DEP	Mean	-	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.00	0.01	0.09
	Density	95% UCI	0.03	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.03	0.02	0.04	0.25
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.01	0.01	0.10
		95% LCI	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.01	0.06
	Avoidance Rate	-2 SD	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.01	0.01	0.10
		+2 SD	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.01	0.07
	Noct. Act.	EB	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.01	0.07

Notes

1. For autumn migration season (Sept-Dec), assumes 1.3% of adult birds are Fowlsheugh SPA breeders (Furness 2015), combined with 82.1% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Jan-Feb), assumes 1.8% of adult birds are Fowlsheugh SPA breeders, combined with 91.3% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Aug), assumes 0% of adult birds are Fowlsheugh SPA breeders

Table 9-170: Predicted Annual Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Fowlsheugh SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase[1]
DEP	0.07 (0.00 - 0.19)	0.01 (0.00 - 0.01)
SEP	0.01 (0.00 - 0.06)	0.00 (0.00 - 0.00)
SEP and DEP	0.09 (0.00 - 0.25)	0.01 (0.00 - 0.02)
Notes 1. Background population is Fowlsheugh SPA breeding adults (28,078 individuals), adult age class annual mortality rate of 14.6% (Horswill and Robinson, 2015)		

1884. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.02% due to the collision impacts of SEP and DEP together.

1885. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Fowlsheugh SPA.**

1886. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.21.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.21.3.1.5.1 Collision Risk

1887. Approximately 49 breeding adults from the Fowlsheugh SPA kittiwake population are predicted to die due to collision with OWFs each breeding season. The OWFs that contribute collisions to this total are Inch Cape, Neart Na Gaoithe, Seagreen, Kincardine, Hywind and Aberdeen. These values were taken from an unpublished OWF assessment that is currently in preparation.

1888. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus the predicted impacts of SEP and DEP, indicates that during the autumn migration season, 1,587 collisions are predicted between kittiwakes belonging to the UK North Sea and Channel BDMPS and OWFs in the North Sea. The corresponding value for the spring migration season is 1,204 birds. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-105**). Of the collisions predicted during the autumn migration season, 21 are estimated to involve breeding adult birds from the Fowlsheugh SPA, assuming 1.3% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015). The corresponding number of collisions for the spring migration season, based on the assumption that 1.8% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015), is 22.

1889. In total therefore, 91.7 collisions per year are predicted for breeding adults of the Fowlsheugh SPA due to in-combination collision risk of OWFs in the North Sea. This would increase the existing mortality within this population by approximately 2.2%. Since increases in mortality of more than 1% could potentially be detectable, an adverse effect due to this in-combination impact is possible.

1890. The predicted impacts of SEP and DEP in isolation and together on the breeding adult kittiwake population of the Fowlsheugh SPA are extremely small, with 0.09 collisions predicted annually (**Table 9-170**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. An impact of this magnitude is not considered to prevent the conservation objectives of the SPA from being met.

1891. It is concluded that predicted kittiwake mortality due to of collision impacts at SEP, DEP, and S**EP and DEP together, in-combination with other projects, would not adversely affect the integrity of Fowlsheugh SPA.**

9.21.3.2 Guillemot

9.21.3.2.1 Status

1892. The Fowlsheugh SPA breeding guillemot population was 56,450 individuals (SNH, 2009b) at classification. The most recent published count was 61,416 individuals in 2018 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 3,746 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.21.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1893. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

1894. Fowlsheugh SPA is located approximately 450km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1895. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 3.0% of birds present are considered to be breeding adults from Fowlsheugh SPA, and impacts are apportioned accordingly. This is based on the SPA adult population as a proportion of the total UK North Sea and Channel BDMPS.

9.21.3.2.3 Potential Effects on the Qualifying Feature

1896. The guillemot qualifying feature of Fowlsheugh SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement and barrier effects.

9.21.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.21.3.2.4.1 Operational Phase Displacement / Barrier Effects

1897. Population estimates of guillemot at SEP, DEP and SEP and DEP by biologically relevant season are provided in **Table 9-171**, **Table 9-172** and **Table 9-173** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides an overview of how information from Furness (2015), in conjunction with the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots present at SEP and DEP that belong to the SPA population. An estimated annual mortality for the population due to operational phase displacement is provided, along with the increase in existing annual mortality of the relevant background population that would occur through such an impact.

1898. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the Fowlsheugh SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-171: Predicted Operational Phase Displacement and Mortality of Fowlsheugh SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 735 (nb) 735 (year round)	2 - 51 (4)	0.06 - 1.37 (0.10)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 447 (nb) 447 (year round)	1 - 31 (2)	0.04 - 0.83 (0.06)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 235 (n) 235 (year round)	1 - 16 (1)	0.02 - 0.44 (0.03)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Fowlsheugh SPA breeding adults. For non-breeding season, assumes 3.0% of birds are Fowlsheugh SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Fowlsheugh SPA breeding adults (61,416 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-172: Predicted Operational Phase Displacement and Mortality of Fowlsheugh SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 47 (nb) 47 (year round)	0 - 3 (0)	0.00 - 0.09 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 33 (nb) 33 (year round)	0 - 2 (0)	0.00 - 0.06 (0.00)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 20 (nb) 20 (year round)	0 - 1 (0)	0.00 - 0.04 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
2. For breeding season (Mar-Jul), assumes 0% of birds are Fowlsheugh SPA breeding adults. For non-breeding season, assumes 3.0% of birds are Fowlsheugh SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Fowlsheugh SPA breeding adults (61,416 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-173: Predicted Operational Phase Displacement and Mortality of Fowlsheugh SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 782 (nb) 782 (year round)	2 - 55 (4)	0.06 - 1.46 (0.10)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 479 (nb) 479 (year round)	1 - 34 (2)	0.04 - 0.90 (0.06)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 255 (nb) 255 (year round)	1 - 18 (1)	0.02 - 0.48 (0.03)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are Fowlsheugh SPA breeding adults. For non-breeding season, assumes 3.0% of birds are Fowlsheugh SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Fowlsheugh SPA breeding adults (61,416 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

1899. Based on the mean peak abundances, the annual total of guillemots from the Fowlsheugh SPA at risk of displacement from SEP and DEP is 479 birds (**Table 9-173**); 447 at DEP (**Table 9-171**) and 33 at SEP (**Table 9-172**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 1.3 to

31.3 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.1 to 2.3 birds due to displacement at SEP.

1900. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding population would increase by 0.83% due to impacts at DEP, and 0.06% due to impacts at SEP (0.90% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.06% due to impacts at DEP (2.2 birds), less than 0.01% due to impacts at SEP (0.2 birds), and 0.06% due to the impacts of SEP and DEP together (2.4 birds).

1901. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1902. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered.

1903. Mortality rate increases of over 1% are predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment instead alongside the highest recommended mortality rates. The probability of this occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, a mortality rate for displaced birds of 10% is much higher than evidence suggests will actually be the case, and use of the evidence-based displacement (0.500) and mortality rate (1%) would result in a mortality increase of significantly less than 1%.

1904. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Fowlsheugh SPA.**

1905. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same

irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

1906. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, impacts from SEP and DEP on this SPA qualifying feature may be close to zero.

9.21.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.21.3.2.5.1 Operational Phase Displacement / Barrier Effects

1907. The Appropriate Assessment for the Neart na Gaoithe OWF (Pelagica Environmental Consultancy and Cork Ecology, 2018) indicated that approximately 7,680 adults from the Fowlsheugh SPA are at risk of displacement during the breeding season. The OWFs contributing to this impact during this season are Neart na Gaoithe and Seagreen.

1908. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 7,692 are estimated to belong to Fowlsheugh SPA, assuming 3.0% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

1909. In total therefore, 15,372 birds from the Fowlsheugh SPA are at risk of in-combination OWF displacement throughout the year. Annual displacement and mortality of breeding adult birds belonging to the Fowlsheugh SPA are presented in **Table 9-174**.

Table 9-174: In-Combination Year Round Displacement Matrix for Guillemot from Fowlsheugh SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	15	31	46	61	77	154	307	461	769	1230	1537
	20	31	61	92	123	154	307	615	922	1537	2460	3074
	30	46	92	138	184	231	461	922	1383	2306	3689	4612
	40	61	123	184	246	307	615	1230	1845	3074	4919	6149
	50	77	154	231	307	384	769	1537	2306	3843	6149	7686
	60	92	184	277	369	461	922	1845	2767	4612	7379	9223
	70	108	215	323	430	538	1076	2152	3228	5380	8608	10760
	80	123	246	369	492	615	1230	2460	3689	6149	9838	12298
	90	138	277	415	553	692	1383	2767	4150	6917	11068	13835
	100	154	307	461	615	769	1537	3074	4612	7686	12298	15372

1910. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 1,076 breeding adult SPA birds would be lost to displacement each year. This would increase the existing mortality within the SPA population (3,746 breeding adult birds per year) by 28.72%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 77 birds. This would increase the existing mortality within this population by 2.05%.

1911. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

1912. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

1913. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Fowlsheugh SPA.**

9.22 Ythan Estuary, Sands of Forvie and Meikle Loch SPA and Ramsar Site

9.22.1 Description of Designation

1914. The Ythan Estuary, Sands of Forvie and Meikle Loch SPA covers a complex area in the north east of Scotland that contains the long, narrow estuary of the River Ythan, the Sands of Forvie on the east bank of the estuary; the eutrophic Meikle Loch and a marine component covering the area between Aberdeen and Cruden Bay to the north.

9.22.2 Conservation Objectives

1915. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.22.3 Appropriate Assessment

1916. The only qualifying species screened into the Appropriate Assessment is Sandwich tern (**Table 5-2**).

9.22.3.1 Sandwich Tern

9.22.3.1.1 Status

1917. The SPA breeding population at classification was 1,125 pairs or 2,250 breeding adults, for the period 1989 to 1991 (NatureScot, 2020a). The most recent count is 1,010 pairs in 2019 (JNCC, 2022), equivalent to 2,020 breeding adults. The baseline mortality of this population is 206 breeding adult birds per year based on the published adult mortality rate of 10.2% (Horswill and Robinson, 2015).

9.22.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1918. The mean maximum foraging range of Sandwich tern is 34.3km (±23.2km), and the maximum foraging range is 54km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Sandwich tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 49km

(±7.1km) based on data from two sites. The updated review of Woodward *et al.* (2019), based on five sites, gives a smaller mean maximum foraging range. However, it was noted by the recent review that clear differences in data collected using different methods (i.e. boat tracking versus tagged birds) means that the confidence level in the data was changed from “high” to “moderate”.

1919. The Ythan Estuary, Sands of Forvie and Meikle Loch SPA is located approximately 470km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1920. Outside the breeding season breeding Sandwich terns are assumed to range widely and to mix with birds of all ages from breeding colonies in the UK and further afield. The relevant background population is considered to be the UK North Sea and Channel BDMPS, consisting of 38,051 individuals during autumn migration (July to September), and spring migration (March to May) (Furness, 2015).

1921. Estimates of the proportion of Sandwich terns present at SEP and DEP during the autumn and spring migration seasons which originate from the Ythan Estuary, Sands of Forvie and Meikle Loch SPA are based on the SPA population as a proportion of the UK North Sea and Channel BDMPS (Furness 2015). During both autumn and spring migration seasons, breeding adult Sandwich terns from the Ythan Estuary, Sands of Forvie and Meikle Loch SPA make up 3.0% of the total BDMPS population. The same percentage of impacts are therefore attributable to birds from this SPA during these times of year.

9.22.3.1.3 Potential Effects on the Qualifying Feature

1922. The Sandwich tern qualifying feature of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.22.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.22.3.1.4.1 Operational Phase Displacement/Barrier Effects

1923. Population estimates of Sandwich tern at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-175**, **Table 9-176** and **Table 9-177** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult Sandwich tern belonging to the Ythan Estuary, Sands of Forvie and Meikle Loch SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

1924. Displacement rates of 0.000 to 0.500 are considered to be appropriate for this species based on a review of available evidence (Cook *et al.*, 2014; Green *et al.*, 2019, 2018; Harwood *et al.*, 2018; Krijgsveld *et al.*, 2011; Scragg *et al.*, 2016;

Thaxter *et al.*, 2018). A maximum mortality rate of 1% of displaced birds is considered to be appropriate, based on the existing mortality of adult birds of 0.102 (Horswill and Robinson, 2015), and low energy expenditure predictions of a closely related species (common tern) due to barrier effects by OWFs (Masden *et al.*, 2010).

Table 9-175: Predicted Operational Phase Displacement and Mortality of Ythan Estuary, Sands of Forvie and Meikle Loch SPA Breeding Adult Sandwich Terns at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	346 (breeding) 132 (autumn) 0 (spring)	0 (breeding) 4 (autumn) 0 (spring)	0 - 0	0.00 - 0.01
Mean	179 (breeding) 45 (autumn) 0 (spring)	0 (breeding) 1 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Lower 95% CI	62 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0 - 0	0.00 - 0.00

Notes
1. For breeding season (Apr-Aug), assumes 0% of adult birds are Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeders. For autumn and spring migration seasons (September and March), assumes 3.0% of adult birds are Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeders

2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds

3. Background population is Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeding adults (2,020 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)

Table 9-176: Predicted Operational Phase Displacement and Mortality of Ythan Estuary, Sands of Forvie and Meikle Loch SPA Breeding Adult Sandwich Terns at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	139 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Mean	77 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0
Lower 95% CI	25 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0	0

Notes
1. For breeding season (Apr-Aug), assumes 0% of adult birds are Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeders. For autumn and spring migration seasons (September and March), assumes 3.0% of adult birds are Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeders

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeding adults (2,020 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

Table 9-177: Predicted Operational Phase Displacement and Mortality of Ythan Estuary, Sands of Forvie and Meikle Loch SPA Breeding Adult Sandwich Terns at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round annual baseline mortality increase range (%)[3]
Upper 95% CI	485 (breeding) 132 (autumn) 0 (spring)	0 (breeding) 4 (autumn) 0 (spring)	0 - 0	0.00 - 0.01
Mean	255 (breeding) 45 (autumn) 0 (spring)	0 (breeding) 1 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Lower 95% CI	86 (breeding) 0 (autumn) 0 (spring)	0 (breeding) 0 (autumn) 0 (spring)	0 - 0	0.00 - 0.00
Notes 1. For breeding season (Apr-Aug), assumes 0% of adult birds are Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeders. For autumn and spring migration seasons (September and March), assumes 3.0% of adult birds are Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeders 2. Assumes displacement rates of 0.000 to 0.500 and mortality rate of 1% of displaced birds 3. Background population is Ythan Estuary, Sands of Forvie and Meikle Loch SPA breeding adults (2,020 individuals), adult age class annual mortality rate of 10.2% (Horswill and Robinson, 2015)				

1925. Based on the mean peak abundances, the annual total of Sandwich terns from the Ythan Estuary, Sands of Forvie and Meikle Loch SPA at risk of displacement from SEP and DEP together is one bird, which would occur at DEP. At displacement rates of 0.000 to 0.500, and a mortality rate of 1% for displaced birds, 0 to 0.01 SPA breeding adults would be predicted to die each year due to displacement from DEP. The combined displacement mortality from SEP and DEP would increase annual mortality within this population by <0.01% (**Table 9-177**). Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peak abundances are used as inputs to the assessment, since the maximum predicted mortality increase that could occur on this basis represents a 0.03% increase to baseline mortality.

1926. **It is concluded that predicted Sandwich tern mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not**

adversely affect the integrity of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.

1927. The confidence in the assessment is high for several reasons. Firstly, despite not being available in large quantities, the evidence used to set the displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.22.3.1.4.2 Collision Risk

1928. Collision risk predictions for Ythan Estuary, Sands of Forvie and Meikle Loch SPA Sandwich terns at SEP, DEP, and SEP and DEP together (mean values with upper and lower 95% CIs based on the variation in the monthly density estimates), are shown in **Table 9-178**. Outputs are based on Option 1 of the Band Model, avoidance rates of 0.980, and the flight height distribution of Harwood (2021). These parameters were agreed with Natural England during the Expert Topic Group (ETG) process. Nocturnal activity was set at 2% of daytime activity, based on an assessment of Sandwich tern tracking data from the Scolt Head population. Further information on this, detailed methodology and information on other input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1929. For DEP, the mean annual collision estimate increases the annual baseline mortality by <0.01%, and the predicted increase in the annual baseline mortality is 0.04% for the annual upper 95% CI output. For SEP, the mean and upper 95% CI collision rates increases the annual baseline mortality by 0.00. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. These are very low collision rates which would be further reduced if correction for birds displaced by OWFs were included in the calculations. Whilst there is uncertainty around the level of macro-avoidance (i.e. displacement) that will actually occur, evidence indicates that this will be greater than zero (Cook *et al.*, 2014; Green *et al.*, 2019, 2018; Harwood *et al.*, 2018; Krijgsveld *et al.*, 2011; Scragg *et al.*, 2016; Thaxter *et al.*, 2018).

1930. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.**

1931. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore**

Ornithology (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

Table 9-178: Predicted Monthly Breeding Season Collision Mortality for Sandwich Tern at SEP and DEP Apportioned to Ythan Estuary, Sands of Forvie and Meikle Loch SPA

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	0.04
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Site	Variable[1]		J	F	M	A	M	J	J	A	S	O	N	D	Total
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	0.00	0.05
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
		95% LCI	-	-	-	-	-	-	-	-	-	-	-	-	0.00
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01

Notes
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity.

9.22.3.1.4.3 Combined Displacement/Barrier Effects and Collision Risk

1932. It was demonstrated in the Appropriate Assessment for Sandwich terns of the North Norfolk Coast SPA that when considering combined displacement and collision mortality, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Section 9.4.3.1.4.3**). The worst case scenario for combined operational phase displacement and collision for Ythan Estuary, Sands of Forvie and Meikle Loch SPA Sandwich terns is therefore presented in **Table 9-178**. The annual mortality predicted and consequent increase in baseline annual mortality of the population is very small, far less than the 1% level at which effects may be detectable.

1933. **It is concluded that predicted Sandwich tern mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.**

9.22.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.22.3.1.5.1 Operational Phase Displacement

1934. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Sandwich tern population of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA are extremely small, with a mean predicted annual mortality rate of up to 0.01 birds (**Table 9-177**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination operational phase OWF displacement effect on this qualifying feature.

1935. During the breeding season, a single operational OWF (EOWDC, Aberdeen) is within mean maximum foraging range of this SPA. No displacement assessment for this species was carried out by the assessment since Sandwich tern was infrequently recorded. Impacts are therefore assumed to be small. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. During passage periods, it is anticipated that displacement impacts will result in very low mortality rates. This is because the increase in energetic expenditure of displacement will be lower than in the breeding season, when little or no impact on survival has also been predicted for some seabirds unless the OWF causing the effect is located close to the breeding colony (Searle *et al*., 2017, 2014).

1936. Furthermore, as just 3.0% of total Sandwich tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1937. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF displacement on breeding Sandwich tern of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA, no such assessment has been performed. However, the information presented still provides relatively high confidence that mortality levels due to this impact are very low.

1938. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.**

9.22.3.1.5.2 Collision Risk

1939. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Sandwich tern population of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA are extremely small, with a mean predicted annual mortality rate of 0.01 birds (**Table 9-69**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature.

1940. During the breeding season, a single operational OWF (EOWDC, Aberdeen) is within mean maximum foraging range of this SPA. No displacement assessment for this species was carried out by the assessment since Sandwich tern was infrequently recorded. Impacts are therefore assumed to be small. Impacts on this qualifying feature are also possible at OWFs during the spring and autumn migration seasons. A review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. However, the low flight heights that are generally used by this species during passage periods ("Corrigendum," 2014; Johnston *et al*., 2014), indicate that the possibility of a substantial in-combination collision impact on this species during these seasons is unlikely. Furthermore, as just 3.0% of total Sandwich tern impacts outside the breeding season would be apportioned to this SPA population (Furness, 2015), the possibility of a substantial impact on this SPA population is considered to be remote.

1941. As there is no information to enable a quantitative assessment on potential in-combination effects of OWF collision on breeding Sandwich tern of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA, no such assessment has been performed. However, the information presented provides relatively high confidence that mortality levels due to this impact are very low. have not been investigated quantitatively.

1942. **It is concluded that predicted Sandwich tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.**

9.22.3.1.5.3 Combined Displacement and Collision Risk

1943. It was demonstrated in the Appropriate Assessment for Sandwich terns of the North Norfolk Coast SPA that when considering combined displacement and collision mortality, the highest mortality rates are obtained when macro-avoidance is 0% (i.e. displacement is not predicted to occur) (**Section 9.4.3.1.4.3**). The worst case scenario for combined operational phase displacement and collision for Ythan Estuary, Sands of Forvie and Meikle Loch SPA Sandwich terns is therefore presented in **Table 9-178**. The annual mortality predicted and consequent increase in baseline annual mortality of the population is very small, far less than the 1% level at which effects may be detectable.

1944. **It is concluded that predicted Sandwich tern mortality due to combined displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Ythan Estuary, Sands of Forvie and Meikle Loch SPA.**

9.23 Troup, Pennan and Lion's Heads SPA

9.23.1 Description of Designation

1945. The Troup, Pennan and Lion's Heads SPA is a 9km stretch of sea cliffs along the Aberdeenshire coast which support large colonies of breeding seabirds.

1946. The seaward extension of the SPA extends 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.23.2 Conservation Objectives

1947. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.23.3 Appropriate Assessment

1948. The qualifying species screened into the Appropriate Assessment are breeding kittiwake and breeding guillemot (**Table 5-2**).

9.23.3.1 Kittiwake

9.23.3.1.1 Status

1949. The SPA breeding population at classification was cited as 31,600 pairs or 63,200 breeding adults in 1995 (SNH, 2009c). The most recent count is 10,616 breeding pairs, or 21,232 breeding adults in 2017 (JNCC, 2022). The baseline mortality of this population is 3,100 breeding adult birds per year based on the published adult mortality rate of 14.6% (Horswill and Robinson, 2015).

9.23.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1950. SEP and DEP are located approximately 530km from Troup, Pennan and Lion's Heads SPA boundary at the nearest point. The mean maximum foraging range of kittiwake is 156.1km (±144.5km), and the maximum foraging range is 770km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of kittiwake from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 60.0km (±23.3km) based on data from six studies. The updated review of Woodward *et al.* (2019), based on 19 studies at 37 sites, gives a substantially larger mean maximum foraging range.

1951. SEP and DEP are therefore beyond the mean maximum foraging range plus one standard deviation of breeding adult kittiwake from this SPA, but within the maximum foraging range. The latter measurement is a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. As a result, no breeding season impacts at SEP and DEP are apportioned to this population.

1952. Outside the breeding season breeding kittiwakes, including those from Troup, Pennan and Lion's Heads SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with kittiwakes of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea BDMPS. This consists of 829,937 individuals during the autumn migration season (August to December), and 627,816 individuals during the spring migration season (January to April) (Furness, 2015).

1953. During the autumn migration season, 60% of the Troup, Pennan and Lion's Heads SPA breeding adults are assumed to be present in the BDMPS, representing 2.2% of the BDMPS population (829,937 individuals of all ages). During this season, 1,609 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 487 birds were able to be assigned to an age class. 400 birds (82.1% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Troup, Pennan and Lion's Heads SPA is 1.8% (i.e. 0.022 x 0.821).

1954. 60% of SPA breeding adults are also assumed to be present in the BDMPS during the spring migration season, representing 2.8% of the BDMPS population (627,816 individuals of all ages). During this season, 63 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 23 birds were able to be assigned to an age class. 21 birds (91.3% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the spring migration season that are breeding adult birds from the Troup, Pennan and Lion's Heads SPA is 2.6% (i.e. 0.028 x 0.913).

9.23.3.1.3 Potential Effects on the Qualifying Feature

1955. The kittiwake qualifying feature of the Troup, Pennan and Lion's Heads SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.23.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.23.3.1.4.1 Collision Risk

1956. Information to inform the Appropriate Assessment for collision risk on breeding adult kittiwakes belonging to the Troup, Pennan and Lion's Heads SPA population is presented in **Table 9-179**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-180**. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

1957. Based on the mean collision rates, the annual total of breeding adult kittiwakes from the Troup, Pennan and Lion's Heads SPA at risk of collision at DEP is 0.12, with 0.02 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.14 Troup, Pennan and Lion's Heads SPA breeding adult kittiwakes. This would increase the existing mortality of the SPA breeding population by 0.01%.

1958. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 205 flying birds were observed across DEP (of which 158 were within DEP-N, and 47 within DEP-S). When corrected for the different survey transect lengths in both regions of DEP, this means that encounter rate was 26.5% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

Table 9-179: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Troup, Pennan and Lion's Heads SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
DEP	Mean	-	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.00	0.01	0.12
	Density	95% UCI	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.05	0.01	0.02	0.31
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.03	0.00	0.01	0.14
		95% LCI	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.00	0.01	0.08
	Avoidance Rate	-2 SD	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.02	0.00	0.01	0.14
		+2 SD	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.01	0.09
	Noct. Act.	EB	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.00	0.01	0.09
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.02	0.03	0.09
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.03
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.03
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.02
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.02

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
SEP and DEP	Mean	-	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.02	0.01	0.02	0.14
	Density	95% UCI	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.05	0.03	0.06	0.40
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.03	0.01	0.02	0.17
		95% LCI	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.01	0.01	0.01	0.10
	Avoidance Rate	-2 SD	0.02	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.02	0.01	0.02	0.16
		+2 SD	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.01	0.01	0.11
	Noct. Act.	EB	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.01	0.01	0.10

Notes

1. For autumn migration season (Sept-Dec), assumes 2.2% of adult birds are Troup, Pennan and Lion's Heads SPA breeders (Furness 2015), combined with 82.1% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Jan-Feb), assumes 2.8% of adult birds are Troup, Pennan and Lion's Heads SPA breeders, combined with 91.3% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Aug), assumes 0% of adult birds are Troup, Pennan and Lion's Heads SPA breeders

Table 9-180: Predicted Annual Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to Troup, Pennan and Lion's Heads SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase[1]
DEP	0.12 (0.00 - 0.31)	0.01 (0.00 - 0.02)
SEP	0.02 (0.00 - 0.09)	0.00 (0.00 - 0.01)
SEP and DEP	0.14 (0.00 - 0.40)	0.01 (0.00 - 0.03)
Notes 1. Background population is Troup, Pennan and Lion's Heads SPA breeding adults (21,232 individuals), adult age class annual mortality rate of 14.6% (Horswill and Robinson, 2015)		

1959. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.01% due to the collision impacts of SEP and DEP together.

1960. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Troup, Pennan and Lion's Heads SPA.**

1961. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.23.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.23.3.1.5.1 Collision Risk

1962. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus the predicted impacts of SEP and DEP, indicates that during the autumn migration season, 1,587 collisions are predicted between kittiwakes belonging to the UK North Sea and Channel BDMPS and OWFs in the North Sea. The corresponding value for the spring migration season is 1,204 birds. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-105**). Of the collisions predicted during the autumn migration season, 34.9 are estimated to involve breeding adult birds from the Troup, Pennan and Lions Heads SPA, assuming 2.2% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015). The corresponding number of collisions for the spring migration season, based on the assumption that 2.8% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015), is 33.7. In total therefore, 68.6 collisions per year are predicted for breeding adults of the Troup, Pennan and Lions Heads SPA due to in-combination collision risk of OWFs in the North Sea. This would increase the existing mortality within this population by 2.2%.

1963. These collision rates are based largely on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than their consent allows. These will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

1964. The predicted impacts of SEP and DEP in isolation and together on the breeding adult kittiwake population of Troup, Pennan and Lions Heads SPA are small, with a mean predicted annual mortality rate of 0.14 birds, or 0.2% of all predicted collisions (**Table 9-180**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay, the conservation objectives for the SPA being met.

1965. **It is concluded that predicted kittiwake mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Troup, Pennan and Lions Heads SPA.**

9.23.3.2 Guillemot

9.23.3.2.1 Status

1966. At classification, the Troup, Pennan and Lion's Heads SPA breeding guillemot population was 44,600 individuals (SNH, 2009c). The most recent published count was 23,801 individuals in 2017 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 1,452 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.23.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1967. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

1968. Troup, Pennan and Lion's Head SPA is located approximately 530km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

1969. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 0.9% of birds present are considered to be breeding adults from Troup, Pennan and Lion's Head SPA, and impacts are apportioned accordingly. This is based on the SPA adult population as a proportion of the total UK North Sea and Channel BDMPS.

9.23.3.2.3 Potential Effects on the Qualifying Feature

1970. The guillemot qualifying feature of Troup, Pennan and Lion's Head SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement and barrier effects.

9.23.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.23.3.2.4.1 Operational Phase Displacement / Barrier Effects

1971. Population estimates of guillemot at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-181**, **Table 9-182** and **Table 9-183** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides an overview of how information from Furness (2015), in conjunction with the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots present at SEP and DEP that belong to the SPA population. An estimated annual mortality for the population due to operational phase displacement is provided, along with the increase in existing annual mortality of the relevant background population that would occur through such an impact.

1972. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the Troup, Pennan and Lion's Head SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-181: Predicted Operational Phase Displacement and Mortality of Troup, Pennan and Lion's Head SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 221 (nb) 221 (year round)	1 - 15 (1)	0.05 - 1.06 (0.08)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 134 (nb) 134 (year round)	0 - 9 (1)	0.03 - 0.65 (0.05)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 70 (n) 70 (year round)	0 - 5 (0)	0.01 - 0.34 (0.02)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Troup, Pennan and Lion's Head SPA breeding adults. For non-breeding season, assumes 0.9% of birds are Troup, Pennan and Lion's Head SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Troup, Pennan and Lion's Head SPA breeding adults (23,801 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-182: Predicted Operational Phase Displacement and Mortality of Troup, Pennan and Lion's Head SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 14 (nb) 14 (year round)	0 - 1 (0)	0.00 - 0.07 (0.00)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 10 (nb) 10 (year round)	0 - 1 (0)	0.00 - 0.05 (0.00)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 6 (nb) 6 (year round)	0 - 0 (0)	0.00 - 0.03 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
2. For breeding season (Mar-Jul), assumes 0% of birds are Troup, Pennan and Lion's Head SPA breeding adults. For non-breeding season, assumes 0.9% of birds are Troup, Pennan and Lion's Head SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Troup, Pennan and Lion's Head SPA breeding adults (23,801 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-183: Predicted Operational Phase Displacement and Mortality of Troup, Pennan and Lion's Head SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 235 (nb) 235 (year round)	1 - 16 (1)	0.05 - 1.13 (0.08)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 144 (nb) 144 (year round)	0 - 10 (1)	0.03 - 0.69 (0.05)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 76 (nb) 76 (year round)	0 - 5 (0)	0.02 - 0.37 (0.03)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are Troup, Pennan and Lion's Head SPA breeding adults. For non-breeding season, assumes 0.9% of birds are Troup, Pennan and Lion's Head SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Troup, Pennan and Lion's Head SPA breeding adults (23,801 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

1973. Based on the mean peak abundances, the annual total of guillemots from Troup, Pennan and Lion's Head SPA at risk of displacement from SEP and DEP together is 144 birds (**Table 9-183**); 134 at DEP (**Table 9-181**) and 10 at SEP (**Table 9-182**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 0.4 to 9.4 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.0 to 0.7 birds due to displacement at SEP.

1974. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding population would increase by 0.65% due to impacts at DEP and 0.05% due to impacts at SEP (0.69% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.05% due to impacts at DEP (0.7 birds), zero due to impacts at SEP (0.0 birds) and 0.05% due to the impacts of SEP and DEP together (0.7 birds).

1975. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

1976. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered.

1977. Mortality rate increases of over 1% are predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment instead alongside a 0.700 displacement rate and 10% mortality rate for displaced birds. The probability of this occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, displacement and mortality rates of 0.700 and 10% are much higher than evidence suggests will actually be the case, and use of the evidence-based displacement (0.500) and mortality rate (1%) would result in a mortality increase of significantly less than 1%.

1978. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Troup, Pennan and Lion's Head SPA.**

1979. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

1980. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, impacts from SEP and DEP on this SPA qualifying feature are in fact zero.

9.23.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.23.3.2.5.1 Operational Phase Displacement / Barrier Effects

1981. The Appropriate Assessment for the Moray West OWF (Marine Scotland, 2019) indicated that approximately 619 adults from the Troup, Pennan and Lion's Head SPA are at risk of displacement during the breeding season. There is uncertainty surrounding this figure since it is not clear from the information assessed whether birds on sabbatical are included in this total; if not, the figure could be up to 7% greater. The OWFs contributing to this impact during this season are Moray West, Moray East, Beatrice, Kincardine and Hywind.

1982. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 2,308 are estimated to belong to Troup, Pennan and Lion's Head SPA, assuming 0.9% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

1983. In total therefore, 2,927 birds from the Troup, Pennan and Lion's Head SPA are at risk of in-combination OWF displacement throughout the year. Annual displacement and mortality of breeding adult birds belonging to the Troup, Pennan and Lion's Head SPA are presented in **Table 9-184**.

Table 9-184: In-Combination Year Round Displacement Matrix for Guillemot from Troup, Pennan and Lion's Head SPA Year Round from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
Displacement (%)		1	2	3	4	5	10	20	30	50	80	100
	10	3	6	9	12	15	29	59	88	146	234	293
	20	6	12	18	23	29	59	117	176	293	468	585
	30	9	18	26	35	44	88	176	263	439	702	878
	40	12	23	35	47	59	117	234	351	585	937	1171
	50	15	29	44	59	73	146	293	439	732	1171	1464
	60	18	35	53	70	88	176	351	527	878	1405	1756
	70	20	41	61	82	102	205	410	615	1024	1639	2049
	80	23	47	70	94	117	234	468	702	1171	1873	2342
	90	26	53	79	105	132	263	527	790	1317	2107	2634
	100	29	59	88	117	146	293	585	878	1464	2342	2927

1984. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 205 breeding adult SPA birds would be lost to displacement annually. This would increase the existing mortality within the SPA population (1,452 breeding adult birds per year) by 14.11%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 15 birds. This would increase the existing mortality within this population by 1.01%.

1985. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

1986. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

1987. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Troup, Pennan and Lion's Head SPA.**

9.24 East Caithness Cliffs SPA

9.24.1 Description of Designation

1988. The East Caithness Cliffs SPA is of high nature conservation and scientific importance within Britain and Europe for supporting very large populations of breeding seabirds. It includes most of the sea cliff areas between Wick and Helmsdale on the north-east coast of the Scottish mainland.

1989. The seaward extension of the SPA extends 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.24.2 Conservation Objectives

1990. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.24.3 Appropriate Assessment

1991. The qualifying species screened into the Appropriate Assessment from this SPA are breeding kittiwake, breeding guillemot, and breeding razorbill (**Table 5-2**).

9.24.3.1 Kittiwake

9.24.3.1.1 Status

1992. The SPA breeding population at classification was 32,500 pairs or 65,000 breeding adults, for the period 1985 to 1987 (SNH, 2017). The most recent count was 24,460 breeding pairs, or 48,920 breeding adults in 2015 (JNCC, 2022). This count is used as the reference population for the assessment. The baseline mortality of this population is 7,142 breeding adult birds per year, based on the published adult mortality rate of 14.6% (Horswill and Robinson, 2015).

9.24.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

1993. SEP and DEP are located approximately 610km from the East Caithness Cliffs SPA boundary at the nearest point. The mean maximum foraging range of kittiwake is 156.1km (±144.5km), and the maximum foraging range is 770km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of kittiwake from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 60.0km (±23.3km) based on data from six studies. The updated review of Woodward *et al.* (2019), based on 19 studies at 37 sites, gives a substantially larger mean maximum foraging range.

1994. SEP and DEP are therefore beyond the mean maximum foraging range plus one standard deviation from the East Caithness Cliffs SPA, but within the maximum foraging range. The latter measurement is a poor indicator of typical foraging behaviour. It would be expected that few birds or foraging trips will occur at this distance from the colony, and even fewer with any regularity. SEP and DEP are within the mean maximum foraging range of kittiwakes from the Flamborough and Filey Coast SPA. Foraging areas of kittiwakes from different colonies often tend not to overlap (Cleasby *et al*., 2020, 2018; Wakefield *et al*., 2017). This further increases the likelihood that birds from the East Caithness Cliffs SPA will not occur at SEP and DEP during the breeding season. This is the assumption made by the assessment.

1995. Outside the breeding season breeding kittiwakes, including those from the East Caithness Cliffs SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with kittiwakes of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea BDMPS. This consists of 829,937 individuals during the autumn migration season (August to December), and 627,816 individuals during the spring migration season (January to April) (Furness, 2015).

1996. During the autumn migration season, 60% of the East Caithness Cliffs SPA breeding adults are assumed to be present in the BDMPS, representing 5.8% of the BDMPS population (829,937 individuals of all ages). During this season, 1,609 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 487 birds were able to be assigned to an age class. 400 birds (82.1% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the East Caithness Cliffs SPA is 4.8% (i.e. 0.058 x 0.821).

1997. 60% of SPA breeding adults are also assumed to be present in the BDMPS during the spring migration season, representing 7.7% of the BDMPS population (627,816 individuals of all ages). During this season, 63 kittiwakes were recorded during the baseline surveys of SEP and DEP. Of these, 23 birds were able to be assigned to an age class. 21 birds (91.3% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of kittiwakes recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the East Caithness Cliffs SPA is 7.1% (i.e. 0.077 x 0.913).

9.24.3.1.3 Potential Effects on the Qualifying Feature

1998. The kittiwake qualifying feature of the East Caithness Cliffs SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.24.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.24.3.1.4.1 Collision Risk

1999. Information to inform the Appropriate Assessment for collision risk on breeding adult kittiwakes belonging to the East Caithness Cliffs SPA population is presented in **Table 9-185**. Collision estimates are presented by month. A summary of the annual outputs and the corresponding increase in the annual baseline mortality rate is presented in **Table 9-186**. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

2000. Based on the mean collision rates, the annual total of breeding adult kittiwakes from the East Caithness Cliffs SPA at risk of collision at DEP is 0.06, with 0.00 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.06 East Caithness Cliffs SPA breeding adult kittiwakes. This would increase the existing mortality of the SPA breeding population by <0.01%.

2001. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 205 flying birds were observed across DEP (of which 158 were within DEP-N, and 47 within DEP-S). When corrected for the different survey transect lengths in both regions of DEP, this means that encounter rate was 26.5% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

Table 9-185: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to East Caithness Cliffs SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
DEP	Mean	-	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.06	0.01	0.03	0.31
	Density	95% UCI	0.13	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.38	0.13	0.04	0.06	0.83
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Flight Height	95% UCI	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.07	0.01	0.04	0.38
		95% LCI	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.04	0.00	0.02	0.23
	Avoidance Rate	-2 SD	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.07	0.01	0.04	0.37
		+2 SD	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.05	0.01	0.03	0.26
	Noct. Act.	EB	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.04	0.00	0.02	0.24
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.01	0.02	0.06
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.05	0.09	0.25
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.02	0.07
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.01	0.04
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.02	0.02	0.07
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.01	0.05
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.01	0.01	0.04

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[1]	O[1]	N[1]	D[1]	Total
SEP and DEP	Mean	-	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.06	0.02	0.05	0.37
	Density	95% UCI	0.13	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.13	0.09	0.15	1.08
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.01
	Flight Height	95% UCI	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.07	0.02	0.06	0.45
		95% LCI	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.04	0.01	0.04	0.27
	Avoidance Rate	-2 SD	0.06	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.18	0.07	0.02	0.06	0.44
		+2 SD	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.05	0.02	0.04	0.30
	Noct. Act.	EB	0.04	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.04	0.01	0.03	0.28

Notes

1. For autumn migration season (Sept-Dec), assumes 5.8% of adult birds are East Caithness Cliffs SPA breeders (Furness 2015), combined with 82.1% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Jan-Feb), assumes 7.7% of adult birds are East Caithness Cliffs SPA breeders, combined with 91.3% of kittiwakes allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Aug), assumes 0% of adult birds are East Caithness Cliffs SPA breeders

Table 9-186: Predicted Annual Breeding Season Collision Mortality for Breeding Adult Kittiwake at SEP and DEP Apportioned to East Caithness Cliffs SPA with Corresponding Increases to Baseline Mortality of the Population

Site	Annual collisions (mean and 95% CIs)	% background annual mortality increase[1]
DEP	0.31 (0.01 - 0.83)	0.02 (0.00 - 0.06)
SEP	0.06 (0.00 - 0.25)	0.00 (0.00 - 0.02)
SEP and DEP	0.37 (0.01 - 1.08)	0.03 (0.00 - 0.08)
Notes 1. Background population is East Caithness Cliffs SPA breeding adults (48,920 individuals), adult age class annual mortality rate of 14.6% (Horswill and Robinson, 2015)		

2002. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is 0.01% due to the collision impacts of SEP and DEP together.

2003. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of East Caithness Cliffs SPA.**

2004. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.24.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.24.3.1.5.1 Collision Risk

2005. The Appropriate Assessment for the Moray West OWF (Marine Scotland, 2019) indicated that approximately 91 breeding adult kittiwakes from the East Caithness Cliffs SPA are at risk of collision during the breeding season. The OWFs contributing to this impact during this season are Moray West, Moray East and Beatrice.

2006. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus the predicted impacts of SEP and DEP, indicates that during the autumn migration season, 1,587 collisions are predicted between kittiwakes belonging to the UK North Sea and Channel BDMPS and OWFs in the North Sea. The corresponding value for the spring migration season is 1,204 birds.

This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-105**). Of the collisions predicted during the autumn migration season, 92.0 are estimated to involve breeding adult birds from the East Caithness Cliffs SPA, assuming 5.8% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015). The corresponding number of collisions for the spring migration season, based on the assumption that 7.7% of birds of the total BDMPS population belong to the breeding population of this SPA (Furness, 2015), is 92.7.

2007. In total therefore, 275.7 collisions per year are predicted for breeding adults of the East Caithness Cliffs SPA due to in-combination collision risk of OWFs in the North Sea. This would increase the existing mortality within this population by 3.9%.

2008. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted.

2009. The predicted impacts of SEP and DEP in isolation and together on the breeding adult kittiwake population of the East Caithness Cliffs SPA are extremely small relative to the overall annual in-combination impact predicted , with a mean predicted annual mortality rate of 0.37 birds (**Table 9-186**). It is therefore considered that the predicted impacts SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature, and will not prevent, or delay, the conservation objectives for this SPA from being met.

2010. **It is concluded that predicted kittiwake mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the East Caithness Cliffs SPA.**

9.24.3.2 Guillemot

9.24.3.2.1 Status

2011. The SPA breeding population at classification was 106,700 individuals (SNH, 2017). The most recent published count was 149,228 individuals in 2015 (Swann, 2016). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 9,103 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.24.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2012. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2013. The East Caithness Cliffs SPA is located approximately 610km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2014. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 9.2% of birds present are considered to be breeding adults from East Caithness Cliffs SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

9.24.3.2.3 Potential Effects on the Qualifying Feature

2015. The guillemot qualifying feature of East Caithness Cliffs SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.24.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.24.3.2.4.1 Operational Phase Displacement / Barrier Effects

2016. Population estimates of guillemot at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-187**, **Table 9-188** and **Table 9-189**, respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the East Caithness Cliffs SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2017. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the East Caithness Cliffs SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-187: Predicted Operational Phase Displacement and Mortality of East Caithness Cliffs SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb)	0 (b) 2,255 (nb)	7 - 158 (11)	0.07 - 1.73 (0.12)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
	30,328 (year round)	2,255 (year round)		
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 1,370 (nb) 1,370 (year round)	4 - 96 (7)	0.05 - 1.05 (0.08)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 720 (n) 720 (year round)	2 - 50 (4)	0.02 - 0.55 (0.04)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are East Caithness Cliffs SPA breeding adults. For non-breeding season, assumes 9.2% of birds are East Caithness Cliffs SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is East Caithness Cliffs SPA breeding adults (149,228 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-188: Predicted Operational Phase Displacement and Mortality of East Caithness Cliffs SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 144 (nb) 144 (year round)	0 - 10 (1)	0.00 - 0.11 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 100 (nb) 100 (year round)	0 - 7 (1)	0.00 - 0.08 (0.01)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year-round)	0 (b) 61 (nb) 61 (year-round)	0 - 4 (0)	0.00 - 0.05 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are East Caithness Cliffs SPA breeding adults. For non-breeding season, assumes 9.2% of birds are East Caithness Cliffs SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
4. Background population is East Caithness Cliffs SPA breeding adults (149,228 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-189: Predicted Operational Phase Displacement and Mortality of East Caithness Cliffs SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 2,399 (nb) 2,399 (year round)	7 - 168 (12)	0.08 - 1.85 (0.13)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 1,469 (nb) 1,469 (year round)	4 - 103 (7)	0.05 - 1.13 (0.08)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 781 (nb) 781 (year round)	2 - 55 (4)	0.03 - 0.60 (0.04)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are East Caithness Cliffs SPA breeding adults. For non-breeding season, assumes 9.2% of birds are East Caithness Cliffs SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is East Caithness Cliffs SPA breeding adults (149,228 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

2018. Based on the mean peak abundances, the annual total of guillemots from East Caithness Cliffs SPA at risk of displacement from SEP and DEP together is 1,469 birds (**Table 9-189**); 1,370 at DEP (**Table 9-187**) and 100 at SEP (**Table 9-188**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 4.1 to 95.9 SPA breeding adults would be predicted to die each year due to displacement from DEP, and 0.3 to 7.0 birds due to displacement at SEP.

2019. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 1.05% due to impacts at DEP and 0.08% due to impacts at SEP (1.13% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.08% due to impacts at DEP (6.8 birds), 0.01% due to impacts at SEP (0.5 birds) and 0.08% due to the impacts of SEP and DEP together (7.3 birds).

2020. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2021. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under almost any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered. The exception is when a displacement rate of 0.700 and a mortality rate for displaced birds of 10% is considered. The probability of this occurring is small, as these displacement and mortality rates are much higher than evidence suggests will actually be the case.

2022. Increases of over 1% are also predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside a 10% mortality rate for displaced birds. The probability of this occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, a mortality rate for displaced birds of 10% is much higher than evidence suggests will actually be the case.

2023. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of East Caithness Cliffs SPA.**

2024. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

2025. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, impacts from SEP and DEP on this SPA qualifying feature are in fact zero.

9.24.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.24.3.2.5.1 Operational Phase Displacement / Barrier Effects

2026. The Appropriate Assessment for the Moray West OWF (Marine Scotland, 2019) indicated that approximately 19,770 adults from the East Caithness Cliffs SPA are at risk of displacement during the breeding season. There is uncertainty surrounding this figure since it is not clear from the information assessed whether birds on sabbatical are included in this total; if not, the figure could be up to 7% greater. The OWFs contributing to this impact during this season are Moray West, Moray East and Beatrice.

2027. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 23,589 are estimated to belong to East Caithness Cliffs SPA, assuming 9.2% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

2028. In total therefore, 43,359 birds from the East Caithness Cliffs SPA are at risk of in-combination OWF displacement throughout the year. Annual displacement and mortality of breeding adult birds from the East Caithness Cliffs SPA are presented in **Table 9-190**.

Table 9-190: In-Combination Year Round Displacement Matrix for Guillemot from East Caithness Cliffs SPA Year Round from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	43	87	130	173	217	434	867	1301	2168	3469	4336
	20	87	173	260	347	434	867	1734	2602	4336	6937	8672
	30	130	260	390	520	650	1301	2602	3902	6504	10406	13008
	40	173	347	520	694	867	1734	3469	5203	8672	13875	17344
	50	217	434	650	867	1084	2168	4336	6504	10840	17344	21680
	60	260	520	780	1041	1301	2602	5203	7805	13008	20812	26015
	70	304	607	911	1214	1518	3035	6070	9105	15176	24281	30351
	80	347	694	1041	1387	1734	3469	6937	10406	17344	27750	34687
	90	390	780	1171	1561	1951	3902	7805	11707	19512	31218	39023
	100	434	867	1301	1734	2168	4336	8672	13008	21680	34687	43359

2029. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 3,035 breeding adult SPA birds would be lost to displacement each year. This would increase the existing mortality within the SPA population (9,103 breeding adult birds per year) by 33.34%. Using an evidence-based displacement rate of

0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 217 birds. This would increase the existing mortality within this population by 2.38%.

2030. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2031. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

2032. In addition, the predicted impacts of SEP and DEP in isolation and together on the breeding adult guillemot population of the East Caithness Cliffs SPA are small relative to the overall impact (**Table 9-189**). It is considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature, even if it is assumed that the species is fully migratory.

2033. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of East Caithness Cliffs SPA.**

9.24.3.3 Razorbill

9.24.3.3.1 Status

2034. The SPA breeding population at classification was cited as 15,800 individuals in 1995 (SNH, 2017). The most recent count is 29,873 individuals in 2017 (JNCC, 2022). This is used as the reference population by the assessment.

2035. The baseline mortality of this population is 3,137 adult birds per year based on an adult population of 29,873 individuals and the published adult mortality rate of 10.5% (Horswill and Robinson, 2015).

9.24.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2036. SEP and DEP are situated approximately 630km from the East Caithness Cliffs SPA boundary at the nearest point. The mean maximum foraging range of razorbill is 88.7km (±75.9km) and the maximum foraging range is 313km. When data from breeding razorbills at Fair Isle is excluded, where reduced prey availability was considered to be causing substantially increased foraging ranges during the breeding season, the mean maximum foraging range decreases to 73.8km (±48.4km) and the maximum foraging range to 191km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of razorbill from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 48.5km (±35.0km) based on data from three sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a larger mean maximum foraging range.

2037. SEP and DEP are substantially beyond the mean maximum foraging range of razorbills from the East Caithness Cliffs SPA, and no individuals from the SPA are predicted to be present in or near DEP or SEP during the breeding season (April to July inclusive).

2038. During the non-breeding seasons (i.e. autumn winter and spring), breeding razorbills from the East Caithness Cliffs SPA disperse throughout the North Sea and potentially beyond. The relevant reference population is the UK North Sea and Channel BDMPS, consisting of 591,874 individuals during passage periods (August to October and January to March), and 218,622 individuals during winter (November and December) (Furness, 2015).

2039. Estimates of the proportion of razorbills present at SEP and DEP which originate from the East Caithness Cliffs SPA during the non-breeding season (and therefore the proportion of predicted mortality from displacement which affect the SPA population) are based on the number of adults from the SPA population as a proportion of the UK North Sea and Channel BDMPS (of all ages and sites of origin). During autumn and spring migration 100% of the SPA adult population (25,000 adults based on the 1999 population estimate (Furness, 2015)) are estimated to be present in the BDMPS and compose an estimated 4.2% of the BDMPS population. In winter 30% of the SPA adult population, or 7,500 birds (Furness, 2015) is estimated to be present within the BDMPS, which represent an estimated 3.4% of the BDMPS population. Therefore, during autumn and spring migration, a maximum of 4.2% of predicted mortality is considered to affect birds from the East Caithness Cliffs SPA, whilst in winter, the corresponding value is 3.4%.

9.24.3.3.3 Potential Effects on the Qualifying Feature

2040. The razorbill qualifying feature of the East Caithness Cliffs SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects.

9.24.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.24.3.3.4.1 Operational Phase Displacement / Barrier Effects

2041. Population estimates of razorbill at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-191**, **Table 9-192** and **Table 9-193** respectively.

2042. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots belonging to the East Caithness Cliffs SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2043. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.4.4.1**) is also relevant to this population. The full range of recommended displacement and mortality effects are considered by the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1% respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-191: Predicted Operational Displacement Mortality for Razorbill at DEP Apportioned to East Caithness Cliffs SPA

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	6,857 (b) 1,469 (aut) 1,348 (win) 652 (spr) 10,326 (year round)	0 (b) 62 (aut) 46 (win) 27 (spr) 135 (year round)	0 - 9 (1)	0.01 - 0.30 (0.02)
Mean	3,741 (b) 923 (aut) 845 (win) 320 (spr) 5,829 (year round)	0 (b) 39 (aut) 29 (win) 13 (spr) 81 (year round)	0 - 6 (0)	0.01 - 0.18 (0.01)
Lower 95% CI	1,266 (b) 518 (aut) 450 (win) 85 (spr) 2,319 (year round)	0 (b) 22 (aut) 15 (win) 4 (spr) 41 (year round)	0 - 3 (0)	0.00 - 0.09 (0.01)

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For breeding season (Apr-Jul), assumes 0% of birds are East Caithness Cliffs SPA breeding adults. For autumn migration and spring migration seasons, assumes 4.2% of birds are East Caithness Cliffs SPA breeding adults. For winter season, assumes 3.4% of birds are East Caithness Cliffs SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is East Caithness Cliffs SPA breeding adults (29,873 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)

Table 9-192: Predicted Operational Displacement Mortality for Razorbill at SEP Apportioned to East Caithness Cliffs SPA

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,245 (b) 421 (aut) 1,112 (win) 300 (spr) 3,078 (year round)	0 (b) 18 (aut) 38 (win) 13 (spr) 68 (year round)	0 - 5 (0)	0.01 - 0.15 (0.01)
Mean	759 (b) 316 (aut) 686 (win) 144 (spr) 1,905 (year round)	0 (b) 13 (aut) 23 (win) 6 (spr) 43 (year round)	0 - 3 (0)	0.00 - 0.10 (0.01)
Lower 95% CI	326 (b) 206 (aut) 339 (win) 26 (spr) 897 (year round)	0 (b) 9 (aut) 1 (win) 1 (spr) 11 (year round)	0 - 1 (0)	0.00 - 0.02 (0.01)

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For breeding season (Apr-Jul), assumes 0% of birds are East Caithness Cliffs SPA breeding adults. For autumn migration and spring migration seasons, assumes 4.2% of birds are East Caithness Cliffs SPA breeding adults. For winter season, assumes 3.4% of birds are East Caithness Cliffs SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is East Caithness Cliffs SPA breeding adults (29,873 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)

Table 9-193: Predicted Operational Displacement Mortality for Razorbill at SEP and DEP Apportioned to East Caithness Cliffs SPA

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	8,101 (b) 1,890 (aut) 2,460 (win) 951 (spr) 13,402 (year round)	0 (b) 79 (aut) 84 (win) 40 (spr) 203 (year round)	1 - 14 (1)	0.02 - 0.45 (0.03)
Mean	4,500 (b) 1,239 (aut)	0 (b) 52 (aut)	0 - 9 (1)	0.01 - 0.28 (0.02)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	1,531 (win) 464 (spr) 7,734 (year round)	52 (win) 19 (spr) 124 (year round)		
Lower 95% CI	1,591 (b) 724 (aut) 789 (win) 111 (spr) 3,214 (year round)	0 (b) 30 (aut) 16 (win) 5 (spr) 51 (year round)	0 - 4 (0)	0.01 - 0.11 (0.01)

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For breeding season (Apr-Jul), assumes 0% of birds are East Caithness Cliffs SPA breeding adults. For autumn migration and spring migration seasons, assumes 4.2% of birds are East Caithness Cliffs SPA breeding adults. For winter season, assumes 3.4% of birds are East Caithness Cliffs SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is East Caithness Cliffs SPA breeding adults (29,873 individuals), adult age class annual mortality rate of 10.5% (Horswill and Robinson, 2015)

2044. The predicted annual mortality increase for breeding adults from this SPA due to this impact is between 0.00% to 0.18% for DEP, 0.00% to 0.10% for SEP, and 0.01% to 0.28% for SEP and DEP together when displacement and mortality rates of 0.300 to 0.700 and 1% to 10% are considered alongside mean peak abundance estimates for SEP and DEP. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the East Caithness Cliffs SPA breeding adult razorbill population would increase by 0.01% due to impacts at DEP (0.4 birds), 0.01% due to impacts at SEP (0.2 birds), and 0.02% due to the impacts of SEP and DEP together (0.6 birds).

2045. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 12.6% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2046. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered. This remains the case when upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside the highest recommended displacement and mortality rates.

2047. **It is concluded that predicted razorbill mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the East Caithness Cliffs SPA.**

2048. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.24.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.24.3.3.5.1 Operational Phase Displacement / Barrier Effects

2049. The Appropriate Assessment for the Moray West OWF (Marine Scotland, 2019) indicated that approximately 2,739 adults from the East Caithness Cliffs SPA are at risk of displacement during the breeding season. There is uncertainty surrounding this figure since it is not clear from the information assessed whether birds on sabbatical are included in this total; if not, the figure could be up to 7% greater. The OWFs contributing to this impact during this season are Moray West, Moray East and Beatrice.

2050. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn migration, winter, and spring migration seasons respectively, 42,299, 26,311 and 37,204 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-120**). Of the birds at risk of displacement, 4,155 are estimated to belong to the East Caithness Cliffs SPA, assuming 4.2% of birds of the total BDMPS during the migration seasons, and 3.1% of birds of the total BDMPS during the winter season, belong to the breeding population of this SPA (Furness, 2015).

2051. In total therefore, 6,894 birds from the East Caithness Cliffs SPA are at risk of in-combination OWF displacement throughout the year. Annual in-combination displacement and mortality rates of birds belonging to the East Caithness Cliffs SPA are presented in **Table 9-194**.

Table 9-194: In-Combination Year Round Displacement Matrix for Razorbill from East Caithness Cliffs SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	7	14	21	28	34	69	138	207	345	552	689
	20	14	28	41	55	69	138	276	414	689	1103	1379
	30	21	41	62	83	103	207	414	620	1034	1655	2068
	40	28	55	83	110	138	276	552	827	1379	2206	2758
	50	34	69	103	138	172	345	689	1034	1724	2758	3447
	60	41	83	124	165	207	414	827	1241	2068	3309	4136
	70	48	97	145	193	241	483	965	1448	2413	3861	4826
	80	55	110	165	221	276	552	1103	1655	2758	4412	5515
	90	62	124	186	248	310	620	1241	1861	3102	4964	6205
	100	69	138	207	276	345	689	1379	2068	3447	5515	6894

2052. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 483 breeding adult SPA birds would be lost to displacement each year. This would increase the mortality within this population by 15.39%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 34 birds. This would increase the mortality within this population by 1.10%.

2053. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that detectable changes in mortality rates would occur due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2054. The predicted impacts of SEP and DEP in isolation and together on the breeding adult razorbill population of the East Caithness Cliffs SPA are small relative to the overall impact (**Table 9-193**). It is considered that SEP and DEP do not contribute substantially to any in-combination displacement impacts on this qualifying feature, and the magnitude of the contribution is unlikely to prevent, or delay, the conservation objectives of the SPA being met.

2055. **It is concluded that predicted razorbill mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the East Caithness Cliffs SPA.**

9.25 North Caithness Cliffs SPA

9.25.1 Description of Designation

2056. The North Caithness Cliffs SPA is of special nature conservation and scientific importance within Britain and Europe for supporting very large populations of several breeding seabird species.

2057. The seaward extension of the SPA extends 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.25.2 Conservation Objectives

2058. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.25.3 Appropriate Assessment

2059. The only qualifying species from this SPA screened into the Appropriate Assessment is breeding guillemot (**Table 5-2**).

9.25.3.1 Guillemot

9.25.3.1.1 Status

2060. The SPA breeding population at classification was 38,300 individuals (SNH, 2018b). The most recent published count was 38,863 individuals in 2015 and 2016 (Swann, 2018). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 2,371 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.25.3.1.2 Functional linkage and seasonal apportionment of potential effects

2061. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al*. (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2062. North Caithness Cliffs SPA is located approximately 640km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2063. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 4.1% of birds present are considered to be breeding adults from North Caithness Cliffs SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

2064. It should be noted that Furness (2015) uses the SPA breeding adult population from 2000 during calculation of the non-breeding BDMPS, which was 94,000 birds. If the more recent population estimates are incorporated into these calculations, the contribution of the North Caithness Cliffs SPA breeding population to the UK North Sea and Channel BDMPS is likely to be around 1.7%, as opposed to the 4.1% calculated above. This means that impacts on this population as a result of the assessment methodology employed here will result in significant overestimation of impacts on this population.

9.25.3.1.3 Potential Effects on the Qualifying Feature

2065. The guillemot qualifying feature of North Caithness Cliffs SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.25.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.25.3.1.4.1 Operational Phase Displacement / Barrier Effects

2066. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-195**, **Table 9-196**, and **Table 9-197**, respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the North Caithness Cliffs SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2067. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the North Caithness Cliffs SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-195: Predicted Operational Phase Displacement and Mortality of North Caithness Cliffs SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year-round mortality range[3]	Year-round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 1,005 (nb) 1,005 (year round)	3 - 70 (5)	0.13 - 2.97 (0.21)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 610 (nb) 610 (year round)	2 - 43 (3)	0.08 - 1.80 (0.13)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 321 (n) 321 (year round)	1 - 22 (2)	0.04 - 0.95 (0.07)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are North Caithness Cliffs SPA breeding adults. For non-breeding season, assumes 4.1% of birds are North Caithness Cliffs SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is North Caithness Cliffs SPA breeding adults (38,863 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-196: Predicted Operational Phase Displacement and Mortality of North Caithness Cliffs SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 64 (nb) 64 (year round)	0 - 5 (0)	0.01 - 0.19 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 44 (nb) 44 (year round)	0 - 3 (0)	0.01 - 0.13 (0.01)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 27 (nb) 27 (year round)	0 - 2 (0)	0.00 - 0.08 (0.01)

Notes

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are North Caithness Cliffs SPA breeding adults. For non-breeding season, assumes 4.1% of birds are North Caithness Cliffs SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is North Caithness Cliffs SPA breeding adults (38,863 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-197: Predicted Operational Phase Displacement and Mortality of North Caithness Cliffs SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 1,069 (nb) 1,069 (year round)	3 - 75 (5)	0.14 - 3.16 (0.23)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 655 (nb) 655 (year round)	2 - 46 (3)	0.08 - 1.93 (0.14)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 348 (nb) 348 (year round)	1 - 24 (2)	0.04 - 1.03 (0.07)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are North Caithness Cliffs SPA breeding adults. For non-breeding season, assumes 4.1% of birds are North Caithness Cliffs SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is North Caithness Cliffs SPA breeding adults (38,863 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

2068. Based on the mean peak abundances, the annual total of guillemots from the North Caithness Cliffs SPA at risk of displacement from SEP and DEP together is 655 birds (**Table 9-197**); 610 at DEP (**Table 9-195**) and 44 at SEP (**Table 9-196**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 1.8 to 42.7 SPA breeding adults would be predicted to die each year due to displacement from DEP and 0.1 to 3.1 birds due to displacement at SEP.

2069. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by

1.80% due to impacts at DEP and 0.13% due to impacts at SEP (1.93% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.13% due to impacts at DEP (3.1 birds), 0.01% due to impacts at SEP (0.2 birds) and 0.14% due to the impacts of SEP and DEP together (3.3 birds).

2070. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2071. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under almost any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered.

2072. Mortality rate increases of over 1% are predicted for mean peak abundance estimate assessments only when a mortality rate for displaced birds of 10% is considered. The probability of such events occurring is small, as a mortality rate for displaced birds of 10% is much higher than evidence suggests will actually be the case, with 1% or less being suggested as a more reasonable precautionary value.

2073. Increases of over 1% in the existing annual mortality of this population are also predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside a 10% mortality rate for displaced birds. The probability of such events occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP,. Secondly, a mortality rate of 10% is much higher than evidence suggests will actually be the case, with 1% or less being suggested as a more reasonable precautionary value.

2074. It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of North Caithness Cliffs SPA.

2075. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same

irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

2076. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, impacts from SEP and DEP on this SPA qualifying feature are in fact zero.

9.25.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.25.3.1.5.1 Operational Phase Displacement / Barrier Effects

2077. The Appropriate Assessment for the Moray West OWF (Marine Scotland, 2019) indicated that approximately 2,000 adults from the North Caithness Cliffs SPA are at risk of displacement during the breeding season. There is uncertainty surrounding this figure since it is not clear from the information assessed whether birds on sabbatical are included in this total; if not, the figure could be up to 7% greater.

2078. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (see **Table 9-110**). Of the birds at risk of displacement, 10,512 are estimated to belong to North Caithness Cliffs SPA, assuming 4.1% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

2079. In total therefore, 12,512 birds from the North Caithness Cliffs SPA are at risk of in-combination OWF displacement throughout the year. Annual displacement and mortality of breeding adult birds from the North Caithness Cliffs SPA are presented in **Table 9-198**.

Table 9-198: In-Combination Year Round Displacement Matrix for Guillemot from North Caithness Cliffs SPA Year Round from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	13	25	38	50	63	125	250	375	626	1001	1251
	20	25	50	75	100	125	250	500	751	1251	2002	2502
	30	38	75	113	150	188	375	751	1126	1877	3003	3754
	40	50	100	150	200	250	500	1001	1501	2502	4004	5005
	50	63	125	188	250	313	626	1251	1877	3128	5005	6256
	60	75	150	225	300	375	751	1501	2252	3754	6006	7507
	70	88	175	263	350	438	876	1752	2628	4379	7007	8758
	80	100	200	300	400	500	1001	2002	3003	5005	8008	10010
	90	113	225	338	450	563	1126	2252	3378	5630	9009	11261
	100	125	250	375	500	626	1251	2502	3754	6256	10010	12512

2080. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 876 breeding adult SPA birds would be lost to displacement each non-breeding season. This would increase the existing mortality within the SPA population (2,371 breeding adult birds per year) by 36.95%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 63 birds. This would increase the existing mortality within this population by 2.64%.

2081. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2082. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

2083. In addition, the predicted impacts of SEP and DEP in isolation and together on the breeding adult guillemot population of the North Caithness Cliffs SPA are small relative to the overall impact (**Table 9-197**). It is considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature, even if it is assumed that the species is fully migratory.

2084. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-**

combination with other projects, would not adversely affect the integrity of North Caithness Cliffs SPA.

9.26 Hoy SPA

9.26.1 Description of Designation

2085. Hoy is a mountainous island at the south-western end of the Orkney archipelago. Hoy SPA covers the northern and western two-thirds of Hoy island and adjacent coastal waters. These upland areas and the high sea cliffs at the coast support an important assemblage of moorland breeding birds and breeding seabirds.

2086. The seaward extension of the SPA extends 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.26.2 Conservation Objectives

2087. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.26.3 Appropriate Assessment

2088. The only qualifying species from this SPA that is screened into the Appropriate Assessment is breeding red-throated diver (**Table 5-2**).

9.26.3.1 Red-Throated Diver

9.26.3.1.1 Status

2089. The SPA breeding population at classification was 58 pairs, or 116 breeding adults (SNH, 2009d). Furness (2015) gives an estimate of 60 pairs, or 120 breeding adults, in 2007. This is used as the reference population by the assessment. Based on the latest SPA population estimate, and an annual breeding adult baseline mortality rate of 16.0% (Horswill and Robinson, 2015), 19 breeding adults from the SPA population would be expected to die each year.

9.26.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2090. The mean maximum foraging range of red-throated diver is 9km (±0km), as is the maximum foraging range (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of red-throated diver from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was identical. There is very little information available on this subject, with just one study identified by the above reviews.

2091. Hoy SPA is located approximately 670km from SEP and DEP. This means that red-throated divers from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2092. Outside the breeding season, breeding red-throated divers from the SPA are assumed to range widely and to mix with red-throated divers of all ages from breeding colonies in the UK and further afield. The relevant background population during the autumn and spring migration seasons is the UK North Sea BDMPS, consisting of 13,277 individuals during autumn and spring passage periods (September to November and February to April) (Furness, 2015). The relevant background population during the winter season is the SW North Sea BDMPS, consisting of 10,177 individuals (Furness, 2015).

2093. During the spring and autumn migration seasons, it is estimated that 0.9% of birds present are considered to be breeding adults from Hoy SPA. The corresponding value during the winter season is 0.2%. Impacts are apportioned accordingly during these seasons. This is based on the SPA adult population from Furness (2015) as a proportion of the total relevant BDMPS.

9.26.3.1.3 Potential Effects on the Qualifying Feature

2094. The red-throated diver qualifying feature of the Hoy SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement and barrier effects.

9.26.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.26.3.1.4.1 Operational Phase Displacement / Barrier Effects

2095. Population estimates of red-throated diver at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-199**, **Table 9-200** and **Table 9-201** respectively.

2096. Red-throated divers have a very high sensitivity to disturbance and displacement from operational OWFs. The majority of birds present before OWFs are constructed are displaced by the operation of OWFs. It is expected (based on expert opinion), that this is due to a combination of anthropogenic activities (mainly vessel movements), as well as the presence of OWF infrastructure. A large body of work investigating the effects of displacement of red-throated divers due to operational OWFs exists (Dorsch *et al.*, 2020; Elston *et al.*, 2016; Gill *et al.*, 2018; Heinänen and Skov, 2018; Hi Def Aerial Surveying, 2017; Irwin *et al.*, 2019; MacArthur Green and

Royal HaskoningDHV, 2021b; McGovern *et al.*, 2016; Mendel *et al.*, 2019; NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017; Petersen *et al.*, 2014, 2006; Vilela *et al.*, 2020; Welcker and Nehls, 2016).

2097. There is a high degree of concordance of the available literature with respect to effects of operation of OWFs on red-throated diver distribution and abundance within OWFs. There is also a high degree of concordance that displacement effects extend beyond OWF boundaries. However, there is considerable variation with respect to the distance at which this effect remains detectable. Studies within the UK have ranged from no significant displacement effects being reported (McGovern *et al.*, 2016), displacement effects being restricted to 1km to 2km of an OWF (NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017), to clear displacement effects across many years. These effects have been reported extending to 7km from OWFs (MacArthur Green and Royal HaskoningDHV, 2021b), 9km from OWFs (Elston *et al*., 2016; Hi Def Aerial Surveying, 2017), and beyond, though not all evidence was available to be referenced by this assessment. Studies from other countries have also recorded variable displacement distances, ranging from 1.5km to 2km (Welcker and Nehls, 2016) to 10km and beyond (Dorsch *et al*., 2020; Vilela *et al*., 2020). Displacement effects were detectable up to 20km from OWFs in one case.

2098. There is also concordance in the studies reviewed that displacement effects on red-throated diver due to operational OWFs occur on a gradient, with the strongest effects observed either within, or close to OWFs. As the distance from the OWF increases, the magnitude of the effect reduces, until a distance is reached at which the effect is no longer detectable.

2099. No study to date has managed to provide insight into whether changes in red-throated diver distribution at any spatial scale have the potential to result in population level effects, either at local, regional, national or international levels. Red-throated divers are capable of utilising a range of marine habitats and prey species (Dierschke *et al*., 2017; Guse *et al*., 2009; Kleinschmidt *et al*., 2016). Recent data from the Outer Thames Estuary SPA indicate that birds are much more commonly recorded in water depths of less than 20m (Irwin *et al*., 2019). During the non-breeding season, red-throated divers are mostly widely dispersed, at densities often less than four birds per km2 (Dierschke *et al*., 2017), and are highly mobile (Dorsch *et al*., 2020; Duckworth *et al*., 2020). In some instances, home ranges of many thousands of square kilometres have been demonstrated (Nehls *et al*., 2018). This implies that following displacement, red-throated divers will be able to find alternative foraging sites, in some cases distant from the original area of displacement, which may already have been part of their existing non-breeding season range. It seems likely that in the vast majority of cases, mortality is not a consequence of displacement.

2100. Displacement rates of 1.000, along with a range of mortality rates of 1% to 10% of displaced birds is considered for this species at this SPA (UK SNCBs, 2017). However, it is considered that there is a high possibility that displacement and mortality rates are substantially lower than this. Since the aerial survey study area covered SEP and DEP plus a 4km buffer, this is the maximum extent of the buffer that can be incorporated into the assessment. Whilst there are other data sources that could be used in the assessment, they predict much lower numbers of birds to be present than the baseline data, as evidenced by work carried out within **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). This assessment therefore focuses on the baseline survey data.

2101. Natural England has previously advised other OWF projects that for the assessment of red-throated diver operational displacement, a displacement rate of 1.000 within the OWF and 4km buffer and a mortality rate of up to 10% for displaced birds is used. However, during the baseline surveys, when SOW and DOW were both operational, red-throated divers were observed within 4km of both OWFs (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). This indicates that the suggestion of 100% displacement within this distance of these OWFs is an overestimate.

2102. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult red-throated divers belonging to the Hoy SPA population is presented in **Table 9-199** (DEP), **Table 9-200** (SEP) and **Table 9-201** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult red-throated divers belonging to the Hoy SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-199: Predicted Operational Phase Displacement and Mortality of Hoy SPA Breeding Adult Red-Throated Divers at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 59 (aut) 15 (win) 76 (spr) 150 (year round)	0 (b) 1 (aut) 0 (win) 1 (spr) 2 (year round)	0 - 0	0.06 - 0.64
Mean	0 (b) 31 (aut) 5 (win) 54 (spr) 90 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.04 - 0.40
Lower 95% CI	0 (b) 8 (aut) 0 (win) 33 (spr) 40 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.02 - 0.19
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr				

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
2. For autumn migration and spring migration seasons, assumes 0.9% of birds are Hoy SPA breeding adults. For winter season, assumes 0.2% of birds are Hoy SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is Hoy SPA breeding adults (120 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)				

Table 9-200: Predicted Operational Phase Displacement and Mortality of Hoy SPA Breeding Adult Red-Throated Divers at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 137 (aut) 15 (win) 463 (spr) 615 (year round)	0 (b) 1 (aut) 0 (win) 4 (spr) 5 (year round)	0 - 1	0.28 - 2.79
Mean	0 (b) 75 (aut) 5 (win) 191 (spr) 271 (year round)	0 (b) 1 (aut) 0 (win) 2 (spr) 3 (year round)	0 - 0	0.12 - 1.24
Lower 95% CI	0 (b) 30 (aut) 0 (win) 29 (spr) 59 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.03 - 0.27
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 0.9% of birds are Hoy SPA breeding adults. For winter season, assumes 0.2% of birds are Hoy SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds. 4. Background population is Hoy SPA breeding adults (120 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015).				

Table 9-201: Predicted Operational Phase Displacement and Mortality of Hoy SPA Breeding Adult Red-Throated Divers at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 196 (aut) 30 (win) 539 (spr) 765 (year round)	0 (b) 2 (aut) 0 (win) 5 (spr) 6 (year round)	0 - 1	0.34 - 3.44
Mean	0 (b) 106 (aut) 10 (win) 245 (spr) 361 (year round)	0 (b) 1 (aut) 0 (win) 2 (spr) 3 (year round)	0 - 0	0.16 - 1.64
Lower 95% CI	0 (b) 37 (aut) 0 (win) 162 (spr) 199 (year round)	0 (b) 0 (aut) 0 (win) 1 (spr) 1 (year round)	0 - 0	0.05 - 0.46

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For autumn migration and spring migration seasons, assumes 0.9% of birds are Hoy SPA breeding adults. For winter season, assumes 0.2% of birds are Hoy SPA breeding adults.

3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds

4. Background population is Hoy SPA breeding adults (120 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)

2103. Based on the mean peak abundances, the annual total of red-throated divers from Hoy SPA at risk of displacement from SEP and DEP together is three birds (**Table 9-201**); zero at DEP (**Table 9-199**) and three at SEP (**Table 9-200**). At a displacement rate of 1.000, and mortality rates of 1% to 10% for displaced birds, zero to 0.1 SPA breeding adults would be predicted to die each year due to displacement from DEP, and zero to 0.2 birds due to displacement from SEP.

2104. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.40% due to impacts at DEP, and 1.24% due to impacts at SEP (1.64% due to SEP and DEP together). Using what is thought to be a more reasonable worst case scenario of 1% mortality, annual mortality in the Hoy SPA breeding adult red-throated diver population would increase by 0.04% due to impacts at DEP, 0.12% due to impacts at SEP, and 0.16% due to the impacts of SEP and DEP together.

2105. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for

DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 15.1% higher at DEP-N than DEP as a whole, though the sample size of birds recorded in DEP as a whole (43 birds) was so small that differences between DEP-N and DEP-S are unlikely to be statistically significant. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2106. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under realistic worst case displacement and mortality rates when the mean peak or upper 95% CIs for mean peak abundance estimate assessments are considered.

2107. **It is concluded that predicted red-throated diver mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Hoy SPA.**

2108. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species has been demonstrated to be highly mobile during the non-breeding season, and individuals frequently possess very large home ranges during this time (Dorsch *et al.*, 2020; Nehls *et al.*, 2018). It is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the realistic worst case displacement and mortality rates are used.

9.26.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.26.3.1.5.1 Operational Phase Displacement / Barrier Effects

2109. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding red-throated diver population of Hoy SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the foraging activity of red-throated diver from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2110. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, approximately 3,180 birds belonging to the UK North Sea BDMPS are at risk of displacement from OWFs in the North Sea (**ES Chapter 11,**

Offshore Ornithology (document reference 6.1.11)). Of the birds at risk of displacement, 23 are estimated to belong to the Hoy SPA, assuming up to 0.9% of birds of the total BDMPS belong to the breeding population of this SPA during passage seasons, and 0.2% of birds of the total BDMPS belong to the breeding population of this SPA during the winter. Displacement and mortality rates of birds belonging to the Hoy SPA are presented in **Table 9-202**.

Table 9-202: In-Combination Year Round Displacement Matrix for Red-Throated Diver from Hoy SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	0	0	0	0	0	0	0	1	1	2	2
	20	0	0	0	0	0	0	1	1	2	4	5
	30	0	0	0	0	0	1	1	2	3	5	7
	40	0	0	0	0	0	1	2	3	5	7	9
	50	0	0	0	0	1	1	2	3	6	9	11
	60	0	0	0	1	1	1	3	4	7	11	14
	70	0	0	0	1	1	2	3	5	8	13	16
	80	0	0	1	1	1	2	4	5	9	15	18
	90	0	0	1	1	1	2	4	6	10	16	20
	100	0	0	1	1	1	2	5	7	11	18	23

2111. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, two breeding adult SPA birds would be lost to displacement each non-breeding season. This would increase the existing mortality within the SPA population (19 breeding adult birds per year) by 12.27%. Using a displacement rate of 1.000, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 0.23 birds. This would increase the existing mortality within this population by 1.23%.

2112. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that detectable changes in mortality rates could occur due to the level or mortality predicted if the more realistic worst case rates for mortality are used. However, the numbers of birds predicted to be displacement is small (i.e. less than a single bird annually). It is also anticipated that displacement and mortality rates may be considerably lower than those considered by this assessment. Finally, it is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2113. **It is concluded that predicted red-throated diver mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Hoy SPA**.

9.27 Auskerry SPA

9.27.1 Description of Designation

2114. Auskerry is a small low-lying island situated 5km south of Stronsay in Orkney. Auskerry is of interest for its diverse overall assemblage of breeding seabirds. A total of fourteen seabird species breed at the site.

9.27.2 Conservation Objectives

2115. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.27.3 Appropriate Assessment

2116. The only qualifying species from this SPA screened into the Appropriate Assessment is Arctic tern (**Table 5-2**).

9.27.3.1 Arctic tern

9.27.3.1.1 Status

2117. The SPA breeding population at classification was 780 pairs or 1,560 breeding adults, for the period 1992 to 1995 (Natural England, 2017a). The most recent count was 200 breeding adults, in 2018 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 33 breeding adult birds per year based on the published adult mortality rate of 16.3% (Horswill and Robinson, 2015).

9.27.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2118. The mean maximum foraging range of Arctic tern is 25.7km (±14.8km) and the maximum foraging range is 46km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Arctic tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 24.2km (±6.3km) based on data from four sites. The updated review of Woodward *et al.* (2019), based on five studies at nine sites, gives a smaller mean maximum foraging range.

2119. The Auskerry SPA is located approximately 670km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2120. During the pre and post breeding periods, breeding Arctic terns from the Auskerry SPA migrate through UK waters. The relevant reference population is the UK North Sea and Channel BDMPS, consisting of 163,930 individuals during autumn migration (July to early September) and spring migration (late April to May) (Furness, 2015). During these seasons it is estimated that 0.8% of birds present are breeding adults from the Auskerry SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.27.3.1.3 Potential Effects on the Qualifying Feature

2121. The Arctic tern qualifying feature of the Auskerry SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.27.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.27.3.1.4.1 Collision Risk

2122. Information to inform the Appropriate Assessment for collision risk on breeding adult Arctic terns belonging to the Auskerry SPA population is presented in **Table 9-203**. Collision estimates are presented by month. The avoidance rate used was 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

2123. Based on the mean collision rates, the annual total of breeding adult Arctic terns from the Auskerry SPA at risk of collision at SEP and DEP together is <0.01. This would increase the existing mortality of the SPA breeding population by <0.01%.

Table 9-203: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Arctic Tern at SEP and DEP Apportioned to Auskerry SPA

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
Notes															

Site	Variable[1]	J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity. 2. For autumn migration season (Jul-Sept) and spring migration season (Apr-May), assumes 0.8% of adult birds are Auskerry SPA breeders (Furness 2015). For breeding season (May-Aug), assumes 0% of adult birds are Auskerry SPA breeders.														

2124. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is <0.01% due to the collision impacts of SEP and DEP together.

2125. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Auskerry SPA.**

2126. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.27.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.27.3.1.5.1 Collision Risk

2127. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Arctic tern population of the Auskerry SPA are extremely small (i.e. virtually zero) (**Table 9-203**). Potential in-combination effects of OWF collision on Arctic tern have not been investigated quantitatively. However, the low flight heights that are generally used by this species ("Corrigendum," 2014; Johnston *et al*., 2014), particularly during migration (Hedenström and Åkesson, 2016), indicate that the possibility of a substantial cumulative impact on this species is unlikely.

2128. During the breeding season, no OWFs are within mean maximum foraging range plus one standard deviation of this SPA, therefore no breeding season impacts on this qualifying feature are predicted.

2129. Outside the breeding season, there is potential for other OWFs to impact this qualifying feature during the spring and autumn migration seasons. However, a review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. As approximately just 0.8% of migration season impacts on this species would be apportioned to this SPA population (Furness, 2015), it is considered unlikely that in-combination effects on this qualifying feature will occur to the level where an adverse effect on the integrity of the site would be possible.

2130. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Auskerry SPA.**

9.28 Marwick Head SPA

9.28.1 Description of Designation

2131. The Marwick Head SPA is a 2km stretch of sea cliffs along the west coast of Orkney Mainland. The cliffs support large colonies of breeding seabirds.

2132. The seaward extension of the SPA extends approximately 1km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.28.2 Conservation Objectives

2133. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.28.3 Appropriate Assessment

2134. The only qualifying species from this SPA screened into the Appropriate Assessment is breeding guillemot (**Table 5-2**).

9.28.3.1 Guillemot

9.28.3.1.1 Status

2135. The SPA breeding population at classification was 37,700 individuals (SNH, 2009e). The most recent published count was 11,985 individuals in 2018 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 731 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.28.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2136. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2137. Marwick Head SPA is located approximately 700km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2138. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 1.0% of birds present are considered to be breeding adults from Marwick Head SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

2139. It should be noted that Furness (2015) uses the SPA breeding adult population from 2000 during calculation of the non-breeding BDMPS, which was 22,194 birds. If the more recent population estimates are incorporated into these calculations, the contribution of the Marwick Head SPA breeding population to the UK North Sea and Channel BDMPS is likely to be around 0.5%, as opposed to the 1.0% calculated above. This means that impacts on this population as a result of the assessment methodology employed here will result in significant overestimation of impacts on this population.

9.28.3.1.3 Potential Effects on the Qualifying Feature

2140. The guillemot qualifying feature of Marwick Head SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.28.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.28.3.1.4.1 Operational Phase Displacement / Barrier Effects

2141. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-204**, **Table 9-205**, and **Table 9-206** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the Marwick Head SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2142. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the Marwick Head SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-204: Predicted Operational Phase Displacement and Mortality of Marwick Head SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 245 (nb) 245 (year round)	1 - 17 (1)	0.10 - 2.35 (0.17)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 149 (nb) 149 (year round)	0 - 10 (1)	0.06 - 1.43 (0.10)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 78 (n) 78 (year round)	0 - 5 (0)	0.03 - 0.75 (0.05)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Marwick Head SPA breeding adults. For non-breeding season, assumes 1.0% of birds are Marwick Head SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Marwick Head SPA breeding adults (11,985 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-205: Predicted Operational Phase Displacement and Mortality of Marwick Head SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 16 (nb) 16 (year round)	0 - 1 (0)	0.01 - 0.15 (0.01)
Mean	1,095 (b) 1,085 (nb)	0 (b) 11 (nb)	0 - 1 (0)	0.00 - 0.10 (0.01)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	2,180 (year round)	11 (year round)		
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 7 (nb) 7 (year round)	0 - 0 (0)	0.00 - 0.06 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Marwick Head SPA breeding adults. For non-breeding season, assumes 1.0% of birds are Marwick Head SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Marwick Head SPA breeding adults (11,985 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-206: Predicted Operational Phase Displacement and Mortality of Marwick Head SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 261 (nb) 261 (year round)	1 - 18 (1)	0.11 - 2.50 (0.18)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 160 (nb) 160 (year round)	0 - 11 (1)	0.07 - 1.53 (0.11)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 85 (nb) 85 (year round)	0 - 6 (0)	0.03 - 0.81 (0.06)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Marwick Head SPA breeding adults. For non-breeding season, assumes 1.0% of birds are Marwick Head SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Marwick Head SPA breeding adults (11,985 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

2143. Based on the mean peak abundances, the annual total of guillemots from Marwick Head SPA at risk of displacement from SEP and DEP together is 160 birds (**Table 9-206**); 149 at DEP (**Table 9-204**) and 11 at SEP (**Table 9-205**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 0.4 to

10.4 SPA breeding adults would be predicted to die each year due to displacement from DEP and 0.0 to 0.8 birds due to displacement at SEP.

2144. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 1.43% due to impacts at DEP and 0.10% due to impacts at SEP (1.53% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.10% due to impacts at DEP (0.7 birds), 0.01% due to impacts at SEP (0.1 birds) and 0.11% due to the impacts of SEP and DEP together (0.8 birds).

2145. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2146. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under almost any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered.

2147. Mortality rate increases of over 1% are predicted for mean peak abundance estimate assessments only when a mortality rate for displaced birds of 10% is considered alongside a displacement rate of 0.500 or more. The probability of such events occurring is small, as a mortality rate for displaced birds of 10% is much higher than evidence suggests will actually be the case, with 1% or less being suggested as a more reasonable precautionary value.

2148. Increases of over 1% are also predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside the upper limits of recommended displacement and mortality rates. The probability of such events occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, displacement and mortality rates of 0.700 and 10% are much higher than evidence suggests will actually be the case, and use of the evidence-based displacement (0.500) and mortality rate (1%) would again result in a mortality increase of less than 1%.

2149. It should also be noted that the assumption that 1.0% of birds are Marwick Head SPA breeding adults is based on an SPA breeding adult population from 2012 used in Furness (2015), which was approximately double the 2018 population referred to in this assessment, hence it is likely that the proportion is now likely to be considerably smaller.

2150. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Marwick Head SPA.**

2151. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

2152. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, impacts from SEP and DEP on this SPA qualifying feature are in fact zero.

9.28.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.28.3.1.5.1 Operational Phase Displacement / Barrier Effects

2153. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding guillemot population of the Marwick Head SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the vast majority of foraging activity of guillemot from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2154. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 2,564 are estimated to belong to Marwick Head SPA, assuming 1.0% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to Marwick Head SPA are presented in **Table 9-207**.

Table 9-207: In-Combination Year Round Displacement Matrix for Guillemot from Marwick Head SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

	Mortality (%)										
Displacement (%)		1	2	3	4	5	10	20	30	50	80	100
	10	3	5	8	10	13	26	51	77	128	205	256
	20	5	10	15	21	26	51	103	154	256	410	513
	30	8	15	23	31	38	77	154	231	385	615	769
	40	10	21	31	41	51	103	205	308	513	820	1026
	50	13	26	38	51	64	128	256	385	641	1026	1282
	60	15	31	46	62	77	154	308	462	769	1231	1538
	70	18	36	54	72	90	179	359	538	897	1436	1795
	80	21	41	62	82	103	205	410	615	1026	1641	2051
	90	23	46	69	92	115	231	462	692	1154	1846	2308
	100	26	51	77	103	128	256	513	769	1282	2051	2564

2155. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 179 breeding adult SPA birds would be lost to displacement each non-breeding season. This would increase the existing mortality within the SPA population (731 breeding adult birds per year) by 24.55%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 13 birds. This would increase the existing mortality within this population by 1.75%.

2156. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2157. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

2158. In addition, the predicted impacts of SEP and DEP in isolation and together on the breeding adult guillemot population of the Marwick Head SPA are small relative to the overall impact (**Table 9-206**). It is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature, even if it is assumed that the species is fully migratory.

2159. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-**

combination with other projects, would not adversely affect the integrity of Marwick Head SPA.

9.29 West Westray SPA

9.29.1 Description of Designation

2160. West Westray SPA is an 8km stretch of sea cliffs, adjacent grassland and heathland, along the west coast of the island of Westray in Orkney. The cliffs support large colonies of breeding auks and kittiwakes while the grassland and heathland areas support breeding colonies of skuas and terns.

2161. The seaward extension of the SPA extends approximately 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.29.2 Conservation Objectives

2162. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.29.3 Appropriate Assessment

2163. The only qualifying species from this SPA screened into the Appropriate Assessment is breeding guillemot (**Table 5-2**).

9.29.3.1 Guillemot

9.29.3.1.1 Status

2164. The SPA breeding population at classification was 42,150 individuals (SNH, 2009f). The most recent published count was 28,697 individuals in 2017 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 1,751 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson (2015).

9.29.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2165. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al*. (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2166. West Westray SPA is located approximately 710km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2167. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 2.9% of birds present are considered to be breeding adults from West Westray SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

2168. It should be noted that Furness (2015) uses the SPA breeding adult population from 2007 during calculation of the non-breeding BDMPS, which was 67,800 birds. If the more recent population estimates are incorporated into these calculations, the contribution of the West Westray SPA breeding population to the UK North Sea and Channel BDMPS is likely to be around 1.3%, as opposed to the 2.9% calculated above. This means that impacts on this population as a result of the assessment methodology employed here will result in significant overestimation of impacts on this population.

9.29.3.1.3 Potential Effects on the Qualifying Feature

2169. The guillemot qualifying feature of West Westray SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.29.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.29.3.1.4.1 Operational Phase Displacement / Barrier Effects

2170. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-208**, **Table 9-209**, and **Table 9-210**, respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the West Westray SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2171. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the West Westray SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-208: Predicted Operational Phase Displacement and Mortality of West Westray SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 711 (nb) 711 (year round)	2 - 50 (4)	0.12 - 2.84 (0.20)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 432 (nb) 432 (year round)	1 - 30 (2)	0.07 - 1.73 (0.12)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 227 (n) 227 (year round)	1 - 16 (1)	0.04 - 0.91 (0.06)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are West Westray SPA breeding adults. For non-breeding season, assumes 2.9% of birds are West Westray SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is West Westray SPA breeding adults (28,697 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-209: Predicted Operational Phase Displacement and Mortality of West Westray SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 46 (nb) 46 (year round)	0 - 3 (0)	0.01 - 0.18 (0.01)
Mean	1,095 (b) 1,085 (nb)	0 (b) 31 (nb)	0 - 2 (0)	0.01 - 0.13 (0.01)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	2,180 (year round)	31 (year round)		
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 19 (nb) 19 (year round)	0 - 1 (0)	0.00 - 0.08 (0.01)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are West Westray SPA breeding adults. For non-breeding season, assumes 2.9% of birds are West Westray SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is West Westray SPA breeding adults (28,697 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-210: Predicted Operational Phase Displacement and Mortality of West Westray SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 756 (nb) 756 (year round)	2 - 53 (4)	0.13 - 3.02 (0.22)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 463 (nb) 463 (year round)	1 - 32 (2)	0.08 - 1.85 (0.13)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 246 (nb) 246 (year round)	1 - 17 (1)	0.04 - 0.98 (0.07)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are West Westray SPA breeding adults. For non-breeding season, assumes 2.9% of birds are West Westray SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is West Westray SPA breeding adults (28,697 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

2172. Based on the mean peak abundances, the annual total of guillemots from West Westray SPA at risk of displacement from SEP and DEP together is 463 birds (**Table 9-210**); 432 at DEP (**Table 9-208**) and 31 at SEP (**Table 9-209**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 1.3 to

30.2 SPA breeding adults would be predicted to die each year due to displacement from DEP and 0.1 to 2.2 birds due to displacement at SEP.

2173. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 1.73% due to impacts at DEP and 0.13% due to impacts at SEP (1.85% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.12% due to impacts at DEP (2.2 birds), 0.01% due to impacts at SEP (0.2 birds) and 0.13% due to the impacts of SEP and DEP together (2.3 birds).

2174. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2175. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under almost any combination of displacement and mortality rates when the mean peak abundance estimate assessments are considered.

2176. Mortality rate increases of over 1% are predicted for mean peak abundance estimate assessments only when a mortality rate for displaced birds of 10% is considered alongside a displacement rate of 0.400 or more. The probability of such events occurring is small, as a mortality rate for displaced birds of 10% is much higher than evidence suggests will actually be the case. The use of evidence-based displacement (0.500) and mortality rates (1%) would result in a mortality increase of substantially less than 1%.

2177. Increases of over 1% are also predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside the upper limits of recommended displacement and mortality rates. The probability of such events occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, displacement and mortality rates of 0.700 and 10% are much higher than evidence suggests will actually be the case. The use of evidence-based displacement (0.500) and mortality rates (1%) would result in a mortality increase of substantially less than 1%.

2178. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of West Westray SPA.**

2179. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.29.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.29.3.1.5.1 Operational Phase Displacement / Barrier Effects

2180. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding guillemot population of the West Westray SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the vast majority of foraging activity of guillemot from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2181. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 7,436 are estimated to belong to West Westray SPA, assuming 2.9% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to West Westray SPA are presented in **Table 9-211**.

Table 9-211: In-Combination Year Round Displacement Matrix for Guillemot from West Westray SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	7	15	22	30	37	74	149	223	372	595	744
	20	15	30	45	59	74	149	297	446	744	1190	1487
	30	22	45	67	89	112	223	446	669	1115	1785	2231
	40	30	59	89	119	149	297	595	892	1487	2380	2974
	50	37	74	112	149	186	372	744	1115	1859	2974	3718
	60	45	89	134	178	223	446	892	1338	2231	3569	4462
	70	52	104	156	208	260	521	1041	1562	2603	4164	5205
	80	59	119	178	238	297	595	1190	1785	2974	4759	5949
	90	67	134	201	268	335	669	1338	2008	3346	5354	6692
	100	74	149	223	297	372	744	1487	2231	3718	5949	7436

2182. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 521 breeding adult SPA birds would be lost to displacement each non-breeding season. This would increase the existing mortality within the SPA population (1,751 breeding adult birds per year) by 29.74%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 37 birds. This would increase the existing mortality within this population by 2.12%.

2183. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2184. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

2185. In addition, the predicted impacts of SEP and DEP in isolation and together on the breeding adult guillemot population of the West Westray SPA are small relative to the overall impact (**Table 9-210**). It is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature, even if it is assumed that the species is fully migratory.

2186. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-**

combination with other projects, would not adversely affect the integrity of West Westray SPA.

9.30 Fair Isle SPA

9.30.1 Description of Designation

2187. Fair Isle SPA is situated on the most southerly island of the Shetland group, lying halfway between Mainland and Orkney. It has a rocky, cliff coastline and supports a wide range of breeding seabird populations of international importance.

2188. The seaward extension of the SPA extends approximately 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.30.2 Conservation Objectives

2189. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.30.3 Appropriate Assessment

2190. The only qualifying species from this SPA screened into the Appropriate Assessment is breeding guillemot (**Table 5-2**).

9.30.3.1 Guillemot

9.30.3.1.1 Status

2191. The SPA breeding population at classification was 32,300 individuals (SNH, 2009g). The most recent available count is 20,924 individuals in 2015 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 1,276 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson (2015).

9.30.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2192. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al*. (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2193. Fair Isle SPA is located approximately 715km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2194. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 1.1% of birds present are considered to be breeding adults from Fair Isle SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

9.30.3.1.3 Potential Effects on the Qualifying Feature

2195. The guillemot qualifying feature of Fair Isle SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.30.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.30.3.1.4.1 Operational Phase Displacement / Barrier Effects

2196. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-212**, **Table 9-213**, and **Table 9-214**, respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the Fair Isle SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2197. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the Fair Isle SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-212: Predicted Operational Phase Displacement and Mortality of Fair Isle SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 270 (nb) 270 (year round)	1 - 19 (1)	0.06 - 1.48 (0.11)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 164 (nb) 164 (year round)	0 - 11 (1)	0.04 - 0.90 (0.06)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 86 (n) 86 (year round)	0 - 6 (0)	0.02 - 0.47 (0.03)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Fair Isle SPA breeding adults. For non-breeding season, assumes 1.1% of birds are Fair Isle SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Fair Isle SPA breeding adults (20,924 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-213: Predicted Operational Phase Displacement and Mortality of Fair Isle SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 17 (nb) 17 (year round)	0 - 1 (0)	0.00 - 0.09 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 12 (nb) 12 (year round)	0 - 1 (0)	0.00 - 0.07 (0.00)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 7 (nb) 7 (year round)	0 - 1 (0)	0.00 - 0.04 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Fair Isle SPA breeding adults. For non-breeding season, assumes 1.1% of birds are Fair Isle SPA breeding adults.

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Fair Isle SPA breeding adults (20,924 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

Table 9-214: Predicted Operational Phase Displacement and Mortality of Fair Isle SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 287 (nb) 287 (year round)	1 - 20 (1)	0.07 - 1.57 (0.11)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 176 (nb) 176 (year round)	1 - 12 (1)	0.04 - 0.96 (0.07)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 93 (nb) 93 (year round)	0 - 7 (0)	0.02 - 0.51 (0.04)
Notes 1. Breeding season = b, non-breeding season = nb 2. For breeding season (Mar-Jul), assumes 0% of birds are Fair Isle SPA breeding adults. For non-breeding season, assumes 1.1% of birds are Fair Isle SPA breeding adults. 3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses. 4. Background population is Fair Isle SPA breeding adults (20,924 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

2198. Based on the mean peak abundances, the annual total of guillemots from Fair Isle SPA at risk of displacement from SEP and DEP together is 176 birds (**Table 9-214**); 164 at DEP (**Table 9-212**) and 12 at SEP (**Table 9-213**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 0.5 to 11.5 SPA breeding adults would be predicted to die each year due to displacement from DEP and 0.0 to 0.8 birds due to displacement at SEP.

2199. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 0.90% due to impacts at DEP and 0.07% due to impacts at SEP (0.96% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.06% due to impacts at DEP (0.8 birds), less than 0.01% due to impacts at SEP (0.1 birds) and 0.07% due to the impacts of SEP and DEP together (0.9 birds).

2200. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2201. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of recommended displacement and mortality rates when the mean peak abundance estimate assessments are considered.

2202. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Foula SPA.**

2203. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.30.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.30.3.1.5.1 Operational Phase Displacement / Barrier Effects

2204. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding guillemot population of the Fair Isle SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the vast majority of foraging activity of guillemot from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2205. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 2,820 are estimated to belong to Fair Isle SPA, assuming 1.1% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to Fair Isle SPA are presented in **Table 9-215**.

Table 9-215: In-Combination Year Round Displacement Matrix for Guillemot from Fair Isle SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	3	6	8	11	14	28	56	85	141	226	282
	20	6	11	17	23	28	56	113	169	282	451	564
	30	8	17	25	34	42	85	169	254	423	677	846
	40	11	23	34	45	56	113	226	338	564	903	1128
	50	14	28	42	56	71	141	282	423	705	1128	1410
	60	17	34	51	68	85	169	338	508	846	1354	1692
	70	20	39	59	79	99	197	395	592	987	1579	1974
	80	23	45	68	90	113	226	451	677	1128	1805	2256
	90	25	51	76	102	127	254	508	762	1269	2031	2538
	100	28	56	85	113	141	282	564	846	1410	2256	2820

2206. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 197 breeding adult SPA birds would be lost to displacement each non-breeding season. This would increase the existing mortality within the SPA population (1,276 breeding adult birds per year) by 15.47%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 14 birds. This would increase the existing mortality within this population by 1.10%.

2207. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2208. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

2209. In addition, the predicted impacts of SEP and DEP in isolation and together on the breeding adult guillemot population of the Fair Isle SPA are small relative to the overall impact (**Table 9-214**). It is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature, even if it is assumed that the species is fully migratory.

2210. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Fair Isle SPA.**

9.31 Noss SPA

9.31.1 Description of Designation

2211. Noss SPA is an offshore island lying 5km east of Lerwick, Shetland. It supports breeding seabirds on cliffs, inland heathlands and grasslands.

2212. The seaward extension of the SPA extends approximately 2km into the marine environment and includes the seabed, water column and surface. Seabirds included within the designation feed both inside and outside the SPA in nearby waters, as well as more distantly in the wider North Sea.

9.31.2 Conservation Objectives

2213. The overarching conservation objectives of the site are:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.31.3 Appropriate Assessment

2214. The qualifying species from this SPA that are screened into the Appropriate Assessment are breeding guillemot and breeding gannet (**Table 5-2**).

9.31.3.1 Gannet

9.31.3.1.1 Status

2215. The SPA breeding population at classification was 6,860 pairs or 13,720 breeding adults (SNH, 2009h). The most recent available count is 13,765 pairs, or 27,530 breeding adults, in 2019 (JNCC, 2022). The latter estimate is considered the best available evidence for the gannet population of this designated site. Using the published adult mortality rate of 8.1% (Horswill and Robinson (2015)), 2,230 birds would be expected to die annually from the breeding adult population of 27,530 individuals.

9.31.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2216. Noss SPA is located approximately 765km from SEP and DEP. The mean maximum foraging range of gannet is 315.2km (±194.2km), and the maximum foraging range is 709km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of gannet from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 229.4km (±124.3km) based on data from seven studies. The updated review of Woodward *et al*. (2019), based on data from 21 studies, gives a considerably larger mean maximum foraging range.

2217. This means that breeding adult gannets from this SPA are beyond the maximum recorded foraging range for this species from SEP and DEP. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2218. Outside the breeding season, breeding gannets, including those from Noss SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with gannets of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea and Channel BDMPS. This consists of 456,299 individuals during autumn migration (September to November), and 248,385 individuals during spring migration (December to March) (Furness, 2015).

2219. During autumn migration, 80% of Noss SPA breeding adults are thought to be present in the BDMPS, representing 3.4% of the total BDMPS population (456,299 individuals of all ages). During this season, 458 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 182 birds were able to be assigned to an age class. 170 birds (93.4% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Noss SPA is 3.2% (i.e. 0.034 x 0.934).

2220. During spring migration, 70% of Noss SPA breeding adults are thought to be present in the BDMPS, representing 5.5% of the BDMPS population (248,385 individuals of all ages). During this season, 28 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 21 birds were able to be assigned to an age class. 20 birds (95.2% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Noss SPA is 5.2% (i.e. 0.055 x 0.952).

9.31.3.1.3 Potential Effects on the Qualifying Feature

2221. The gannet qualifying feature of Noss SPA has been screened into the Appropriate Assessment due the potential risk of collision and operational phase displacement/barrier effects.

9.31.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.31.3.1.4.1 Operational Phase Displacement / Barrier effects

2222. Following statutory guidance (UK SNCBs, 2017), abundance estimates for gannet for DEP and its 2km buffer, and SEP and its 2km buffer have been used to produce displacement matrices. Based on the recommended displacement rate of Cook *et al.* (2018) and the findings of Skov *et al*. (2018), displacement rates of 0.600 to 0.800 are considered. These rates appear to be broadly in line with recent research on gannet displacement by OWFs (Peschko *et al*., 2021).

2223. The mortality rate of displaced birds due to displacement is assumed to be a maximum of 1%. This value has been selected firstly because gannet is known to possess high habitat flexibility (Furness and Wade, 2012). This suggests that displaced birds will readily find alternative habitats including foraging areas. Secondly, no evidence of displacement-induced mortality has been identified, which means there is limited justification for setting predicted mortality rates at a higher level.

2224. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult gannets belonging to the Noss SPA population is presented in **Table 9-216** (DEP), **Table 9-217** (SEP) and **Table 9-218** (SEP and DEP together). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult gannets belonging to the Noss SPA population by season. An estimated annual mortality for the population is provided, along with the increase of existing mortality within the breeding adult SPA population that would occur due to such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-216: Predicted Operational Phase Displacement and Mortality of Noss SPA Breeding Adult Gannets at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of Noss SPA breeding adults present by season[1]	Year-round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	554 (autumn)	18 (autumn)	0 - 0	0.01 - 0.01

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of Noss SPA breeding adults present by season[1]	Year-round mortality range[2]	Year round% background mortality annual increase range[3]
	103 (spring) 692 (breeding) 1,349 (year round)	5 (spring) 0 (breeding) 23 (year round)		
Mean	343 (autumn) 47 (spring) 417 (breeding) 807 (year round)	11 (autumn) 2 (spring) 0 (breeding) 13 (year round)	0 - 0	0.00 - 0.00
Lower 95% CI	186 (autumn) 10 (spring) 180 (breeding) 376 (year round)	6 (autumn) 0 (spring) 0 (breeding) 6 (year round)	0 - 0	0.00 - 0.00

Notes
1. For autumn migration season (Oct-Nov), assumes 3.4% of adult birds are Noss SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 5.5% of adult birds are Noss SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Noss SPA breeders.

2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds

3. Background population is Noss SPA breeding adults (27,530 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

Table 9-217: Predicted Operational Phase Displacement and Mortality of Noss SPA Breeding Adult Gannets at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of Noss SPA breeding adults present by season[1]	Year-round mortality range[2]	Year-round% background mortality annual increase range[3]
Upper 95% CI	426 (autumn) 31 (spring) 47 (breeding) 504 (year round)	14 (autumn) 2 (spring) 0 (breeding) 15 (year round)	0 - 0	0.00 - 0.01
Mean	295 (autumn) 11 (spring) 23 (breeding) 329 (year round)	9 (autumn) 1 (spring) 0 (breeding) 10 (year round)	0 - 0	0.00 - 0.00
Lower 95% CI	193 (autumn) 0 (spring) 3 (breeding) 196 (year round)	6 (autumn) 0 (spring) 0 (breeding) 6 (year round)	0 - 0	0.00 - 0.00

Notes
1. For autumn migration season (Oct-Nov), assumes 3.4% of adult birds are Noss SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of Noss SPA breeding adults present by season[1]	Year-round mortality range[2]	Year-round% background mortality annual increase range[3]
baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 5.5% of adult birds are Noss SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Noss SPA breeders. 2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds 3. Background population is Noss SPA breeding adults (27,530 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

Table 9-218: Predicted Operational Phase Displacement and Mortality of Noss SPA Breeding Adult Gannets at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of Noss SPA breeding adults present by season[1]	Year-round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	980 (autumn) 133 (spring) 739 (breeding) 1,852 (year round)	31 (autumn) 7 (spring) 0 (breeding) 38 (year round)	0 - 0	0.01 - 0.01
Mean	638 (autumn) 57 (spring) 440 (breeding) 1,135 (year round)	20 (autumn) 3 (spring) 0 (breeding) 23 (year round)	0 - 0	0.01 - 0.01
Lower 95% CI	378 (autumn) 10 (spring) 183 (breeding) 571 (year round)	12 (autumn) 0 (spring) 0 (breeding) 13 (year round)	0 - 0	0.00 - 0.00
Notes 1. For autumn migration season (Oct-Nov), assumes 3.4% of adult birds are Noss SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 5.5% of adult birds are Noss SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Noss SPA breeders. 2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds 3. Background population is Noss SPA breeding adults (27,530 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

2225. Based on the mean peak abundances, the annual total of breeding adult gannets from Noss SPA at risk of displacement from DEP is 13, 10 from SEP, and 23 for SEP and DEP together. At displacement rates of 0.600 to 0.800 and a maximum mortality rate of 1% for displaced birds, 0.14 to 0.19 SPA breeding adults would be predicted to die each year due to displacement from both OWFs (**Table 9-218**). The combined displacement mortality of SEP and DEP would increase the existing mortality of the SPA breeding population by 0.01%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

2226. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 22.0% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2227. **It is concluded that predicted gannet mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Noss SPA.**

2228. The confidence in the assessment is high for several reasons. Firstly, the evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.31.3.1.4.2 Collision Risk

2229. Information to inform the Appropriate Assessment for collision risk on breeding adult gannets belonging to the Noss SPA population is presented in **Table 9-219**. An estimated monthly and annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). The methodology and input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

2230. Based on the mean collision rates, the annual total of breeding adult gannets from Noss SPA at risk of collision at DEP is 0.10, with 0.02 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.12 Noss SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.01%. Using an evidence-based nocturnal activity factor of 8% (Furness *et al.*, 2018), which has been calculated more recently than the value of 25% recommended for use in CRM by Natural England (originally estimated by Garthe and Hüppop (2004)), reduces the mean collision rate to 0.02 and 0.08 birds per year for SEP and DEP, respectively. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peaks are used as an input into the assessment, since the maximum predicted mortality increase that could occur is 0.01%.

2231. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 59 flying birds were observed across DEP (of which 41 were within DEP-N, and 18 within DEP-S). This means that encounter rate was 14.0% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

2232. **It is concluded that predicted gannet mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Noss SPA.**

2233. The confidence in the assessment is high. The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

2234. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

Table 9-219: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Gannet at SEP and DEP Apportioned to Noss SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.01	0.10
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.10	0.04	0.28
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.09	0.02	0.18
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.04
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.06	0.01	0.12
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.01	0.08
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.01	0.08
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.01
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.01	0.12
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.14	0.04	0.33
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.13	0.02	0.22
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	0.05
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.08	0.01	0.15
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.06	0.01	0.10
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.06	0.01	0.10
Notes															

Site	Variable	J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
1. For autumn migration season (Oct-Nov), assumes 3.4% of adult birds are Noss SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults 2. For spring migration season (Dec-Feb), assumes 5.5% of adult birds are Noss SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults 3. For breeding season (Mar-Sept), assumes 0% of adult birds are Noss SPA breeders														

9.31.3.1.4.3 Combined Displacement / Barrier Effects and Collision Risk

2235. The combined displacement and collision rates for breeding adult gannet from Noss SPA for SEP and DEP in isolation and together are presented in **Table 9-220**.

Table 9-220: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Noss SPA Breeding Adult Gannets at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population

Site	Annual displacement mortality[1]	Annual collision mortality	Annual displacement and collision mortality	% annual mortality increase[2]
DEP	0.09 (0.04 - 0.16)	0.10 (0.00 - 0.28)	0.20 (0.04 - 0.44)	0.01 (0.00 - 0.02)
SEP	0.07 (0.04 - 0.11)	0.02 (0.00 - 0.05)	0.09 (0.04 - 0.16)	0.00 (0.00 - 0.01)
SEP and DEP	0.16 (0.09 - 0.27)	0.12 (0.00 - 0.33)	0.29 (0.09 - 0.60)	0.01 (0.00 - 0.03)

Notes
1. Assumes displacement rates of 0.700 and mortality rate of 1% of displaced birds

2. Background population is Noss SPA breeding adults (27,530 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

2236. Based on the mean combined displacement and collision rates, the annual mortality of breeding adult gannets from Noss SPA at DEP is 0.20, and 0.09 at SEP. This gives a combined total annual displacement and collision mortality rate for SEP and DEP together of 0.29 Noss SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.01%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates are likely in a typical year of impacts due to SEP and DEP. The use of upper 95% CI outputs does not change the conclusions of the assessment.

2237. **It is concluded that predicted gannet mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Noss SPA.**

2238. The confidence in the assessment is high, for the reasons provided in the individual displacement and collision assessments.

9.31.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

2239. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding gannet population of the Noss SPA are anticipated to be very small, or even zero. Whilst some OWFs in Scottish waters (particularly in the Moray Firth) are situated within mean maximum foraging range of the qualifying feature from the SPA, it is assumed, based on the geographical location of the SPA, that the vast majority of foraging activity of gannet from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

9.31.3.1.5.1 Operational Phase Displacement / Barrier Effects

2240. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn and spring migration seasons respectively, 22,374 and 5,728 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-98**). Of the birds at risk of displacement, 1,076 are estimated to belong to the breeding adult population of Noss SPA, assuming 3.4% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the autumn migration season, and 5.5% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the spring migration season (Furness, 2015). Displacement and mortality rates of birds belonging to Noss SPA are presented in **Table 9-221**.

Table 9-221: In-Combination Year Round Displacement Matrix for Gannet from Noss SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	1	2	3	4	5	11	22	32	54	86	108
	20	2	4	6	9	11	22	43	65	108	172	215
	30	3	6	10	13	16	32	65	97	161	258	323
	40	4	9	13	17	22	43	86	129	215	344	430
	50	5	11	16	22	27	54	108	161	269	430	538
	60	6	13	19	26	32	65	129	194	323	516	645
	70	8	15	23	30	38	75	151	226	377	602	753
	80	9	17	26	34	43	86	172	258	430	688	861
	90	10	19	29	39	48	97	194	290	484	775	968
	100	11	22	32	43	54	108	215	323	538	861	1076

2241. Assuming a displacement rate of 0.600 to 0.800, and a mortality rate of 1% of displaced birds, 6 to 9 SPA birds would be lost to displacement each year. This would increase the existing mortality within the SPA population (2,230 breeding adult birds per year) by 0.29% to 0.39%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable change in mortality rate is predicted due to operational phase OWF displacement impacts.

2242. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of Noss SPA due to this impact are small, with a mean predicted annual mortality rate of 0.16 birds (**Table 9-220**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay, the conservation objectives for the SPA being met.

2243. **It is concluded that predicted gannet mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Noss SPA.**

9.31.3.1.5.2 Collision Risk

2244. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn and spring migration seasons respectively, 836 and 333 birds belonging to the UK North Sea and Channel BDMPS are predicted to die due to collision with OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-100**).

2245. These collision rates are based largely on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than their consent allows. These will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

2246. Of these birds, 47 are estimated to belong to the breeding adult population of Noss SPA, assuming 3.4% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the autumn migration season, and 5.5% of birds of the total relevant BDMPS belong to the breeding population of this SPA (Furness, 2015) during the spring migration season. This would increase the existing mortality within the SPA population (2,230 breeding adult birds per year) by 2.10%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to collision risk.

2247. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of Noss SPA are small, with a mean predicted annual mortality rate of 0.12 birds (**Table 9-220**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay, the conservation objectives for the SPA being met.

2248. **It is concluded that predicted gannet mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Noss SPA.**

2249. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

9.31.3.1.5.3 Combined Displacement / Barrier Effects and Collision Risk

2250. The predicted annual in-combination breeding adult Noss SPA gannet mortality from collision and displacement of OWFs screened into the Appropriate Assessment is between 53 and 56 birds, depending on whether a displacement rate of 0.600 to 0.800 is used in calculations. This represents an increase in existing annual mortality of 2.38% to 2.51%, assuming an existing mortality of 2,230 breeding adult birds per year. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to collision risk.

2251. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of Noss SPA are small, with a mean predicted annual mortality rate of 0.29 birds (**Table 9-220**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay, the conservation objectives for the SPA being met.

2252. **It is concluded that predicted gannet mortality due to the combined impacts of operational phase displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Noss SPA.**

9.31.3.2 Guillemot

9.31.3.2.1 Status

2253. The SPA breeding population at classification was 38,970 individuals (SNH, 2009h). The most recent published count was 24,456 individuals in 2015 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 1,492 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.31.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2254. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2255. Noss SPA is located approximately 765km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2256. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 1.3% of birds present are considered to be breeding adults from Noss SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

9.31.3.2.3 Potential Effects on the Qualifying Feature

2257. The guillemot qualifying feature of Noss SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.31.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.31.3.2.4.1 Operational Phase Displacement / Barrier Effects

2258. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-222**, **Table 9-223**, and **Table 9-224**, respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the Noss SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2259. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the Noss SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-222: Predicted Operational Phase Displacement and Mortality of Noss SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 319 (nb) 319 (year round)	1 - 22 (2)	0.06 - 1.50 (0.11)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 194 (nb) 194 (year round)	1 - 14 (1)	0.04 - 0.91 (0.06)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 102 (n) 102 (year round)	0 - 7 (1)	0.02 - 0.48 (0.03)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Noss SPA breeding adults. For non-breeding season, assumes 1.3% of birds are Noss SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Noss SPA breeding adults (24,456 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-223: Predicted Operational Phase Displacement and Mortality of Noss SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 20 (nb) 20 (year round)	0 - 1 (0)	0.00 - 0.10 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 14 (nb) 14 (year round)	0 - 1 (0)	0.00 - 0.07 (0.00)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 9 (nb) 9 (year round)	0 - 1 (0)	0.00 - 0.04 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Noss SPA breeding adults. For non-breeding season, assumes 1.3% of birds are Noss SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Noss SPA breeding adults (24,456 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-224: Predicted Operational Phase Displacement and Mortality of Noss SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 339 (nb) 339 (year round)	1 - 24 (2)	0.07 - 1.59 (0.11)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 208 (nb) 208 (year round)	1 - 15 (1)	0.04 - 0.97 (0.07)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 110 (nb) 110 (year round)	0 - 8 (1)	0.02 - 0.52 (0.04)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Noss SPA breeding adults. For non-breeding season, assumes 1.3% of birds are Noss SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Noss SPA breeding adults (24,456 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

2260. Based on the mean peak abundances, the annual total of guillemots from Noss SPA at risk of displacement from SEP and DEP together is 208 birds (**Table 9-224**); 194 at DEP (**Table 9-222**) and 14 at SEP (**Table 9-223**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 0.6 to 13.5 SPA breeding adults would be predicted to die each year due to displacement from DEP and 0.0 to 1.0 birds due to displacement at SEP.

2261. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 0.91% due to impacts at DEP and 0.07% due to impacts at SEP (0.97% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.06% due to impacts at DEP (1.0 birds), less than 0.01% due to impacts at SEP (0.1 birds) and 0.07% due to the impacts of SEP and DEP together (1.0 birds).

2262. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2263. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of recommended displacement and mortality rates when the mean peak abundance estimate assessments are considered.

2264. Mortality rate increases of over 1% are only predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside a mortality rate for displaced birds of 10% combined with a displacement rate of 0.500 or more. The probability of such events occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, a mortality rate of 10% is much higher than evidence suggests will actually be the case. The use of evidence-based displacement (0.500) and mortality rate (1%) would result in a mortality increase of substantially less than 1%.

2265. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Noss SPA.**

2266. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.31.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

2267. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding guillemot population of the Noss SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the vast majority of foraging activity of guillemot from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

9.31.3.2.5.1 Operational Phase Displacement / Barrier Effects

2268. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 3,333 are estimated to belong to Noss SPA, assuming 1.3% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to Noss SPA are presented in **Table 9-225**.

Table 9-225: In-Combination Year Round Displacement Matrix for Guillemot from Noss SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	3	7	10	13	17	33	67	100	167	267	333
	20	7	13	20	27	33	67	133	200	333	533	667
	30	10	20	30	40	50	100	200	300	500	800	1000
	40	13	27	40	53	67	133	267	400	667	1067	1333
	50	17	33	50	67	83	167	333	500	833	1333	1667
	60	20	40	60	80	100	200	400	600	1000	1600	2000
	70	23	47	70	93	117	233	467	700	1167	1866	2333
	80	27	53	80	107	133	267	533	800	1333	2133	2666
	90	30	60	90	120	150	300	600	900	1500	2400	3000
	100	33	67	100	133	167	333	667	1000	1667	2666	3333

2269. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 233 breeding adult SPA birds would be lost to displacement each year. This would increase the existing mortality within the SPA population (1,492 breeding adult birds per year) by 15.64%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 17 birds. This would increase the existing mortality within this population by 1.12%.

2270. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to the level of mortality predicted if the evidence-based rates for mortality and displacement are used.

2271. The Scoping Opinion on the assessment approach for the Berwick Bank OWF (MS-LOT, 2022) means that the BDMPS approach for determining potential impacts on guillemot SPAs is not considered applicable by NatureScot, and Marine Scotland. This advice is that since guillemot is a dispersive rather than a fully migratory species, birds do not travel great distances from the breeding colony during the non-breeding season, and that breeding season foraging ranges are applicable year round to determining connectivity with OWFs. On that basis, whilst existing mortality of birds from this SPA may be at a level where effects could be detectable in the context of natural variation due to this impact, SEP and DEP, along with the majority of UK North Sea OWFs, do not contribute to it.

2272. In addition, the predicted impacts of SEP and DEP in isolation and together on the breeding adult guillemot population of the Noss SPA are small relative to the overall impact (**Table 9-224**). It is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature, even if it is assumed that the species is fully migratory.

2273. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Noss SPA.**

9.32 East Mainland Coast Shetland SPA

9.32.1 Description of Designation

2274. The East Mainland Coast Shetland SPA encompasses the marine waters to the east of mainland Shetland, from Samphrey in the north to Aith Ness in the south. Shetland's east coast is relatively sheltered. Cliffs dominate, interspersed with sandy beaches and bays. The sea depth is quite shallow along this coastline with a mixture of sand, mud and gravel forming the seabed. These habitats support a rich diversity of fish and invertebrates (such as marine worms, crabs and mussels), which in turn support divers, grebes and seaducks, amongst other bird species.

9.32.2 Conservation Objectives

2275. The overarching conservation objectives of the site were not located, but are assumed to be as follows:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.32.3 Appropriate Assessment

2276. The only qualifying species from this SPA that are screened into the Appropriate Assessment is breeding red-throated diver (**Table 5-2**).

9.32.3.1 Red-Throated Diver

9.32.3.1.1 Status

2277. The SPA breeding population at classification was 205 pairs, or 410 breeding adults (NatureScot, 2020b). This is used as the reference population by the assessment. Based on this SPA population estimate, and an annual breeding adult baseline mortality rate of 16.0% (Horswill and Robinson, 2015), 66 breeding adults from the SPA population would be expected to die each year.

9.32.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2278. The mean maximum foraging range of red-throated diver is 9km (±0km), as is the maximum foraging range (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of red-throated diver from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was identical. There is very little information available on this subject, with just one study identified by the above reviews.

2279. East Mainland Coast Shetland SPA is located approximately 770km from SEP and DEP. This means that red-throated divers from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2280. Outside the breeding season, breeding red-throated divers from the SPA are assumed to range widely and to mix with red-throated divers of all ages from breeding colonies in the UK and further afield. The relevant background population during the autumn and spring migration seasons is the UK North Sea BDMPS, consisting of 13,277 individuals during autumn and spring passage periods (September to November and February to April) (Furness, 2015). The relevant background population during the winter season is the SW North Sea BDMPS, consisting of 10,177 individuals (Furness, 2015).

2281. During the spring and autumn migration seasons, it is estimated that 3.0% of birds present are considered to be breeding adults from East Mainland Coast Shetland SPA. The corresponding value during the winter season is 3.9%. Impacts are apportioned accordingly during these seasons. This is based on the SPA adult population at citation as a proportion of the total relevant BDMPS from Furness (2015).

9.32.3.1.3 Potential Effects on the Qualifying Feature

2282. The red-throated diver qualifying feature East Mainland Coast Shetland SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement and barrier effects.

9.32.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.32.3.1.4.1 Operational Phase Displacement / Barrier Effects

2283. Population estimates of red-throated diver at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-226**, **Table 9-227** and **Table 9-228** respectively.

2284. Red-throated divers have a very high sensitivity to disturbance and displacement from operational OWFs. The majority of birds present before OWFs are constructed are displaced by the operation of OWFs. It is expected (based on expert opinion), that this is due to a combination of anthropogenic activities (mainly vessel movements), as well as the presence of OWF infrastructure. A large body of work investigating the effects of displacement of red-throated divers due to operational OWFs exists (Dorsch *et al*., 2020; Elston *et al*., 2016; Gill *et al*., 2018; Heinänen and Skov, 2018; Hi Def Aerial Surveying, 2017; Irwin *et al*., 2019; MacArthur Green and Royal HaskoningDHV, 2021b; McGovern *et al*., 2016; Mendel *et al*., 2019; NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017; Petersen *et al*., 2014, 2006; Vilela *et al*., 2020; Welcker and Nehls, 2016).

2285. There is a high degree of concordance of the available literature with respect to effects of operation of OWFs on red-throated diver distribution and abundance within OWFs. There is also a high degree of concordance that displacement effects extend beyond OWF boundaries. However, there is considerable variation with respect to the distance at which this effect remains detectable. Studies within the UK have ranged from no significant displacement effects being reported (McGovern *et al*., 2016), displacement effects being restricted to 1km to 2km of an OWF (NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017), to clear displacement effects across many years. These effects have been reported extending to 7km from OWFs (MacArthur Green and Royal HaskoningDHV, 2021b), 9km from OWFs (Elston *et al*., 2016; Hi Def Aerial Surveying, 2017), and beyond, though not all evidence was available to be referenced by this assessment. Studies from other countries have also recorded variable displacement distances, ranging from 1.5km to 2km (Welcker and Nehls, 2016) to 10km and beyond (Dorsch *et al*., 2020; Vilela *et al*., 2020). Displacement effects were detectable up to 20km from OWFs in one case.

2286. There is also concordance in the studies reviewed that displacement effects on red-throated diver due to operational OWFs occur on a gradient, with the strongest effects observed either within, or close to OWFs. As the distance from the OWF increases, the magnitude of the effect reduces, until a distance is reached at which the effect is no longer detectable.

2287. No study to date has managed to provide insight into whether changes in red-throated diver distribution at any spatial scale have the potential to result in population level effects, either at local, regional, national or international levels. Red-throated divers are capable of utilising a range of marine habitats and prey species (Dierschke *et al.*, 2017; Guse *et al.*, 2009; Kleinschmidt *et al.*, 2016). Recent data from the Outer Thames Estuary SPA indicate that birds are much more commonly recorded in water depths of less than 20m (Irwin *et al.*, 2019). During the non-breeding season, red-throated divers are mostly widely dispersed, at densities often less than four birds per km^2 (Dierschke *et al.*, 2017), and are highly mobile (Dorsch *et al.*, 2020; Duckworth *et al.*, 2020). In some instances, home ranges of many thousands of square kilometres have been demonstrated (Nehls *et al.*, 2018). This implies that following displacement, red-throated divers will be able to find alternative foraging sites, in some cases distant from the original area of displacement, which may already have been part of their existing non-breeding season range. It seems likely that in the vast majority of cases, mortality is not a consequence of displacement.

2288. Displacement rates of 1.000, along with a range of mortality rates of 1% to 10% of displaced birds is considered for this species at this SPA (UK SNCBs, 2017). Since the aerial survey study area covered SEP and DEP plus a 4km buffer, this is the maximum extent of the buffer that can be incorporated into the assessment. Whilst there are other data sources that could be used in the assessment, they predict much lower numbers of birds to be present than the baseline data, as evidenced by work carried out within **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). This assessment therefore focuses on the baseline survey data.

2289. Natural England has previously advised other OWF projects that for the assessment of red-throated diver operational displacement, a displacement rate of 1.000 within the OWF and 4km buffer and a mortality rate of up to 10% for displaced birds is used. However, during the baseline surveys, when SOW and DOW were both operational, red-throated divers were observed within 4km of both OWFs (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). This indicates that the suggestion of 100% displacement within this distance of these OWFs is an overestimate in this case.

2290. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult red-throated divers belonging to the East Mainland Coast Shetland SPA population is presented in **Table 9-226** (DEP), **Table 9-227** (SEP) and **Table 9-228** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult red-throated divers belonging to the East Mainland Coast Shetland SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-226: Predicted Operational Phase Displacement and Mortality of East Mainland Coast Shetland SPA Breeding Adult Red-Throated Divers at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 59 (aut) 15 (win)	0 (b) 2 (aut) 1 (win)	0 - 0	0.07 - 0.71

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	76 (spr) 150 (year round)	2 (spr) 5 (year round)		
Mean	0 (b) 31 (aut) 5 (win) 54 (spr) 90 (year round)	0 (b) 1 (aut) 0 (win) 2 (spr) 3 (year round)	0 - 0	0.04 - 0.42
Lower 95% CI	0 (b) 8 (aut) 0 (win) 33 (spr) 40 (year round)	0 (b) 0 (aut) 0 (win) 1 (spr) 1 (year round)	0 - 0	0.02 - 0.19

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For autumn migration and spring migration seasons, assumes 3.0% of birds are East Mainland Coast Shetland SPA breeding adults. For winter season, assumes 3.9% of birds are East Mainland Coast Shetland SPA breeding adults.

3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds

4. Background population is East Mainland Coast Shetland SPA breeding adults (410 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015).

Table 9-227: Predicted Operational Phase Displacement and Mortality of East Mainland Coast Shetland SPA Breeding Adult Red-Throated Divers at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 137 (aut) 15 (win) 463 (spr) 615 (year round)	0 (b) 4 (aut) 1 (win) 14 (spr) 19 (year round)	0 - 2	0.28 - 2.83
Mean	0 (b) 75 (aut) 5 (win) 191 (spr) 271 (year round)	0 (b) 2 (aut) 0 (win) 6 (spr) 8 (year round)	0 - 1	0.12 - 1.24
Lower 95% CI	0 (b) 30 (aut) 0 (win) 29 (spr) 59 (year round)	0 (b) 1 (aut) 0 (win) 1 (spr) 2 (year round)	0 - 0	0.03 - 0.27

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 3.0% of birds are East Mainland Coast Shetland SPA breeding adults. For winter season, assumes 3.9% of birds are East Mainland Coast Shetland SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is East Mainland Coast Shetland SPA breeding adults (410 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015).				

Table 9-228: Predicted Operational Phase Displacement and Mortality of East Mainland Coast Shetland SPA Breeding Adult Red-Throated Divers at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 196 (aut) 30 (win) 539 (spr) 765 (year round)	0 (b) 6 (aut) 1 (win) 16 (spr) 23 (year round)	0 - 2	0.35 - 3.53
Mean	0 (b) 106 (aut) 10 (win) 245 (spr) 361 (year round)	0 (b) 3 (aut) 0 (win) 7 (spr) 11 (year round)	0 - 1	0.17 - 1.66
Lower 95% CI	0 (b) 37 (aut) 0 (win) 162 (spr) 199 (year round)	0 (b) 1 (aut) 0 (win) 2 (spr) 3 (year round)	0 - 0	0.05 - 0.46
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 3.0% of birds are East Mainland Coast Shetland SPA breeding adults. For winter season, assumes 3.9% of birds are East Mainland Coast Shetland SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is East Mainland Coast Shetland SPA breeding adults (410 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015).				

2291. Based on the mean peak abundances, the annual total of red-throated divers from the East Mainland Coast Shetland SPA at risk of displacement from SEP and DEP together is 11 birds (**Table 9-228**); three at DEP (**Table 9-226**) and eight at SEP (**Table 9-227**). At a displacement rate of 1.000, and mortality rates of 1% to 10% for displaced birds, zero to 0.3 SPA breeding adults would be predicted to die each year due to displacement from DEP, and zero to 0.8 birds due to displacement from SEP.

2292. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.42% due to impacts at DEP, and 1.24% due to impacts at SEP (1.66% due to SEP and DEP together). Using what is thought to be a more reasonable worst case scenario of 1% mortality, annual mortality in the East Mainland Coast Shetland SPA breeding adult red-throated diver population would increase by 0.04% due to impacts at DEP, 0.12% due to impacts at SEP, and 0.17% due to the impacts of SEP and DEP together.

2293. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under realistic worst case displacement and mortality rates when the mean peak or upper 95% CIs for mean peak abundance estimate assessments are considered.

2294. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 15.1% higher at DEP-N than DEP as a whole, though the sample size of birds recorded in DEP as a whole (43 birds) was so small that differences between DEP-N and DEP-S are unlikely to be statistically significant. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2295. **It is concluded that predicted red-throated diver mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the East Mainland Coast Shetland SPA.**

2296. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species has been demonstrated to be highly mobile during the non-breeding season, and individuals frequently possess very large home ranges during this time (Dorsch *et al.*, 2020; Nehls *et al.*, 2018). It is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the realistic worst case displacement and mortality rates are used.

9.32.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.32.3.1.5.1 Operational Phase Displacement / Barrier Effects

2297. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding red-throated diver population of the East Mainland Coast Shetland SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the foraging activity of red-throated diver from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2298. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 3,180 birds belonging to the UK North Sea BDMPS are at risk of displacement from OWFs in the North Sea (**ES Chapter 11, Offshore Ornithology** (document reference 6.1.11)). Of the birds at risk of displacement, 103 are estimated to belong to the East Mainland Coast Shetland SPA, assuming up to 3.0% of birds of the total BDMPS during the spring and autumn migration seasons belong to the breeding population of this SPA, and 3.9% of birds of the total BDMPS during the winter belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to the East Mainland Coast Shetland SPA are presented in **Table 9-229**.

Table 9-229: In-Combination Year Round Displacement Matrix for Red-Throated Diver from East Mainland Coast Shetland SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	**2**	**3**	**4**	**5**	**10**	**20**	**30**	**50**	**80**	**100**
Displacement (%)	**10**	0	0	0	0	1	1	2	3	5	8	10
	20	0	0	1	1	1	2	4	6	10	16	21
	30	0	1	1	1	2	3	6	9	15	25	31
	40	0	1	1	2	2	4	8	12	21	33	41
	50	1	1	2	2	3	5	10	15	26	41	51
	60	1	1	2	2	3	6	12	19	31	49	62
	70	1	1	2	3	4	7	14	22	36	58	72
	80	1	2	2	3	4	8	16	25	41	66	82
	90	1	2	3	4	5	9	19	28	46	74	93
	100	1	2	3	4	5	10	21	31	51	82	103

2299. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, 10 breeding adult SPA birds would be lost to displacement annually. This would increase the existing mortality within the SPA population (66 breeding adult birds per year) by 15.69%. Using a realistic worst case displacement rate of 1.000, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be one bird. This would increase the existing mortality within this population by 1.57%.

2300. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that detectable changes in mortality rates could occur due to the level or mortality predicted if the more realistic worst case rates for mortality are used. However, the numbers of birds predicted to be displacement is small (i.e. less than a single bird annually). It is also anticipated that displacement and mortality rates may be considerably lower than those considered by this assessment. Finally, it is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2301. **It is concluded that predicted red-throated diver mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of East Mainland Coast Shetland SPA**.

9.33 Foula SPA

9.33.1 Description of Designation

2302. Foula is the most westerly of the Shetland Islands, lying 20km west of Shetland Mainland. It consists of a rocky coastline, large areas of mire, and adjacent coastal waters which support internationally important breeding populations of seabirds.

2303. The boundary of the SPA extends approximately 2km into the marine environment to include the seabed, water column and surface.

9.33.2 Conservation Objectives

2304. The overarching conservation objectives of the site are as follows:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.33.3 Appropriate Assessment

2305. The qualifying species from this SPA that are screened into the Appropriate Assessment are breeding red-throated diver, breeding guillemot and breeding puffin (**Table 5-2**).

9.33.3.1 Guillemot

9.33.3.1.1 Status

2306. The SPA breeding population at classification was 37,500 individuals (SNH, 2009i). The most recent published full count was 33,230 individuals in 2007 (Furness, 2015). This is used as the reference population for the assessment. The baseline mortality rate of the reference population is 2,027 adult birds per year based on the published adult mortality rate of 6.1% (Horswill and Robinson, 2015).

9.33.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2307. The mean maximum foraging range of guillemot is 73.2km (±80.5km) and the maximum recorded foraging range is 338km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of guillemot from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 84.2km (±50.1km) based on data from six sites. The updated review of Woodward *et al.* (2019), based on 16 sites, gives a smaller mean maximum foraging range.

2308. Foula SPA is located approximately 775km from SEP and DEP. This means that guillemots from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season are therefore apportioned to birds breeding at this colony.

2309. Outside the breeding season, breeding guillemots from the SPA are assumed to range widely and to mix with guillemots of all ages from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 1,617,306 individuals (August to February) (Furness, 2015). During the non-breeding season, it is estimated that 1.4% of birds present are considered to be breeding adults from Foula SPA, and impacts are apportioned accordingly. This is based on the SPA adult population from Furness (2015) as a proportion of the total UK North Sea and Channel BDMPS.

9.33.3.1.3 Potential Effects on the Qualifying Feature

2310. The guillemot qualifying feature of Foula SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement / barrier effects during the non-breeding season.

9.33.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.33.3.1.4.1 Operational Phase Displacement / Barrier Effects

2311. Population estimates of guillemot at SEP, DEP, and SEP and DEP together by biologically relevant season are provided in **Table 9-230**, **Table 9-231**, and **Table**

9-232, respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult guillemots that belong to the Foula SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2312. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Section 9.15.3.3.4.1**) is also relevant to the Foula SPA population. The full range of recommended displacement and mortality effects are considered in the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1%, respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-230: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Guillemots at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	5,817 (b) 24,511 (nb) 30,328 (year round)	0 (b) 343 (nb) 343 (year round)	1 - 24 (2)	0.05 - 1.18 (0.08)
Mean	3,839 (b) 14,887 (nb) 18,726 (year round)	0 (b) 208 (nb) 208 (year round)	1 - 15 (1)	0.03 - 0.72 (0.05)
Lower 95% CI	2,376 (b) 7,827 (nb) 10,203 (year round)	0 (b) 110 (n) 110 (year round)	0 - 8 (1)	0.02 - 0.38 (0.03)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Foula SPA breeding adults. For non-breeding season, assumes 1.4% of birds are Foula SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Foula SPA breeding adults (33,230 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-231: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Guillemots at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	1,868 (b) 1,569 (nb) 3,347 (year round)	0 (b) 22 (nb) 22 (year round)	0 - 2 (0)	0.00 - 0.08 (0.01)
Mean	1,095 (b) 1,085 (nb) 2,180 (year round)	0 (b) 15 (nb) 15 (year round)	0 - 1 (0)	0.00 - 0.05 (0.00)
Lower 95% CI	592 (b) 661 (nb) 1,253 (year round)	0 (b) 9 (nb) 9 (year round)	0 - 1 (0)	0.00 - 0.03 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Foula SPA breeding adults. For non-breeding season, assumes 1.4% of birds are Foula SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Foula SPA breeding adults (33,230 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)

Table 9-232: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Guillemots at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	7,685 (b) 26,080 (nb) 33,765 (year round)	0 (b) 365 (nb) 365 (year round)	1 - 26 (2)	0.05 - 1.26 (0.09)
Mean	4,934 (b) 15,972 (nb) 20,906 (year round)	0 (b) 224 (nb) 224 (year round)	1 - 16 (1)	0.03 - 0.77 (0.06)
Lower 95% CI	2,968 (b) 8,488 (nb) 11,456 (year round)	0 (b) 119 (nb) 119 (year round)	0 - 8 (1)	0.02 - 0.41 (0.03)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Mar-Jul), assumes 0% of birds are Foula SPA breeding adults. For non-breeding season, assumes 1.4% of birds are Foula SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
4. Background population is Foula SPA breeding adults (33,230 individuals), adult age class annual mortality rate of 6.1% (Horswill and Robinson, 2015)				

2313. Based on the mean peak abundances, the annual total of guillemots from Foula SPA at risk of displacement from SEP and DEP together is 224 birds (**Table 9-232**); 208 at DEP (**Table 9-230**) and 15 at SEP (**Table 9-231**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, 0.6 to 14.6 SPA breeding adults would be predicted to die each year due to displacement from DEP and 0.0 to 1.1 birds due to displacement at SEP.

2314. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within the SPA breeding adult population would increase by 0.72% due to impacts at DEP and 0.05% due to impacts at SEP (0.77% due to SEP and DEP together). Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, annual mortality in the population would instead increase by 0.05% due to impacts at DEP (1.0 birds), less than 0.01% due to impacts at SEP (0.1 birds) and 0.06% due to the impacts of SEP and DEP together (1.1 birds).

2315. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 18.8% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2316. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of recommended displacement and mortality rates when the mean peak abundance estimate assessments are considered.

2317. Mortality rate increases of over 1% are only predicted if the upper 95% CIs for mean peak abundances are used as inputs to the assessment alongside a mortality rate for displaced birds of 10% combined with a displacement rate of 0.600 or more. The probability of such events occurring is extremely small for two reasons. Firstly, the upper 95% CI for the mean peak abundances are highly unlikely to occur regularly at DEP or SEP. Secondly, a displacement rate of 0.600 and mortality rate of 10% are higher than evidence suggests will actually be the case. The use of evidence-based displacement (0.500) and mortality rate (1%) would result in a mortality increase of substantially less than 1%.

2318. **It is concluded that predicted guillemot mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of Foula SPA.**

2319. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.33.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.33.3.1.5.1 Operational Phase Displacement / Barrier Effects

2320. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding guillemot population of the Foula SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the vast majority of foraging activity of guillemot from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2321. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, 256,401 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-110**). Of the birds at risk of displacement, 3,590 are estimated to belong to Foula SPA, assuming 1.4% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to Foula SPA are presented in **Table 9-233**.

Table 9-233: In-Combination Year Round Displacement Matrix for Guillemot from Foula SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
Displacement (%)		1	2	3	4	5	10	20	30	50	80	100
	10	4	7	11	14	18	36	72	108	180	287	359
	20	7	14	22	29	36	72	144	215	359	574	718
	30	11	22	32	43	54	108	215	323	539	862	1077
	40	14	29	43	57	72	144	287	431	718	1149	1436
	50	18	36	54	72	90	180	359	539	898	1436	1795
	60	22	43	65	86	108	215	431	646	1077	1723	2154
	70	25	50	75	101	126	251	503	754	1257	2010	2513
	80	29	57	86	115	144	287	574	862	1436	2298	2872
	90	32	65	97	129	162	323	646	969	1616	2585	3231
	100	36	72	108	144	180	359	718	1077	1795	2872	3590

2322. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 251 breeding adult SPA birds would be lost to displacement each non-breeding season (and therefore annually). This would increase the existing mortality within the SPA population (2,027 breeding adult birds per year) by 12.40%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 18 birds. This would increase the existing mortality within this population by 0.89%.

2323. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that detectable changes in mortality rates will not occur due to the level or mortality predicted if the more realistic worst case rates for mortality are used.

2324. **It is concluded that predicted guillemot mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Foula SPA.**

9.33.3.2 Puffin

9.33.3.2.1 Status

2325. The Foula SPA breeding puffin population at classification was 96,000 individuals (SNH, 2009a). The most recent published count was 6,351 individuals in 2016 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 597 adult birds per year based on this reference population and the published adult mortality rate of 9.4% (Horswill and Robinson, 2015).

9.33.3.2.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2326. The mean maximum foraging range of puffin is 137.1km (±128.3km) and the maximum foraging range is 383km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of puffin from the previous industry standard review of seabird foraging ranges, Thaxter *et al.* (2012), was 105.4km (±46.0km) based on data from eight studies. The updated review of Woodward *et al*. (2019), based on five studies across seven breeding sites, therefore gives an increased mean maximum foraging range.

2327. SEP and DEP are located approximately 780km from the Foula SPA boundary at the nearest point. This means that puffins from this SPA are beyond the maximum foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2328. Outside the breeding season, breeding puffins from the SPA are assumed to range widely and to mix with puffins of all age classes from breeding colonies in the UK and further afield. The relevant non-breeding season reference population is the UK North Sea and Channel BDMPS, consisting of 231,957 individuals (mid-August to March) (Furness, 2015). During the non-breeding season, it is estimated that 2.9% of birds present are considered to be breeding adults from the Foula SPA. This is based on the SPA adult population as a proportion of the UK North Sea and Channel BDMPS, and impacts are apportioned accordingly. However, in Furness (2015), the puffin population of the Foula SPA was estimated to be approximately 45,000 breeding adults. This means that between 2000, when that count was undertaken, and the count of 2016, the population decreased sevenfold. Therefore, the Foula SPA is in reality likely to make up far less than 2.9% of the UK North Sea and Channel BDMPS.

9.33.3.2.3 Potential Effects on the Qualifying Feature

2329. The puffin qualifying feature of the Foula SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement/barrier effects during the non-breeding season.

9.33.3.2.4 Potential Effects of SEP and DEP in Isolation and Together

9.33.3.2.4.1 Operational Phase Displacement / Barrier Effects

2330. Population estimates of puffin at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-234**, **Table 9-235** and **Table 9-236** respectively. The information to inform the Appropriate Assessment is presented alongside the population estimates. Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult puffins belonging to the Foula SPA population. An estimated annual mortality for the population is provided due to operational phase displacement, along with the increase of existing mortality that would occur through such an impact.

2331. Displacement rates of 0.300 to 0.700 are considered for this species, along with a range of mortality rates of 1% to 10% of displaced birds (UK SNCBs, 2017). The available evidence suggests that the upper ranges of these displacement and mortality rates may be excessively precautionary. The evidence reviewed in the Appropriate Assessment for the Flamborough and Filey Coast SPA with respect to other auk species (**Section 9.15.3.3.4.1**) is also relevant to this population. The full range of recommended displacement and mortality effects are considered by the assessment, along with evidence-based displacement and mortality rates of 0.500 and 1% respectively (APEM, 2022; MacArthur Green, 2019c).

Table 9-234: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Puffins at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of FFC SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 58 (nb) 58 (year round)	0 (b) 2 (nb) 2 (year round)	0 - 0 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 22 (nb) 22 (year round)	0 (b) 1 (nb) 1 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Foula SPA breeding adults. For non-breeding season, assumes 2.9% of birds are Foula SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Foula SPA breeding adults (6,351 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)

Table 9-235: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Puffins at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of FFC SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 23 (nb) 23 (year round)	0 (b) 1 (nb) 0 (year round)	0 - 1 (0)	0.00 - 0.01 (0.00)
Mean	0 (b) 11 (nb) 11 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb)	0 (b) 0 (nb)	0 - 0 (0)	0.00 - 0.00 (0.00)

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of FFC SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	0 (year round)	0 (year round)		

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Foula SPA breeding adults. For non-breeding season, assumes 2.9% of birds are Foula SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Foula SPA breeding adults (6,351 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)

Table 9-236: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Puffins at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of FFC SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 80 (nb) 80 (year round)	0 (b) 3 (nb) 3 (year round)	0 - 1 (0)	0.00 - 0.03 (0.00)
Mean	0 (b) 32 (nb) 32 (year round)	0 (b) 1 (nb) 1 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)
Lower 95% CI	0 (b) 0 (nb) 0 (year round)	0 (b) 0 (nb) 0 (year round)	0 - 0 (0)	0.00 - 0.00 (0.00)

Notes
1. Breeding season = b, non-breeding season = nb

2. For breeding season (Apr-early Aug), assumes 0% of birds are Foula SPA breeding adults. For non-breeding season, assumes 2.9% of birds are Foula SPA breeding adults.

3. Assumes displacement rates of 0.300 to 0.700 and mortality rate of 1% to 10% of displaced birds. Evidence-based estimates assuming a 0.500 displacement rate and 1% mortality of displaced birds are presented in parentheses.

4. Background population is Foula SPA breeding adults (6,351 individuals), adult age class annual mortality rate of 9.4% (Horswill and Robinson, 2015)

2332. Based on the mean peak abundances, the annual total of puffins from the Foula SPA at risk of displacement from SEP and DEP together is 1 birds (**Table 9-236**); 1 at DEP (**Table 9-234**) and 0 at SEP (**Table 9-235**). At displacement rates of 0.300 to 0.700, and mortality rates of 1% to 10% for displaced birds, less than one (0.00 -

0.06) SPA breeding adult would be predicted to die each year due to displacement from SEP and DEP together. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by <0.01% due to impacts at SEP and DEP together.

2333. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under any combination of displacement and mortality rates when either the mean peak abundance estimate assessments, or those using the upper 95% CI of mean peak abundance are considered.

2334. **It is concluded that predicted puffin mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Foula SPA.**

2335. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species is not regarded as being highly specialised in its habitat requirements (Bradbury *et al.*, 2014; Furness and Wade, 2012; Garthe and Hüppop, 2004), and it is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the evidence-based displacement and mortality rates are used.

9.33.3.2.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.33.3.2.5.1 Operational Phase Displacement / Barrier Effects

2336. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding puffin population of the Foula SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the vast majority of foraging activity of puffin from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2337. The cumulative impact assessment presented in the Hornsea Project Four OWF (APEM, 2021), plus impacts from SEP and DEP, indicates that during the non-breeding season, 45,017 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. Of the birds at risk of displacement, 1,310 are estimated to belong to the Foula SPA, assuming 2.9% of birds of the total BDMPS belong to the breeding population of this SPA (Furness, 2015).

2338. Puffin was screened out of the EIA for SEP and DEP due to the low abundance of this species in the SEP and DEP wind farm sites and 2km buffers. In total, zero and one bird from this SPA population was present at SEP and DEP respectively.

2339. In total therefore, 1,311 breeding adult puffins from Foula SPA are at risk of in-combination OWF annually. Displacement and mortality rates of birds belonging to the Foula SPA are presented in **Table 9-237**.

Table 9-237: In-Combination Year Round Displacement Matrix for Puffin from Foula SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	1	3	4	5	7	13	26	39	66	105	131
	20	3	5	8	10	13	26	52	79	131	210	262
	30	4	8	12	16	20	39	79	118	197	315	393
	40	5	10	16	21	26	52	105	157	262	420	524
	50	7	13	20	26	33	66	131	197	328	524	656
	60	8	16	24	31	39	79	157	236	393	629	787
	70	9	18	28	37	46	92	184	275	459	734	918
	80	10	21	31	42	52	105	210	315	524	839	1049
	90	12	24	35	47	59	118	236	354	590	944	1180
	100	13	26	39	52	66	131	262	393	656	1049	1311

2340. Assuming a displacement rate of 0.700 and a mortality rate of 10% of displaced birds, 92 breeding adult SPA birds would be lost to displacement each non-breeding season (and therefore annually). This would increase the mortality within this population by 15.37%. Using an evidence-based displacement rate of 0.500, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 7 birds. This would increase the mortality within this population by 1.10%. However, this is likely a considerable overestimate, due to the different between the latest population estimate of the Foula SPA, and that used by Furness (2015). It is expected that the actual mortality increase due to in-combination operational OWF displacement is between 0.1% and 0.2%, based on the sevenfold population reduction between 2000 and the latest count in 2016.

2341. In addition to the relatively low increase in annual mortality predicted due to the impact of operational phase displacement, the predicted impacts of SEP and DEP in isolation and together on the breeding adult puffin population of the Foula SPA are small relative to the overall impact (**Table 9-236**). It is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2342. **It is concluded that predicted puffin mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Foula SPA.**

9.33.3.3 Red-Throated Diver

9.33.3.3.1 Status

2343. The SPA breeding population at classification was 11 pairs, or 22 breeding adults (SNH, 2009i). Furness (2015) gives an estimate of 12 pairs, or 24 breeding adults, in 2013. This is used as the reference population by the assessment. Based on the latest SPA population estimate, and an annual breeding adult baseline mortality rate of 16.0%, (Horswill and Robinson, 2015), four breeding adults from the SPA population would be expected to die each year.

9.33.3.3.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2344. The mean maximum foraging range of red-throated diver is 9km (±0km), as is the maximum foraging range (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of red-throated diver from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was identical. There is very little information available on this subject, with just one study identified by the above reviews.

2345. The Foula SPA is located approximately 780km from SEP and DEP. This means that red-throated divers from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2346. Outside the breeding season, breeding red-throated divers from the SPA are assumed to range widely and to mix with red-throated divers of all ages from breeding colonies in the UK and further afield. The relevant background population during the autumn and spring migration seasons is the UK North Sea BDMPS, consisting of 13,277 individuals during autumn and spring passage periods (September to November and February to April) (Furness, 2015). The relevant background population during the winter season is the SW North Sea BDMPS, consisting of 10,177 individuals (Furness, 2015).

2347. During the spring and autumn migration seasons, it is estimated that 0.2% of birds present are considered to be breeding adults from Foula SPA. The corresponding value during the winter season is 0.05%. Impacts are apportioned accordingly during these seasons. This is based on the SPA adult population from Furness (2015) as a proportion of the total relevant BDMPS.

9.33.3.3.3 Potential Effects on the Qualifying Feature

2348. The red-throated diver qualifying feature of the Foula SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement and barrier effects.

9.33.3.3.4 Potential Effects of SEP and DEP in Isolation and Together

9.33.3.3.4.1 Operational Phase Displacement / Barrier Effects

2349. Population estimates of red-throated diver at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-238**, **Table 9-239** and **Table 9-240** respectively.

2350. Red-throated divers have a very high sensitivity to disturbance and displacement from operational OWFs. The majority of birds present before OWFs are constructed are displaced by the operation of OWFs. It is expected (based on expert opinion), that this is due to a combination of anthropogenic activities (mainly vessel movements), as well as the presence of OWF infrastructure. A large body of work investigating the effects of displacement of red-throated divers due to operational OWFs exists (Dorsch *et al.*, 2020; Elston *et al.*, 2016; Gill *et al.*, 2018; Heinänen and Skov, 2018; Hi Def Aerial Surveying, 2017; Irwin *et al.*, 2019; MacArthur Green and Royal HaskoningDHV, 2021b; McGovern *et al.*, 2016; Mendel *et al.*, 2019; NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017; Petersen *et al.*, 2014, 2006; Vilela *et al.*, 2020; Welcker and Nehls, 2016).

2351. There is a high degree of concordance of the available literature with respect to effects of operation of OWFs on red-throated diver distribution and abundance within OWFs. There is also a high degree of concordance that displacement effects extend beyond OWF boundaries. However, there is considerable variation with respect to the distance at which this effect remains detectable. Studies within the UK have ranged from no significant displacement effects being reported (McGovern *et al.*, 2016), displacement effects being restricted to 1km to 2km of an OWF (NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017), to clear displacement effects across many years. These effects have been reported extending to 7km from OWFs (MacArthur Green and Royal HaskoningDHV, 2021b), 9km from OWFs (Elston *et al*., 2016; Hi Def Aerial Surveying, 2017), and beyond, though not all evidence was available to be referenced by this assessment. Studies from other countries have also recorded variable displacement distances, ranging from 1.5km to 2km (Welcker and Nehls, 2016) to 10km and beyond (Dorsch *et al*., 2020; Vilela *et al*., 2020). Displacement effects were detectable up to 20km from OWFs in one case.

2352. There is also concordance in the studies reviewed that displacement effects on red-throated diver due to operational OWFs occur on a gradient, with the strongest effects observed either within, or close to OWFs. As the distance from the OWF increases, the magnitude of the effect reduces, until a distance is reached at which the effect is no longer detectable.

2353. No study to date has managed to provide insight into whether changes in red-throated diver distribution at any spatial scale have the potential to result in population level effects, either at local, regional, national or international levels. Red-throated divers are capable of utilising a range of marine habitats and prey species (Dierschke *et al*., 2017; Guse *et al*., 2009; Kleinschmidt *et al*., 2016). Recent data from the Outer Thames Estuary SPA indicate that birds are much more commonly recorded in water depths of less than 20m (Irwin *et al*., 2019). During the non-breeding season, red-throated divers are mostly widely dispersed, at densities often less than four birds per km2 (Dierschke *et al*., 2017), and are highly mobile (Dorsch *et al*., 2020; Duckworth *et al*., 2020). In some instances, home ranges of many thousands of square kilometres have been demonstrated (Nehls *et al*., 2018). This implies that following displacement, red-throated divers will be able to find alternative foraging sites, in some cases distant from the original area of displacement, which may already have been part of their existing non-breeding season range. It seems likely that in the vast majority of cases, mortality is not a consequence of displacement.

2354. Displacement rates of 1.000, along with a range of mortality rates of 1% to 10% of displaced birds is considered for this species at this SPA (UK SNCBs, 2017). Since the aerial survey study area covered SEP and DEP plus a 4km buffer, this is the maximum extent of the buffer that can be incorporated into the assessment. Whilst there are other data sources that could be used in the assessment, they predict much lower numbers of birds to be present than the baseline data, as evidenced by work carried out within **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). This assessment therefore focuses on the baseline survey data.

2355. Natural England has previously advised other OWF projects that for the assessment of red-throated diver operational displacement, a displacement rate of 1.000 within the OWF and 4km buffer and a mortality rate of up to 10% for displaced birds is used. However, during the baseline surveys, when SOW and DOW were both operational, red-throated divers were observed within 4km of both OWFs (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). This indicates that the suggestion of 100% displacement within this distance of these OWFs is an overestimate in this case.

2356. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult red-throated divers belonging to the Foula SPA population is presented in **Table 9-238** (DEP), **Table 9-239** (SEP) and **Table 9-240** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult red-throated divers belonging to the Foula SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-238: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Red-Throated Divers at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of Foula SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 59 (aut) 15 (win) 76 (spr)	0 (b) 0 (aut) 0 (win) 0 (spr)	0 - 0	0.06 - 0.63

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of Foula SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
	150 (year round)	0 (year round)		
Mean	0 (b) 31 (aut) 5 (win) 54 (spr) 90 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.04 - 0.39
Lower 95% CI	0 (b) 8 (aut) 0 (win) 33 (spr) 40 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.02 - 0.18
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 0.2% of birds are Foula SPA breeding adults. For winter season, assumes 0.05% of birds are Foula SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is Foula SPA breeding adults (24 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)				

Table 9-239: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Red-Throated Divers at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of Foula SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 137 (aut) 15 (win) 463 (spr) 615 (year round)	0 (b) 0 (aut) 0 (win) 1 (spr) 1 (year round)	0 - 0	0.27 - 2.73
Mean	0 (b) 75 (aut) 5 (win) 191 (spr) 271 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.12 - 1.21
Lower 95% CI	0 (b) 30 (aut) 0 (win) 29 (spr) 59 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.03 - 0.27
Notes				

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of Foula SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 0.2% of birds are Foula SPA breeding adults. For winter season, assumes 0.05% of birds are Foula SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is Foula SPA breeding adults (24 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)				

Table 9-240: Predicted Operational Phase Displacement and Mortality of Foula SPA Breeding Adult Red-Throated Divers at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of Foula SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 196 (aut) 30 (win) 539 (spr) 765 (year round)	0 (b) 0 (aut) 0 (win) 1 (spr) 1 (year round)	0 - 0	0.24 - 2.43
Mean	0 (b) 106 (aut) 10 (win) 245 (spr) 361 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.11 - 1.11
Lower 95% CI	0 (b) 37 (aut) 0 (win) 162 (spr) 199 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.03 - 0.28
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 0.2% of birds are Foula SPA breeding adults. For winter season, assumes 0.05% of birds are Foula SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is Foula SPA breeding adults (24 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)				

2357. Based on the mean peak abundances, the annual total of red-throated divers from the Foula SPA at risk of displacement from SEP and DEP together is less than one bird (**Table 9-240**). At a displacement rate of 1.000, and mortality rates of 1% to 10% for displaced birds, zero to 0.01 SPA breeding adults would be predicted to die each year due to displacement from DEP, and zero to 0.05 birds due to displacement from SEP.

2358. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.39% due to impacts at DEP, and 1.21% due to impacts at SEP (1.11% due to SEP and DEP together). Using what is thought to be a more reasonable worst case scenario of 1% mortality, annual mortality in the Foula SPA breeding adult red-throated diver population would increase by 0.04% due to impacts at DEP, 0.12% due to impacts at SEP, and 0.16% due to the impacts of SEP and DEP together.

2359. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under realistic worst case displacement and mortality rates when the mean peak or upper 95% CIs for mean peak abundance estimate assessments are considered.

2360. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 15.1% higher at DEP-N than DEP as a whole, though the sample size of birds recorded in DEP as a whole (43 birds) was so small that differences between DEP-N and DEP-S are unlikely to be statistically significant. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2361. **It is concluded that predicted red-throated diver mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Foula SPA.**

2362. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species has been demonstrated to be highly mobile during the non-breeding season, and individuals frequently possess very large home ranges during this time (Dorsch *et al.*, 2020; Nehls *et al.*, 2018). It is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the realistic worst case displacement and mortality rates are used.

9.33.3.3.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.33.3.3.5.1 Operational Phase Displacement / Barrier Effects

2363. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding red-throated diver population of the Foula SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the foraging activity of red-throated diver from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2364. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, approximately 3,180 birds belonging to the UK North Sea BDMPS are at risk of displacement from OWFs in the North Sea (**ES Chapter 11, Offshore Ornithology** (document reference 6.1.11)). Of the birds at risk of displacement, 5 are estimated to belong to the Foula SPA, assuming up to 0.2% of birds of the total BDMPS during the spring and autumn migration seasons, and 0.05% of birds of the total BDMPS during the belong to the breeding population of this SPA during the winter (Furness, 2015). Displacement and mortality rates of birds belonging to the Foula SPA are presented in **Table 9-241**.

Table 9-241: In-Combination Year Round Displacement Matrix for Red-Throated Diver from Foula SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	1	1
	30	0	0	0	0	0	0	0	0	1	1	1
	40	0	0	0	0	0	0	0	1	1	1	2
	50	0	0	0	0	0	0	0	1	1	2	2
	60	0	0	0	0	0	0	1	1	1	2	3
	70	0	0	0	0	0	0	1	1	2	3	3
	80	0	0	0	0	0	0	1	1	2	3	4
	90	0	0	0	0	0	0	1	1	2	3	4
	100	0	0	0	0	0	0	1	1	2	4	5

2365. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, less than one (0.46) breeding adult SPA birds would be lost to displacement annually. This would increase the existing mortality within the SPA population (16 breeding adult birds per year) by 11.95%. Using a displacement rate of 1.000, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be 0.05 birds. This would increase the existing mortality within this population by 1.20%.

2366. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that detectable changes in mortality rates could occur due to the level or mortality predicted if the more realistic worst case rates for mortality are used. However, the numbers of birds predicted to be displacement is small (i.e. less than a single bird annually). It is also anticipated that displacement and mortality rates may be considerably lower than those considered by this assessment. Finally, it is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2367. **It is concluded that predicted red-throated diver mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Foula SPA**.

9.34 Papa Stour SPA

9.34.1 Description of Designation

2368. Papa Stour SPA is a small island off the western tip of Shetland. Most of the island is covered by lichen-rich heath, which has developed on substrates which formerly consisted of peat and turf. There are also several small lochs scattered around the heathland. The coastline is mainly cliff.

9.34.2 Conservation Objectives

2369. The overarching conservation objectives of the site are as follows:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.34.3 Appropriate Assessment

2370. The only qualifying species from this SPA that is screened into the Appropriate Assessment is breeding Arctic tern (**Table 5-2**).

9.34.3.1 Arctic tern

9.34.3.1.1 Status

2371. The SPA breeding population at classification was 850 pairs or 1,700 breeding adults, for the period 1994 to 1995 (Natural England, 2017a). The most recent count was 94 pairs, or 188 breeding adults, in 2018 (JNCC, 2022). This is used as the reference population for the assessment. The baseline mortality of this population is 31 breeding adult birds per year based on the published adult mortality rate of 16.3% (Horswill and Robinson, 2015).

9.34.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2372. The mean maximum foraging range of Arctic tern is 25.7km (±14.8km) and the maximum foraging range is 46km (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of Arctic tern from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 24.2km (±6.3km) based on data from four sites. The updated review of Woodward *et al*. (2019), based on five studies at nine sites, gives a smaller mean maximum foraging range.

2373. The Papa Stour SPA is located approximately 795km from SEP and DEP. This means that SEP and DEP are beyond the maximum recorded foraging range for this species from this SPA. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2374. During the pre and post breeding periods, breeding Arctic terns from the Papa Stour SPA migrate through UK waters. The relevant reference population is the UK North Sea and Channel BDMPS, consisting of 163,930 individuals during autumn migration (July to early September) and spring migration (late April to May) (Furness, 2015). During these seasons it is estimated that 1.3% of birds present are breeding adults from the Papa Stour SPA, and impacts are apportioned accordingly. This is based on the SPA population as a proportion of the UK North Sea and Channel BDMPS.

9.34.3.1.3 Potential Effects on the Qualifying Feature

2375. The Arctic tern qualifying feature of the Papa Stour SPA has been screened into the Appropriate Assessment due to the potential risk of collision.

9.34.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.34.3.1.4.1 Collision Risk

2376. Information to inform the Appropriate Assessment for collision risk on breeding adult Arctic terns belonging to the Papa Stour SPA population is presented in **Table 9-242**. Collision estimates are presented by month. The avoidance rate used was 0.980, as recommended by the statutory guidance (UK SNCBs, 2014). Other input parameters were agreed with Natural England during the ETG process and are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

2377. Based on the mean collision rates, the annual total of breeding adult Arctic terns from the Papa Stour SPA at risk of collision at SEP and DEP together is <0.01. This would increase the existing mortality of the SPA breeding population by <0.01%.

Table 9-242: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Arctic Tern at SEP and DEP Apportioned to Papa Stour SPA

Site	Variable[1]		J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Avoidance Rate	-2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
		+2 SD	-	-	-	-	-	-	-	-	-	-	-	-	-
	Noct. Act.	EB	-	-	-	-	-	-	-	-	-	-	-	-	-
Notes															

Site	Variable[1]	J	F	M	A[2]	M[2]	J	J[2]	A[2]	S[2]	O	N	D	Total
1. No variation around flight height distribution or avoidance rate was available, so CRM not carried out. Nocturnal activity set at 2% of daytime activity. 2. For autumn migration season (Jul-Sept) and spring migration season (Apr-May), assumes 1.3% of adult birds are Papa Stour SPA breeders (Furness 2015). For breeding season (May-Aug), assumes 0% of adult birds are Papa Stour SPA breeders														

2378. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur on this population whether the mean monthly density estimates for SEP and DEP or the upper 95% CIs of these density estimates are used as an input into the CRM. The maximum predicted mortality increase that could occur in the population is <0.01% due to the collision impacts of SEP and DEP together.

2379. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Papa Stour SPA.**

2380. The confidence in the assessment is high (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or upper 95% CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

9.34.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.34.3.1.5.1 Collision Risk

2381. The predicted impacts of SEP and DEP in isolation and together on the breeding adult Arctic tern population of the Papa Stour SPA are extremely small (i.e. virtually zero) (**Table 9-242**). Potential in-combination effects of OWF collision on Arctic tern have not been investigated quantitatively. However, the low flight heights that are generally used by this species ("Corrigendum," 2014; Johnston *et al*., 2014), particularly during migration (Hedenström and Åkesson, 2016), indicate that the possibility of a substantial cumulative impact on this species is unlikely.

2382. During the breeding season, no OWFs are within mean maximum foraging range plus one standard deviation of this SPA, therefore no breeding season impacts on this qualifying feature are predicted.

2383. Outside the breeding season, there is potential for other OWFs to impact this qualifying feature during the spring and autumn migration seasons. However, a review of other OWF assessments has not revealed any OWFs where substantial impacts on this species are predicted during these seasons. As approximately just 1.3% of migration season impacts on this species would be apportioned to this SPA population (Furness, 2015), it is considered unlikely that in-combination effects on this qualifying feature will occur to the level where an adverse effect on the integrity of the site would be possible.

2384. **It is concluded that predicted Arctic tern mortality due to collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Papa Stour SPA.**

9.35 Ronas Hill – North Roe and Tingon SPA

9.35.1 Description of Designation

2385. The Ronas Hill - North Roe and Tingon SPA comprises two adjacent headlands separated by Ronas Voe in the north of Mainland Shetland. The open landscape of heath, bog, pools and lochans supports an important assemblage of breeding birds.

9.35.2 Conservation Objectives

2386. The overarching conservation objectives of the site are as follows:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
    - Population of the species as a viable component of the site;
    - Distribution of the species within site;
    - Distribution and extent of habitats supporting the species;
    - Structure, function and supporting processes of habitats supporting the species; and
    - No significant disturbance of the species.

9.35.3 Appropriate Assessment

2387. The qualifying species from this SPA that are screened into the Appropriate Assessment are breeding red-throated diver (**Table 5-2**).

9.35.3.1 Red-Throated Diver

9.35.3.1.1 Status

2388. The SPA breeding population at classification was 56 pairs, or 112 breeding adults (SNH, 1997). Furness (2015) gives an estimate of 50 pairs, or 100 breeding adults, in 2006. This is used as the reference population by the assessment. Based on the latest SPA population estimate, and an annual breeding adult baseline mortality rate of 16.0% (Horswill and Robinson, 2015), 16 breeding adults from the SPA population would be expected to die each year.

9.35.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2389. The mean maximum foraging range of red-throated diver is 9km (±0km), as is the maximum foraging range (Woodward *et al.*, 2019). The mean maximum breeding season foraging range of red-throated diver from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was identical. There is very little information available on this subject, with just one study identified by the above reviews.

2390. Ronas Hill - North Roe and Tingon SPA is located approximately 820km from SEP and DEP. This means that red-throated divers from this SPA are beyond the maximum recorded foraging range for this species. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2391. Outside the breeding season, breeding red-throated divers from the SPA are assumed to range widely and to mix with red-throated divers of all ages from breeding colonies in the UK and further afield. The relevant background population during the autumn and spring migration seasons is the UK North Sea BDMPS, consisting of 13,277 individuals during autumn and spring passage periods (September to November and February to April) (Furness, 2015). The relevant background population during the winter season is the SW North Sea BDMPS, consisting of 10,177 individuals (Furness, 2015).

2392. During the spring and autumn migration seasons, it is estimated that 0.7% of birds present are considered to be breeding adults from Ronas Hill - North Roe and Tingon SPA. The corresponding value during the winter season is 0.2%. Impacts are apportioned accordingly during these seasons. This is based on the SPA adult population from Furness (2015) as a proportion of the total relevant BDMPS.

9.35.3.1.3 Potential Effects on the Qualifying Feature

2393. The red-throated diver qualifying feature Ronas Hill – North Roe and Tingon SPA has been screened into the Appropriate Assessment due to the potential risk of operational phase displacement and barrier effects.

9.35.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.35.3.1.4.1 Operational Phase Displacement / Barrier Effects

2394. Population estimates of red-throated diver at SEP, DEP and SEP and DEP together by biologically relevant season are provided in **Table 9-243**, **Table 9-244** and **Table 9-245** respectively.

2395. Red-throated divers have a very high sensitivity to disturbance and displacement from operational OWFs. The majority of birds present before OWFs are constructed are displaced by the operation of OWFs. It is expected (based on expert opinion), that this is due to a combination of anthropogenic activities (mainly vessel movements), as well as the presence of OWF infrastructure. A large body of work investigating the effects of displacement of red-throated divers due to operational

OWFs exists (Dorsch *et al.*, 2020; Elston *et al.*, 2016; Gill *et al.*, 2018; Heinänen and Skov, 2018; Hi Def Aerial Surveying, 2017; Irwin *et al.*, 2019; MacArthur Green and Royal HaskoningDHV, 2021b; McGovern *et al.*, 2016; Mendel *et al.*, 2019; NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017; Petersen *et al.*, 2014, 2006; Vilela *et al.*, 2020; Welcker and Nehls, 2016).

2396. There is a high degree of concordance of the available literature with respect to effects of operation of OWFs on red-throated diver distribution and abundance within OWFs. There is also a high degree of concordance that displacement effects extend beyond OWF boundaries. However, there is considerable variation with respect to the distance at which this effect remains detectable. Studies within the UK have ranged from no significant displacement effects being reported (McGovern *et al*., 2016), displacement effects being restricted to 1km to 2km of an OWF (NIRAS Consulting, 2016; Percival, 2014; Percival and Ford, 2017), to clear displacement effects across many years. These effects have been reported extending to 7km from OWFs (MacArthur Green and Royal HaskoningDHV, 2021b), 9km from OWFs (Elston *et al*., 2016; Hi Def Aerial Surveying, 2017), and beyond, though not all evidence was available to be referenced by this assessment. Studies from other countries have also recorded variable displacement distances, ranging from 1.5km to 2km (Welcker and Nehls, 2016) to 10km and beyond (Dorsch *et al*., 2020; Vilela *et al*., 2020). Displacement effects were detectable up to 20km from OWFs in one case.

2397. There is also concordance in the studies reviewed that displacement effects on red-throated diver due to operational OWFs occur on a gradient, with the strongest effects observed either within, or close to OWFs. As the distance from the OWF increases, the magnitude of the effect reduces, until a distance is reached at which the effect is no longer detectable.

2398. No study to date has managed to provide insight into whether changes in red-throated diver distribution at any spatial scale have the potential to result in population level effects, either at local, regional, national or international levels. Red-throated divers are capable of utilising a range of marine habitats and prey species (Dierschke *et al*., 2017; Guse *et al*., 2009; Kleinschmidt *et al*., 2016). Recent data from the Outer Thames Estuary SPA indicate that birds are much more commonly recorded in water depths of less than 20m (Irwin *et al*., 2019). During the non-breeding season, red-throated divers are mostly widely dispersed, at densities often less than four birds per km2 (Dierschke *et al*., 2017), and are highly mobile (Dorsch *et al*., 2020; Duckworth *et al*., 2020). In some instances, home ranges of many thousands of square kilometres have been demonstrated (Nehls *et al*., 2018). This implies that following displacement, red-throated divers will be able to find alternative foraging sites, in some cases distant from the original area of displacement, which may already have been part of their existing non-breeding season range. It seems likely that in the vast majority of cases, mortality is not a consequence of displacement.

2399. Displacement rates of 1.000, along with a range of mortality rates of 1% to 10% of displaced birds is considered for this species at this SPA (UK SNCBs, 2017). Since the aerial survey study area covered SEP and DEP plus a 4km buffer, this is the maximum extent of the buffer that can be incorporated into the assessment. Whilst there are other data sources that could be used in the assessment, they predict much lower numbers of birds to be present than the baseline data, as evidenced by work carried out within **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11). This assessment therefore focuses on the baseline survey data.

2400. Natural England has previously advised other OWF projects that for the assessment of red-throated diver operational displacement, a displacement rate of 1.000 within the OWF and 4km buffer and a mortality rate of up to 10% for displaced birds is used. However, during the baseline surveys, when SOW and DOW were both operational, red-throated divers were observed within 4km of both OWFs (**Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1)). This indicates that the suggestion of 100% displacement within this distance of these OWFs is an overestimate in this case.

2401. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult red-throated divers belonging to the Ronas Hill - North Roe and Tingon SPA population is presented in **Table 9-243** (DEP), **Table 9-244** (SEP) and **Table 9-245** (SEP and DEP). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult red-throated divers belonging to the Ronas Hill - North Roe and Tingon SPA population. An estimated annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-243: Predicted Operational Phase Displacement and Mortality of Ronas Hill - North Roe and Tingon SPA Breeding Adult Red-Throated Divers at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 59 (aut) 15 (win) 76 (spr) 150 (year round)	0 (b) 0 (aut) 0 (win) 1 (spr) 1 (year round)	0 - 0	0.06 - 0.61
Mean	0 (b) 31 (aut) 5 (win) 54 (spr) 90 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 1 (year round)	0 - 0	0.04 - 0.38
Lower 95% CI	0 (b) 8 (aut) 0 (win) 33 (spr) 40 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.02 - 0.18
Notes				

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 0.7% of birds are Ronas Hill - North Roe and Tingon SPA breeding adults. For winter season, assumes 0.2% of birds are Ronas Hill - North Roe and Tingon SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is Ronas Hill - North Roe and Tingon SPA breeding adults (100 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015).				

Table 9-244: Predicted Operational Phase Displacement and Mortality of Ronas Hill - North Roe and Tingon SPA Breeding Adult Red-Throated Divers at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 137 (aut) 15 (win) 463 (spr) 615 (year round)	0 (b) 1 (aut) 0 (win) 3 (spr) 4 (year round)	0 - 0	0.26 - 2.64
Mean	0 (b) 75 (aut) 5 (win) 191 (spr) 271 (year round)	0 (b) 1 (aut) 0 (win) 1 (spr) 2 (year round)	0 - 0	0.12 - 1.17
Lower 95% CI	0 (b) 30 (aut) 0 (win) 29 (spr) 59 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 0 (year round)	0 - 0	0.03 - 0.26
Notes 1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr 2. For autumn migration and spring migration seasons, assumes 0.7% of birds are Ronas Hill - North Roe and Tingon SPA breeding adults. For winter season, assumes 0.2% of birds are Ronas Hill - North Roe and Tingon SPA breeding adults. 3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds 4. Background population is Ronas Hill - North Roe and Tingon SPA breeding adults (100 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)				

Table 9-245: Predicted Operational Phase Displacement and Mortality of Ronas Hill - North Roe and Tingon SPA Breeding Adult Red-Throated Divers at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season[1]	Number of SPA breeding adults present by season[2]	Year round mortality range[3]	Year round annual baseline mortality increase range (%)[3,4]
Upper 95% CI	0 (b) 196 (aut) 30 (win) 539 (spr) 765 (year round)	0 (b) 1 (aut) 0 (win) 4 (spr) 5 (year round)	0 - 1	0.33 - 3.25
Mean	0 (b) 106 (aut) 10 (win) 245 (spr) 361 (year round)	0 (b) 1 (aut) 0 (win) 2 (spr) 2 (year round)	0 - 0	0.15 - 1.55
Lower 95% CI	0 (b) 37 (aut) 0 (win) 162 (spr) 199 (year round)	0 (b) 0 (aut) 0 (win) 0 (spr) 1 (year round)	0 - 0	0.04 - 0.44

Notes
1. Breeding season = b, autumn migration season = aut, winter season = win, spring migration season = spr

2. For autumn migration and spring migration seasons, assumes 0.7% of birds are Ronas Hill - North Roe and Tingon SPA breeding adults. For winter season, assumes 0.2% of birds are Ronas Hill - North Roe and Tingon SPA breeding adults.

3. Assumes displacement rates of 1.000 and mortality rate of 1% to 10% of displaced birds

4. Background population is Ronas Hill - North Roe and Tingon SPA breeding adults (100 individuals), adult age class annual mortality rate of 16.0% (Horswill and Robinson, 2015)

2402. Based on the mean peak abundances, the annual total of red-throated divers from the Ronas Hill - North Roe and Tingon SPA at risk of displacement from SEP and DEP together is three birds (**Table 9-245**); one at DEP (**Table 9-243**) and two at SEP (**Table 9-244**). At a displacement rate of 1.000, and mortality rates of 1% to 10% for displaced birds, zero to 0.1 SPA breeding adults would be predicted to die each year due to displacement from DEP, and zero to 0.2 birds due to displacement from SEP.

2403. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, annual mortality within this population would increase by 0.38% due to impacts at DEP, and 1.17% due to impacts at SEP (1.55% due to SEP and DEP together). Using what is thought to be a more reasonable worst case scenario of 1% mortality, annual mortality in the Ronas Hill - North Roe and Tingon SPA breeding adult red-throated diver population would increase by 0.04% due to impacts at DEP, 0.12% due to impacts at SEP, and 0.15% due to the impacts of SEP and DEP together.

2404. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 15.1% higher at DEP-N than DEP as a whole, though the sample size of birds recorded in DEP as a whole (43 birds) was so small that differences between DEP-N and DEP-S are unlikely to be statistically significant. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2405. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur under realistic worst case displacement and mortality rates when the mean peak or upper 95% CIs for mean peak abundance estimate assessments are considered.

2406. **It is concluded that predicted red-throated diver mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Ronas Hill - North Roe and Tingon SPA.**

2407. The confidence in the assessment is high for several reasons. Firstly, the evidence used to inform the evidence-based displacement rates is of high applicability and quality (based on the criteria discussed in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11)). Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. This species has been demonstrated to be highly mobile during the non-breeding season, and individuals frequently possess very large home ranges during this time (Dorsch *et al.*, 2020; Nehls *et al.*, 2018). It is therefore anticipated that displaced birds will find alternative habitat in the vast majority of cases. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population, provided the realistic worst case displacement and mortality rates are used.

9.35.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

9.35.3.1.5.1 Operational Phase Displacement / Barrier Effects

2408. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding red-throated diver population of the Ronas Hill - North Roe and Tingon SPA are anticipated to be very small, or even zero. This is because no OWFs are situated within mean maximum foraging range of the qualifying feature from the SPA. This means that the foraging activity of red-throated diver from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

2409. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the non-breeding season, approximately 3,180 birds belonging to the UK North Sea BDMPS are at risk of displacement from OWFs in the North Sea (**ES Chapter 11, Offshore Ornithology** (document reference 6.1.11)). Of the birds at risk of displacement, 18 are estimated to belong to the Ronas Hill - North Roe and Tingon SPA, assuming up to 0.7% of birds of the total BDMPS during the spring and autumn migration seasons belong to the breeding population of this SPA, and 0.2% of birds of the total BDMPS during the winter belong to the breeding population of this SPA (Furness, 2015). Displacement and mortality rates of birds belonging to the Ronas Hill - North Roe and Tingon SPA are presented in **Table 9-246**.

Table 9-246: In-Combination Year Round Displacement Matrix for Red-Throated Diver from Ronas Hill - North Roe and Tingon SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

		Mortality (%)										
		1	2	3	4	5	10	20	30	50	80	100
Displacement (%)	10	0	0	0	0	0	0	0	1	1	1	2
	20	0	0	0	0	0	0	1	1	2	3	4
	30	0	0	0	0	0	1	1	2	3	4	5
	40	0	0	0	0	0	1	1	2	4	6	7
	50	0	0	0	0	0	1	2	3	5	7	9
	60	0	0	0	0	1	1	2	3	5	9	11
	70	0	0	0	1	1	1	3	4	6	10	13
	80	0	0	0	1	1	1	3	4	7	12	14
	90	0	0	0	1	1	2	3	5	8	13	16
	100	0	0	1	1	1	2	4	5	9	14	18

2410. Assuming a displacement rate of 1.000 and a mortality rate of 10% of displaced birds, two breeding adult SPA birds would be lost to displacement annually. This would increase the existing mortality within the SPA population (16 breeding adult birds per year) by 11.25%. Using a realistic worst case displacement rate of 1.000, and a mortality rate for displaced birds of 1%, the annual in-combination displacement mortality would be <1 bird. This would increase the existing mortality within this population by 1.13%.

2411. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that detectable changes in mortality rates could occur due to the level or mortality predicted if the more realistic worst case rates for mortality are used. However, the numbers of birds predicted to be displacement is small (i.e. less than a single bird annually). It is also anticipated that displacement and mortality rates may be considerably lower than those considered by this assessment. Finally, it is considered that SEP and DEP do not contribute substantially to any in-combination impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2412. **It is concluded that predicted red-throated diver mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Ronas Hill - North Roe and Tingon SPA.**

9.36 Hermaness, Saxa Vord and Valla Field

9.36.1 Description of Designation

2413. Hermaness, Saxa Vord and Valla Field SPA lies in the north-west corner of the island of Unst, Shetland. It consists of 100m to 200m high sea cliffs and adjoining areas of grassland, heath and blanket bog. The seaward extension extends approximately 2km into the marine environment to include the seabed, water column and surface.

9.36.2 Conservation Objectives

2414. The overarching conservation objectives of the site are as follows:

- To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

9.36.3 Appropriate Assessment

2415. The single qualifying species from this SPA that is screened into the Appropriate Assessment is breeding gannet (**Table 5-2**).

9.36.3.1 Gannet

9.36.3.1.1 Status

2416. The SPA breeding population at classification was 16,400 pairs or 32,800 breeding adults (SNH, 2009j). The most recent available count is 25,580 breeding pairs, or 51,160 breeding adults, in 2014 (JNCC, 2022).The latter estimate is considered the best available evidence for the gannet population of this designated site. Using the published adult mortality rate of 8.1% (Horswill and Robinson, 2015), 4,144 birds would be expected to die annually from the breeding adult population of 51,160 individuals.

9.36.3.1.2 Functional Linkage and Seasonal Apportionment of Potential Effects

2417. The Hermaness, Saxa Vord and Valla Field SPA is located approximately 850km from SEP and DEP. The mean maximum foraging range of gannet is 315.2km (±194.2km), and the maximum foraging range is 709km (Woodward *et al*., 2019). The mean maximum breeding season foraging range of gannet from the previous industry standard review of seabird foraging ranges, Thaxter *et al*. (2012), was 229.4km (±124.3km) based on data from seven studies. The updated review of Woodward *et al*. (2019), based on data from 21 studies, gives a considerably larger mean maximum foraging range.

2418. This means that breeding adult gannets from this SPA are beyond the maximum recorded foraging range for this species from SEP and DEP. No impacts during the breeding season due to SEP and DEP are therefore apportioned to birds breeding at this colony.

2419. Outside the breeding season breeding gannets, including those from the Hermaness, Saxa Vord and Valla Field SPA, are not constrained by requirements to visit nests to incubate eggs or provision chicks. At this time, they are assumed to range more widely and to mix with gannets of all age classes from breeding colonies in the UK and further afield. The background population during these seasons is the UK North Sea and Channel BDMPS. This consists of 456,298 individuals during autumn migration (September to November), and 248,385 individuals during spring migration (December to March) (Furness, 2015).

2420. During autumn migration, 80% of Hermaness, Saxa Vord and Valla Field SPA breeding adults are thought to be present in the BDMPS, representing 8.5% of the total BDMPS population (456,298 individuals of all ages). During this season, 458 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 182 birds were able to be assigned to an age class. 170 birds (93.4% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Hermaness, Saxa Vord and Valla Field SPA is 8.0% (i.e. 0.085 x 0.934).

2421. During spring migration 70% of Hermaness, Saxa Vord and Valla Field SPA breeding adults are thought to be present in the BDMPS, representing 13.7% of the BDMPS population (248,385 individuals of all ages). During this season, 28 gannets were recorded during the baseline surveys of SEP and DEP. Of these, 21 birds were able to be assigned to an age class. 20 birds (95.2% of those assigned to an age class) were classified as adults. It is therefore assumed that the proportion of gannets recorded at SEP and DEP during the autumn migration season that are breeding adult birds from the Hermaness, Saxa Vord and Valla Field SPA is 13.1% (i.e. 0.137x 0.952).

9.36.3.1.3 Potential Effects on the Qualifying Feature

2422. The gannet qualifying feature of the Hermaness, Saxa Vord and Valla Field SPA has been screened into the Appropriate Assessment due to the potential risk of collision and operational phase displacement/barrier effects.

9.36.3.1.4 Potential Effects of SEP and DEP in Isolation and Together

9.36.3.1.4.1 Operational Phase Displacement / Barrier Effects

2423. Following statutory guidance (UK SNCBs, 2017), abundance estimates for gannet for DEP and its 2km buffer, and SEP and its 2km buffer have been used to produce displacement matrices. Based on the recommended displacement rate of Cook *et al.* (2018) and the findings of Skov *et al.* (2018), displacement rates of 0.600 to 0.800 are considered. These rates appear to be broadly in line with recent research on gannet displacement by OWFs (Peschko *et al*., 2021).

2424. The mortality rate of displaced birds due to displacement is assumed to be a maximum of 1%. This value has been selected firstly because gannet is known to possess high habitat flexibility (Furness and Wade, 2012). This suggests that displaced birds will readily find alternative habitats including foraging areas. Secondly, no evidence of displacement-induced mortality has been identified, which means there is limited justification for setting predicted mortality rates at a higher level.

2425. Information to inform the Appropriate Assessment for operational displacement and barrier effects on breeding adult gannets belonging to the Hermaness, Saxa Vord and Valla Field SPA population is presented in **Table 9-247** (DEP), **Table 9-248** (SEP) and **Table 9-249** (SEP and DEP together). Each table provides information on how the relevant mean peak abundance has been used to estimate the number of breeding adult gannets belonging to the Hermaness, Saxa Vord and Valla Field SPA population by season. An estimated annual mortality for the population is provided, along with the increase of existing mortality within the breeding adult SPA population that would occur due to such an impact. The displacement matrices used to calculate potential impacts are presented in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

Table 9-247: Predicted Operational Phase Displacement and Mortality of Hermaness, Saxa Vord and Valla Field SPA Breeding Adult Gannets at DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	554 (autumn) 103 (spring) 692 (breeding) 1,349 (year round)	44 (autumn) 13 (spring) 0 (breeding) 57 (year round)	0 - 0	0.01 - 0.01
Mean	343 (autumn) 47 (spring) 417 (breeding) 807 (year round)	27 (autumn) 6 (spring) 0 (breeding) 33 (year round)	0 - 0	0.00 - 0.01
Lower 95% CI	186 (autumn) 10 (spring) 180 (breeding)	15 (autumn) 1 (spring) 0 (breeding)	0 - 0	0.00 - 0.00

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
	376 (year round)	16 (year round)		
Notes 1. For autumn migration season (Oct-Nov), assumes 8.5% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 13.7% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders. 2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds 3. Background population is Hermaness, Saxa Vord and Valla Field SPA breeding adults (51,160 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

Table 9-248: Predicted Operational Phase Displacement and Mortality of Hermaness, Saxa Vord and Valla Field SPA Breeding Adult Gannets at SEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	426 (autumn) 31 (spring) 47 (breeding) 504 (year round)	34 (autumn) 4 (spring) 0 (breeding) 38 (year round)	0 - 0	0.01 - 0.01
Mean	295 (autumn) 11 (spring) 23 (breeding) 329 (year round)	23 (autumn) 1 (spring) 0 (breeding) 25 (year round)	0 - 0	0.00 - 0.00
Lower 95% CI	193 (autumn) 0 (spring) 3 (breeding) 196 (year round)	15 (autumn) 0 (spring) 0 (breeding) 15 (year round)	0 - 0	0.00 - 0.00
Notes 1. For autumn migration season (Oct-Nov), assumes 8.5% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 13.7% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders. 2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds				

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
3. Background population is Hermaness, Saxa Vord and Valla Field SPA breeding adults (51,160 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

Table 9-249: Predicted Operational Phase Displacement and Mortality of Hermaness, Saxa Vord and Valla Field SPA Breeding Adult Gannets at SEP and DEP

Mean peak abundance estimate type	Mean peak abundance estimate by season	Number of SPA breeding adults present by season[1]	Year round mortality range[2]	Year round% background mortality annual increase range[3]
Upper 95% CI	980 (autumn) 133 (spring) 739 (breeding) 1,852 (year round)	78 (autumn) 17 (spring) 0 (breeding) 95 (year round)	1 - 1	0.01 - 0.02
Mean	638 (autumn) 57 (spring) 440 (breeding) 1,135 (year round)	51 (autumn) 7 (spring) 0 (breeding) 58 (year round)	0 - 0	0.01 - 0.01
Lower 95% CI	378 (autumn) 10 (spring) 183 (breeding) 571 (year round)	30 (autumn) 1 (spring) 0 (breeding) 31 (year round)	0 - 0	0.00 - 0.01
Notes 1. For autumn migration season (Oct-Nov), assumes 8.5% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults. For spring migration season (Dec-Feb), assumes 13.7% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults. For breeding season (Mar-Sept), assumes 0% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders. 2. Assumes displacement rates of 0.600 to 0.800 and mortality rate of 1% of displaced birds 3. Background population is Hermaness, Saxa Vord and Valla Field SPA breeding adults (51,160 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)				

2426. Based on the mean peak abundances, the annual total of breeding adult gannets from the Hermaness, Saxa Vord and Valla Field SPA at risk of displacement from DEP is 33, 25 from SEP, and 58 for SEP and DEP together. At displacement rates of 0.600 to 0.800 and a maximum mortality rate of 1% for displaced birds, 0.35 to 0.46 SPA breeding adults would be predicted to die each year due to displacement from both OWFs (**Table 9-249**). The combined displacement mortality of SEP and DEP would increase the existing mortality of the SPA breeding population by 0.01%.

Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation.

2427. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. A comparison between the encounter rates of this species within the different parts of DEP indicated that year round, the encounter rate for this species from the raw baseline survey data was 22.0% higher at DEP-N than DEP as a whole. However, in the event that all of DEP's turbines were installed at DEP-N, the footprint of the OWF would be smaller than if all turbines were installed across all of DEP, thereby resulting in smaller impacts than those presented here.

2428. **It is concluded that predicted gannet mortality due to operational phase displacement at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Hermaness, Saxa Vord and Valla Field SPA.**

2429. The confidence in the assessment is high for several reasons. Firstly, the evidence used to set the displacement rates presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is limited available evidence to inform mortality rates, 1% is considered to be sufficiently precautionary based on expert opinion. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI mean peak abundances are used to calculate potential mortality and increases in the baseline mortality rate of the background population.

9.36.3.1.4.2 Collision Risk

2430. Information to inform the Appropriate Assessment for collision risk on breeding adult gannets belonging to the Hermaness, Saxa Vord and Valla Field SPA population is presented in **Table 9-250**. An estimated monthly and annual mortality for the population is provided, along with the increase of existing mortality that would occur through such an impact. The avoidance rate used was 0.989, as recommended by the statutory guidance (UK SNCBs, 2014). The methodology and input parameters for CRM are described in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1).

2431. Based on the mean collision rates, the annual total of breeding adult gannets from the Hermaness, Saxa Vord and Valla Field SPA at risk of collision at DEP is 0.25, with 0.05 collisions annually predicted at SEP. This gives a combined total annual collision rate for SEP and DEP together of 0.30 Hermaness, Saxa Vord and Valla Field SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.01%. Using an evidence-based nocturnal activity factor of 8% (Furness *et al*., 2018), which has been calculated more recently than the value of 25% recommended for use in CRM by Natural England (originally estimated by Garthe and Hüppop (2004)), reduces the mean collision rate to 0.04 and 0.20 birds per year for SEP and DEP respectively. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates would occur even if the upper 95% CIs for mean peaks are used as an input into the assessment, since the maximum predicted mortality increase that could occur is 0.02%.

2432. As explained in **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1), it was not considered possible to produce reliable and precise design-based density estimates for offshore ornithology receptors for DEP-N and DEP-S, only DEP as a whole. In total, 59 flying birds were observed across DEP (of which 41 were within DEP-N, and 18 within DEP-S). This means that encounter rate was 14.0% higher at DEP-N than in DEP as a whole. An increase in the predicted collision rate of this magnitude would not impact the conclusions of the assessment, which is considered to be reasonable representation of the worst case scenario for DEP.

2433. **It is concluded that predicted gannet mortality due to collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Hermaness, Saxa Vord and Valla Field SPA.**

2434. The confidence in the assessment is high. The evidence used to define the CRM input parameters presented in **ES Chapter 11 Offshore Ornithology** (document reference 6.1.11) and **Appendix 11.1 Offshore Ornithology Technical Report** (document reference 6.3.11.1) is of high applicability and quality. Whilst there is uncertainty around some of the input parameters (e.g. avoidance rate), the rates selected are considered to be sufficiently precautionary based on expert opinion to provide confidence that collision rates are not underestimated. Finally, the conclusion of the assessment is the same irrespective of whether the mean or 95% upper CI flying bird densities are used to calculate collision rates and increases in the baseline mortality rate of the background population.

2435. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

Table 9-250: Predicted Monthly Breeding Season Collision Mortality for Breeding Adult Gannet at SEP and DEP Apportioned to Hermaness, Saxa Vord and Valla Field SPA

Site	Variable		J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total
DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.12	0.03	0.25
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.24	0.11	0.71
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.22	0.05	0.46
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.01	0.10
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.14	0.03	0.30
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.10	0.02	0.21
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.10	0.02	0.20
SEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.05
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.00	0.12
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.00	0.10
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.02
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.06
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.04
SEP and DEP	Mean	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.17	0.03	0.30
	Density	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.36	0.36	0.11	0.82
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Flight Height	95% UCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.31	0.05	0.55
		95% LCI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.07	0.01	0.12
	Avoidance Rate	-2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.20	0.03	0.36
		+2 SD	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.14	0.02	0.25
	Noct. Act.	EB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.14	0.02	0.25

Site	Variable	J[2]	F[2]	M[3]	A[3]	M[3]	J[3]	J[3]	A[3]	S[3]	O[1]	N[1]	D[2]	Total

Notes

1. For autumn migration season (Oct-Nov), assumes 8.5% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders (Furness 2015), combined with 93.4% of gannets allocated an age class during breeding season baseline surveys as being adults

2. For spring migration season (Dec-Feb), assumes 13.7% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders, combined with 95.2% of gannets allocated an age class during breeding season baseline surveys as being adults

3. For breeding season (Mar-Sept), assumes 0% of adult birds are Hermaness, Saxa Vord and Valla Field SPA breeders

9.36.3.1.4.3 Combined Displacement / Barrier Effects and Collision Risk

2436. The combined displacement and collision rates for breeding adult gannet from the Hermaness, Saxa Vord and Valla Field SPA for SEP and DEP in isolation and together are presented in **Table 9-251**.

Table 9-251: Predicted Annual Mean and 95% CI Displacement and Collision Mortality of Hermaness, Saxa Vord and Valla Field SPA Breeding Adult Gannets at SEP and DEP, Along with Increases to Existing Annual Mortality of the Population

Site	Annual displacement mortality[1]	Annual collision mortality	Annual displacement and collision mortality	% annual mortality increase[2]
DEP	0.23 (0.11 - 0.40)	0.25 (0.00 - 0.71)	0.49 (0.11 - 1.11)	0.01 (0.01 - 0.03)
SEP	0.17 (0.11 - 0.26)	0.05 (0.00 - 0.12)	0.23 (0.11 - 0.38)	0.01 (0.00 - 0.01)
SEP and DEP	0.41 (0.22 - 0.67)	0.30 (0.00 - 0.82)	0.71 (0.22 - 1.49)	0.02 (0.01 - 0.04)

Notes
1. Assumes displacement rate of 0.700 and mortality rate of 1% of displaced birds

2. Background population is Hermaness, Saxa Vord and Valla Field SPA breeding adults (51,160 individuals), adult age class annual mortality rate of 8.1% (Horswill and Robinson, 2015)

2437. Based on the mean combined displacement and collision rates, the annual mortality of breeding adult gannets from the Hermaness, Saxa Vord and Valla Field SPA at DEP is 0.49, and 0.23 at SEP. This gives a combined total annual displacement and collision mortality rate for SEP and DEP together of 0.71 Hermaness, Saxa Vord and Valla Field SPA breeding adult gannets. This would increase the existing mortality of the SPA breeding population by 0.02%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable changes in mortality rates are likely in a typical year of impacts due to SEP and DEP. The conclusions of the assessment are the same if the upper 95% CI outputs are used.

2438. **It is concluded that predicted gannet mortality due to the combined effects of operational phase displacement and collision at SEP, DEP, and SEP and DEP together would not adversely affect the integrity of the Hermaness, Saxa Vord and Valla Field SPA.**

2439. The confidence in the assessment is high, for the reasons provided in the individual displacement and collision assessments.

9.36.3.1.5 Potential Effects of SEP and DEP In-Combination with Other Projects

2440. During the breeding season, the magnitude of operational phase OWF displacement and barrier effects on the breeding gannet population of the Hermaness, Saxa Vord and Valla Field SPA are anticipated to be very small, or even zero. Whilst some OWFs is Scottish waters (particularly in the Moray Firth) situated within mean maximum foraging range of the qualifying feature from the SPA, it is assumed, based on the geographical location of the SPA, that the vast majority of foraging activity of gannet from this SPA will not overlap with any OWFs. The remainder of the in-combination assessment therefore focuses on non-breeding season impacts.

9.36.3.1.5.1 Operational Phase Displacement / Barrier Effects

2441. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn and spring migration seasons respectively, 22,374 and 5,728 birds belonging to the UK North Sea and Channel BDMPS are at risk of displacement from OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-98**). Of the birds at risk of displacement, 2,687 are estimated to belong to the breeding adult population of the Hermaness, Saxa Vord and Valla Field SPA, assuming 8.5% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the autumn migration season, and 13.7% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the spring migration season (Furness, 2015). Displacement and mortality rates of birds belonging to the Hermaness, Saxa Vord and Valla Field SPA are presented in **Table 9-252**.

Table 9-252: In-Combination Displacement Matrix for Gannet from Hermaness, Saxa Vord and Valla Field SPA from OWFs in the UK North Sea, with the Ranges of Displacement and Mortality Considered by the Assessment Shown in Red

	Mortality (%)										
Displacement (%)	1	2	3	4	5	10	20	30	50	80	100
10	3	5	8	11	13	27	54	81	134	215	269
20	5	11	16	21	27	54	107	161	269	430	537
30	8	16	24	32	40	81	161	242	403	645	806
40	11	21	32	43	54	107	215	322	537	860	1075
50	13	27	40	54	67	134	269	403	672	1075	1344
60	16	32	48	64	81	161	322	484	806	1290	1612
70	19	38	56	75	94	188	376	564	940	1505	1881
80	21	43	64	86	107	215	430	645	1075	1720	2150
90	24	48	73	97	121	242	484	725	1209	1935	2418
100	27	54	81	107	134	269	537	806	1344	2150	2687

2442. Assuming a displacement rate of 0.600 or 0.800, and a mortality rate of 1% of displaced birds, 16 to 21 SPA birds would be lost to displacement each non-breeding season (and therefore annually). This would increase the existing mortality within the SPA population (4,144 breeding adult birds per year) by 0.39% to 0.52%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that no detectable change in mortality rate is predicted due to operational phase OWF displacement impacts.

2443. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of the Hermaness, Saxa Vord and Valla Field SPA due to this impact are small, with a mean predicted annual mortality rate of 0.40 birds (**Table 9-249**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2444. **It is concluded that predicted gannet mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Hermaness, Saxa Vord and Valla Field SPA.**

9.36.3.1.5.2 Collision Risk

2445. The cumulative impact assessment presented during the DCO Examination for the East Anglia ONE North and TWO OWFs (MacArthur Green and Royal HaskoningDHV, 2021a), plus impacts from SEP and DEP, indicates that during the autumn and spring migration seasons respectively, 836 and 333 birds belonging to the UK North Sea and Channel BDMPS are predicted to die due to collision with OWFs in the North Sea. This is presented by OWF in the Appropriate Assessment for the Flamborough and Filey Coast SPA (**Table 9-100**).

2446. These collision rates are based largely on consented OWF designs. This represents a highly precautionary position, since the majority of OWFs are built with larger numbers of smaller turbines than their consent allows. These will have substantially lower collision rates, particularly in cases where the as-built nameplate capacity is lower than the consented nameplate capacity. Previous estimates indicate that using as-built OWF designs will reduce in-combination collision rates by at least 40% (MacArthur Green, 2017). Whilst the as-built scenario represents the most realistic model produced, these OWF designs are not legally secured (The Crown Estate and Womble Bond Dickinson, 2021). This means that there is a theoretical, though extremely unlikely possibility of additional turbines being added to the design of existing OWFs. As a result, CRM outputs using as-built OWF designs are not presented. However, the overestimation of collision risk should be considered during the interpretation of CRM outputs.

2447. Of these birds, 117 are estimated to belong to the breeding adult population Hermaness, Saxa Vord and Valla Field SPA, assuming 8.5% of birds of the total relevant BDMPS belong to the breeding population of this SPA during the autumn migration season, and 13.7% of birds of the total relevant BDMPS belong to the breeding population of this SPA (Furness, 2015) during the spring migration season. This would increase the existing mortality within the SPA population (4,144 breeding adult birds per year) by 2.82%. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to collision risk.

2448. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of the Hermaness, Saxa Vord and Valla Field SPA are small, with a mean predicted annual mortality rate of 0.30 birds (**Table 9-250**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2449. **It is concluded that predicted gannet mortality due to of operational phase displacement impacts at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of Hermaness, Saxa Vord and Valla Field SPA.**

2450. Recently, it has been suggested by Natural England that the application of correction factors to CRM outputs of 0.600 to 0.800 to account for macro-avoidance may be appropriate for this species. This would substantially reduce collision risk presented above. This is not explored quantitatively here since the conclusions would not be affected, but does provide additional confidence in the assessment conclusion.

9.36.3.1.5.3 Combined Displacement / Barrier Effects and Collision Risk

2451. The predicted annual in-combination breeding adult Hermaness, Saxa Vord and Valla Field SPA gannet mortality from collision and displacement of OWFs screened into the Appropriate Assessment is between 133 and 138 birds, depending on whether a displacement rate of 0.600 to 0.800 is used in calculations. This represents an increase in existing annual mortality of 3.21% to 3.34%, assuming an existing mortality of 4,144 breeding adult birds per year. Increases in the existing mortality rate of less than 1% are likely to be undetectable against natural variation. This means that a detectable change in mortality rate is predicted due to collision risk.

2452. The predicted impacts of SEP and DEP in isolation and together on the breeding adult gannet population of the Hermaness, Saxa Vord and Valla Field SPA are small, with a mean predicted annual mortality rate of 0.70 birds (**Table 9-251**). It is therefore considered that SEP and DEP do not contribute substantially to any in-combination collision impacts on this qualifying feature. Mortality rates of this size will not prevent, or delay the conservation objectives for the SPA being met.

2453. **It is concluded that predicted gannet mortality due to the combined impacts of operational phase displacement and collision at SEP, DEP, and SEP and DEP together, in-combination with other projects, would not adversely affect the integrity of the Hermaness, Saxa Vord and Valla Field SPA.**

10 Summary of Potential Effects

2454. **Table 10-1** below summarises the conclusions of the potential effects arising from SEP and DEP.

Table 10-1: Summary of the Potential Effects of SEP and DEP

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
SACs			
River Wensum SAC	• H3260 Watercourses of plain to montane levels with *R. fluitantis* • S1016 Desmoulin's whorl snail	There is potential for both direct and indirect effects upon both the features of the sites and the supporting habitats.	**No adverse effect on site integrity predicted.**
Inner Dowsing, Race Bank and North Ridge SAC	Sandbanks which are slightly covered by sea water all the time	Potential effects from changes to bedload sediment transport from SEP wind farm site infrastructure.	**No adverse effect on site integrity predicted.**
Southern North Sea SAC	Harbour porpoise	Potential effects from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • changes to water quality; • changes to prey availability; and • in-combination effects.	**No adverse effect on site integrity predicted.**
Moray Firth SAC	Bottlenose dolphin	Potential effects from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • changes to water quality; • changes to prey availability; and	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
		• in-combination effects.	
Humber Estuary SAC	Grey seal	Potential effects from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • disturbance at seal haul-out sites; • disturbance of foraging seals at sea; • changes to water quality; • changes to prey availability; and • in-combination effects.	**No adverse effect on site integrity predicted.**
The Wash and North Norfolk Coast SAC	• Sandbanks which are slightly covered by sea water all the time • Harbour seal	Potential effects on sandbanks from: • changes to bedload sediment transport from cable protection Potential effects on harbour seal from: • underwater noise; • barrier effects from underwater noise; • vessel interactions; • disturbance at seal haul-out sites; • disturbance of foraging seals at sea; • changes to water quality;	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
		• changes to prey availability; and • in-combination effects.	
SPAs			
Greater Wash SPA	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the breeding season	**Adverse effect on site integrity could not be ruled out for in-combination collision risk and in-combination combined displacement and collision risk**
	Common tern, breeding	Potential risk of collision during the breeding season	**No adverse effect on site integrity predicted.**
	Red-throated diver, non-breeding	Potential risk of displacement and barrier effects during the non-breeding season.	**No adverse effect on site integrity predicted.**
North Norfolk Coast SPA and Ramsar Site	Sandwich tern (SPA and Ramsar site), breeding	Potential risk of collision and displacement/barrier effects during the breeding and non-breeding (spring and autumn migration) seasons.	**Adverse effect on site integrity could not be ruled out for in-combination collision risk and in-combination combined displacement and collision risk**
	Common tern (SPA and Ramsar site), breeding	Potential risk of collision from SEP and DEP during the breeding season	**No adverse effect on site integrity predicted.**
	Pink-footed goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site Direct and indirect effects on ex-situ habitats	**No adverse effect on site integrity predicted.**
	Dark-bellied brent goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
		Direct and indirect effects on ex-situ habitats	
	Wigeon (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site Direct and indirect effects on ex-situ habitats	**No adverse effect on site integrity predicted.**
	Knot (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site Direct and indirect effects on ex-situ habitats	**No adverse effect on site integrity predicted.**
	Pintail (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site Direct and indirect effects on ex-situ habitats	**No adverse effect on site integrity predicted.**
Outer Thames Estuary SPA	Red-Throated Diver, non-breeding	Potential risk of displacement and barrier effects during the non-breeding season.	**No adverse effect on site integrity predicted.**
Breydon Water SPA and Ramsar Site	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Avocet (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Golden plover (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Lapwing (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Waterbird assemblage (SPA and Ramsar site)	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
The Wash SPA and Ramsar Site	Bar-tailed godwit (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Black-tailed godwit (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Common scoter (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Curlew (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Dark-bellied brent goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Dunlin (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Eider (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Gadwall (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Goldeneye (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Golden plover (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Grey plover (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Knot (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Lapwing (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Oystercatcher (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Pink-footed goose (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Pintail (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Redshank (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Ringed plover (Ramsar site)	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Sanderling (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Shelduck (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Turnstone (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Wigeon (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Waterbird assemblage (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
Gibraltar Point SPA and Ramsar Site	Bar-tailed godwit (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Dark-bellied brent goose (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Grey plover (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Knot (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Sanderling (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Waterbird assemblage (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
Humber Estuary SPA and Ramsar Site	Avocet (SPA), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Bar-tailed godwit (SPA and Ramsar site), non-breeding*	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Bittern (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Black-tailed godwit (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Dunlin (SPA and Ramsar site), non-breeding*	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Golden plover (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Knot (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Redshank (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Shelduck (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Waterbird assemblage (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
Broadland SPA and Ramsar Site	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Bittern (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Gadwall (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Ruff (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Shoveler (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Whooper swan (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Wigeon (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
Ouse Washes SPA and Ramsar Site	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Black-tailed godwit (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Gadwall (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Garganey (SPA), breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Mallard (SPA), breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Pintail (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Teal, (SPA and Ramsar site) non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Whooper swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Wigeon (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Breeding bird assemblage (SPA)	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Waterbird assemblage (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
Minsmere-Walberswick SPA and Ramsar Site	Avocet (SPA), breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Bittern (SPA and Ramsar site), breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	European white-fronted goose (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Gadwall (SPA), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Shoveler (SPA), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Teal (SPA), breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Breeding bird assemblage (SPA and Ramsar site)	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Bewick's swan (SPA and Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
Nene Washes SPA and Ramsar Site	Black-tailed godwit (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Gadwall (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Garganey (SPA and Ramsar site), breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Pintail (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Shoveler (SPA and Ramsar site), breeding and non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Teal (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Whooper Swan (Ramsar site), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
	Wigeon (SPA), non-breeding	Potential risk of collision during migratory flights to and from the site	**No adverse effect on site integrity predicted.**
Alde-Ore Estuary SPA and Ramsar Site	Lesser black-backed gull (SPA and Ramsar site), breeding	Potential risk of collision during the breeding and non-breeding (autumn migration, winter and spring migration) seasons	**No adverse effect on site integrity predicted.**
	Kittiwake, breeding	Potential risk of collision during the breeding and non-breeding	**Adverse effect on site integrity could not be ruled out for in-combination collision risk.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
Flamborough and Filey Coast SPA		(autumn migration and spring migration) seasons	
	Gannet, breeding	Potential risk of collision and displacement/barrier effects during the breeding and non-breeding (autumn migration and spring migration) seasons	**No adverse effect on site integrity predicted.**
	Guillemot, breeding	Potential risk of displacement/barrier effects during the breeding and non-breeding seasons	**No adverse effect on site integrity predicted.**
	Razorbill, breeding	Potential risk of displacement/barrier effects during the breeding and non-breeding (autumn migration, winter and spring migration) seasons	**No adverse effect on site integrity predicted.**
Coquet Island SPA	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Common tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
Farne Islands SPA	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
		the non-breeding season (autumn migration and spring migration)	
	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
	Seabird assemblage, breeding (kittiwake, puffin)	Potential risk of collision and/or displacement and barrier effects during the non-breeding season (autumn migration, spring migration and non-breeding season)	**No adverse effect on site integrity predicted.**
St Abbs Head to Fast Castle SPA	Seabird assemblage, breeding (guillemot)	Potential risk of displacement during the non-breeding season	**No adverse effect on site integrity predicted.**
Forth Islands SPA	Gannet, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Lesser black-backed gull, breeding	Potential risk of collision during the non-breeding season (autumn migration, winter and spring migration)	**No adverse effect on site integrity predicted.**
	Puffin, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
Imperial Dock Lock, Leith, SPA	Common tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
Fowlsheugh SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
	Kittiwake, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
Ythan Estuary, Sands of Forvie and Meikle Loch SPA and Ramsar Site	Sandwich tern, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
Troup, Pennan and Lion’s Heads SPA	Kittiwake, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
East Caithness Cliffs SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
	Kittiwake, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Razorbill, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
North Caithness Cliffs SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
Hoy SPA	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)	**No adverse effect on site integrity predicted.**
Auskerry SPA	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
Marwick Head SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
West Westray SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
Fair Isle SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
Noss SPA	Gannet, breeding	Potential risk of collision and displacement/barrier effects during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
East Mainland Coast, Shetland, SPA	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
		migration, winter and spring migration)	
Foula SPA	Guillemot, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
	Puffin, breeding	Potential risk of displacement/barrier effects during the non-breeding season	**No adverse effect on site integrity predicted.**
	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)	**No adverse effect on site integrity predicted.**
Papa Stour SPA	Arctic tern, breeding	Potential risk of collision during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**
Ronas Hill – North Roe and Tingon SPA	Red-throated diver, breeding	Potential risk of displacement/barrier effects during the non-breeding season (autumn migration, winter and spring migration)	**No adverse effect on site integrity predicted.**
	Great skua, breeding	Potential risk of collision during the non-breeding season (autumn migration)	**No adverse effect on site integrity predicted.**
Hermaness, Saxa Vord and Valla Field SPA	Gannet, breeding	Potential risk of collision and displacement/barrier from SEP and DEP during the non-breeding season (autumn migration and spring migration)	**No adverse effect on site integrity predicted.**

Site	Qualifying features	Potential effects	Potential for adverse effect upon site integrity in combination?
	Great skua, breeding	Potential risk of collision during the non-breeding season (autumn migration)	**No adverse effect on site integrity predicted.**

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