

East Anglia TWO Offshore Windfarm

Habitat Regulations Assessment (HRA)

Information to Support Appropriate Assessment

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Glossary of Acronyms

AA	Appropriate assessment
ADD	Acoustic Deterrent Device
AON	Apparently Occupied Nests
APEM	APEM is an environmental consultancy with specialist expertise in digital aerial survey
BDMPS	Biologically Defined Minimum Population Scale/size
BTO	British Trust for Ornithology
Cefas	Centre for Environment Fisheries and Aquaculture Science
CI	Confidence Interval
cSAC	Candidate Special Area of Conservation
CV	Confidence Variation
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
DOW	Dudgeon Offshore Windfarm
DP	Dynamic Positioning
EATL	East Anglia THREE Ltd
EC	European Commission
EDR	Effective Deterrent Radius
EEC	European Economic Community
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EOWDC	European Offshore Wind Deployment Centre
EPP	Evidence Plan Process
ES	Environmental Statement
ETG	Expert Topic Group
EU	European Union
FAME	Future of the Atlantic Marine Environment (RSPB seabird tracking project)
FCS	Favourable Conservation Status
FFC SPA	Flamborough & Filey Coast Special Protection Area
GB	Great Britain
GBS	Gravity Based Structure
GPS	Global Positioning System
GWF	Galloper Windfarm
HDD	Horizontal Direct Drilling
HF	High Frequency Cetaceans
HLV	Heavy Lift Vessels
HRA	Habitat Regulations Assessment
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea
iPCoD	The interim Population Consequences of Disturbance
JNCC	Joint Nature Conservation Committee
KDE	Kernel Density Estimate
LSE	Likely Significant Effect
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Management Organisation
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MTD	Marine Technical Directorate
MU	Management Unit

NEQ	Net Explosive Quantities
NMFS	National Marine Fisheries Services
NOAA	National Oceanic and Atmospheric Administration
NS	North Sea
O&M	Operations and Maintenance
PBR	Potential Biological Removal
PCBs	Polychlorinated Biphenyls
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
pSAC	Possible Special Area of Conservation
pSPA	Proposed Special Protection Area
PTS	Permanent Threshold Shift
PVA	Population Viability Analysis
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCI	Site of Community Importance
SEL	Sound Exposure Level
SIP	Site Integrity Plan
SMP	Seabird Monitoring Programme
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SNS	Southern North Sea
SPA	Special Protection Area
SPL	Sound Pressure Level
SPR	ScottishPower Renewables (UK) Limited
SSC	Suspended Sediment Concentrations
SSSI	Site of Special Scientific Interest
STAR	Seabird Tracking and Research (RSPB seabird tracking project)
TTS	Temporary Threshold Shift / Temporary Auditory Injury
TWT	The Wildlife Trust
UK	United Kingdom of Great Britain and Northern Ireland
UXO	Unexploded ordnance
WDC	Whale and Dolphin Conservation
WS	West Scotland

Glossary of Terminology

Apparently Occupied Nests	One of the standard units in census of breeding seabirds; in this case it is very similar to the number of breeding pairs, but may include some pairs that build nests but do not lay eggs.
Applicant	East Anglia TWO Limited.
BDMPS	The concept of Biologically Defined Minimum Population Scales (BDMPS) was developed by Natural England to define the smallest appropriate regional populations of seabirds and quantify the numbers of birds in these regional populations (Furness 2015). This approach aims to relate human effects within these defined regions to the appropriate seasonal population rather than to the much larger Biogeographic population scale. It is therefore generally a more precautionary approach than considering the Biogeographic scale.
Construction, operation and maintenance platform	A fixed offshore structure required for construction, operation, and maintenance personnel and activities.
Development area	The area comprising the Indicative Onshore Development Area and the Offshore Development Area
East Anglia TWO project	The proposed project consisting of up to 75 wind turbines, up to four offshore electrical platforms, up to one offshore construction, operation and maintenance platform, inter-array cables, platform link cables, up to one operational meteorological mast, up to two offshore export cables, fibre optic cables, landfall infrastructure, onshore cables and ducts, onshore substation, and National Grid infrastructure.
East Anglia TWO windfarm site	The offshore area within which wind turbines and offshore platforms will be located.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive, as defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017 and regulation 18 of the Conservation of Offshore Marine Habitats and Species Regulations 2017. These include candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas.
Evidence Plan Process	A voluntary consultation process with specialist stakeholders to agree the approach to the EIA and the information required to support HRA.
Habitats Directive	European Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora
Habitats Regulations	The Habitats Directive is transposed in UK law as the The Conservation of Habitats and Species Regulations 2017.
HRA	Habitat Regulations Assessment is a recognised step by step process which helps determine likely significant effect and (where appropriate) assesses any adverse effects on the integrity of Natura 2000 sites protected under the Birds or Habitats Directives
Inter-array cables	Offshore cables which link the wind turbines to each other and the offshore electrical platforms. These will include fibre optic cables.
Kernel Density Estimate	A statistical method to identify core areas used by birds based on tracking data.
Landfall	The area (from Mean Low Water Springs) where the offshore export cables would make contact with land, and connect to the onshore cables.
Likely Significant Effect	Checking for the likelihood of significant effects on Natura sites is a part of HRA. Unless a significant effect can be ruled out, it is considered 'likely' and requires appraisal.

Macro-avoidance	Where birds change flight direction at a distance from an offshore windfarm in order to avoid coming close to the outer turbines and instead pass around the outside of the windfarm.
Meso-avoidance	Where birds enter an offshore windfarm, but alter flight direction to avoid coming close to individual turbines, for example by flying between rows of turbines.
Mitigation areas	Areas captured within the Development Area specifically for mitigating expected or anticipated effects.
Monitoring buoys	Buoys to monitor in situ condition within the windfarm, for example wave and metocean conditions.
Natura 2000 site	A site forming part of the network of sites made up of Special Areas of Conservation and Special Protection Areas designated respectively under the Habitats Directive and Birds Directive.
National Grid overhead line realignment works area	Works required to upgrade the existing electricity pylons and overhead lines (including cable sealing end compounds and cable sealing end (with circuit breaker) compound) to transport electricity from the National Grid substation to the national electricity grid.
National Grid substation	The substation (including all of the electrical equipment within it) necessary to connect the electricity generated by the proposed East Anglia TWO project to the national electricity grid which will be owned by National Grid but is being consented as part of the proposed East Anglia TWO project Development Consent Order.
Offshore cable corridor	This is the area which will contain the offshore export cables between offshore electrical platforms and landfall.
Offshore development area	The East Anglia TWO windfarm site and offshore cable corridor (up to Mean High Water Springs).
Offshore electrical infrastructure	This includes transmission assets required to export generated electricity to shore. This includes inter-array cables from the wind turbines to the offshore electrical platforms, offshore electrical platforms, platform link cables and export cables from the offshore electrical platforms to the landfall.
Offshore electrical platform	A fixed structure located within the windfarm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore export cables	The cables which would bring electricity from the offshore electrical platforms to the landfall. These will include fibre optic cables.
Offshore infrastructure	All of the offshore infrastructure including wind turbines, platforms, and cables.
Offshore platform	A collective term for the offshore construction, operation and maintenance platform and the offshore electrical platforms.
Onshore cable corridor	The corridor within which the onshore cable route will be located.
Onshore cable route	This is the construction swathe within the onshore cable corridor which would contain onshore cables as well as temporary ground required for construction which includes cable trenches, haul road and spoil storage areas.
Onshore development area	The area in which the landfall, onshore cable corridor, onshore substation, landscaping and ecological mitigation areas, temporary construction facilities (such as access roads and construction consolidation sites), and the National Grid Infrastructure will be located.
Onshore infrastructure	The combined name for all of the onshore infrastructure associated with the proposed East Anglia TWO project from landfall to the connection to the national electricity grid.

Onshore substation	The East Anglia TWO substation and all of the electrical equipment, both within and connecting to the National Grid infrastructure.
PBR	Potential Biological Removal is a simple formula allowing managers to estimate the number of animals that can be removed from a population on a sustainable basis (Lonergan 2011). The method has mainly been used to assess acceptable bycatch of marine mammals by fisheries, but has also been used to assess whether or not harvests of seabirds exceed sustainable limits.
Platform link cable	An electrical cable which links one or more offshore platforms. These will include fibre optic cables.
PVA	Population Viability Analysis is a method used to model trajectories of populations on the basis of known demographic parameter values. In assessment of effects from offshore windfarms the counterfactual between the baseline scenario and the scenario with additional effect is generally used as the key metric of effect at the population level (Trinder 2016). Models generally assume a closed population, and may or may not include density-dependence.
Safety zones	A marine area declared for the purposes of safety around a renewable energy installation or works / construction area under the Energy Act 2004.
Seabird Monitoring Programme	The Seabird Monitoring Programme is managed by JNCC and provides an online database of seabird census data and productivity monitoring for colonies around Britain and Ireland.
Scour protection	Protective materials to avoid sediment being eroded away from the base of the foundations as a result of the flow of water.
Transition bay	Underground structures at the landfall that house the joints between the offshore export cables and the onshore cables.

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1 Introduction

1.1 Purpose of this document

1. The purpose of this Information to Support Appropriate Assessment (AA) report is to provide information on the potential for adverse effect on the integrity of European designated sites as a result of the proposed East Anglia TWO project. The report is intended to inform the process of undertaking an AA as required 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'). The Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (hereafter the 'Habitat 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.
2. With regard to the proposed East Anglia TWO project, this document considers Special Protection Area (SPA) features and Special Areas of Conservation (SACs) that were screened in for assessment in the HRA Ornithology Screening (**section 2.1.1**) and Marine Mammals Screening (**section 2.2**). The HRA Screening Report can be found in **Appendix 1**. The Screening Matrices which summarise the information provided in the HRA Screening Report (**Appendix 1**) are provided in **Appendix 2** and the Integrity Matrices which summarise the information within this Information to Support Appropriate Assessment report are provided in **Appendix 3**. The SPAs, SACs and features included in this assessment are therefore those for which it was not possible at the screening stage to rule out the potential for any Likely Significant Effect (LSE) due to the proposed East Anglia TWO project either alone or in-combination with other plans or projects. **Appendix 4** provides the consultation responses received on the draft version of this document which was provided alongside the Preliminary Environmental Information Report (PEIR) in January 2019.
3. For each of these SPAs, SACs, and individual features, evidence is presented that is considered sufficient to enable the Competent Authority to make a decision regarding the possibility of the proposed East Anglia TWO project having an adverse effect on the integrity of the SPA, or SAC considering the specific conservation objectives for the SPA and SAC feature.

2 Overview of HRA Screening

2.1 SPA Sites and Features to be Considered

2.1.1 Conclusions from HRA Screening

4. The HRA Screening Report (**Appendix 1**) identified the following SPA (and Ramsar where relevant) features for which the potential for a Likely Significant Effect (LSE) could not be ruled out. Hence these features and sources of effect require assessment in relation to the proposed East Anglia TWO project.

2.1.1.1 Onshore Ornithology

5. Features and sources of effect requiring assessment in relation to onshore ornithology are:
 - The Sandlings SPA: nightjar and woodlark (habitat loss, and construction phase disturbance during cable installation).
6. The screening report concluded that as the onshore cable corridor would run alongside and potentially through the Sandlings SPA, there is potential for both direct and indirect effects upon the site during all phases of development.

2.1.1.2 Offshore Ornithology

7. Features and sources of effect requiring assessment in relation to offshore ornithology are:
 - Outer Thames Estuary SPA, red-throated diver (disturbance and displacement during cable laying);
 - Greater Wash SPA, red-throated diver (collision risk and barrier effects) and little gull (collision risk);
 - Alde-Ore Estuary SPA, lesser black-backed gull and herring gull (collision risk) (also a Ramsar site);
 - Flamborough and Filey Coast SPA, gannet and kittiwake (collision risk), razorbill, guillemot and puffin (displacement risk);
 - Breydon Water SPA, overwintering wildfowl and waders (collision risk);
 - Broadland SPA, overwintering wildfowl and waders (collision risk); and
 - North Norfolk Coast SPA, overwintering wildfowl and waders (collision risk).
8. Razorbill, guillemot and puffin at Flamborough and Filey Coast SPA were initially screened out of the HRA assessment. However, following discussion at an Expert Topic Group (ETG) meeting in March 2018, Natural England advised that they considered there was the potential for LSE for these features. Consideration of this potential is provided below.

9. East Anglia TWO is a minimum of 248km from the Flamborough and Filey coast SPA, which is much further than the mean maximum auk foraging ranges of 49km, 84km and 105km (razorbill, guillemot and puffin respectively) and also exceeds the respective maximum foraging ranges of 95km, 135km and 200km reported by Thaxter et al. (2012a), which is normally considered to provide the best available peer reviewed data on foraging ranges of UK seabirds. This conclusion is further supported by more recent tracking data: for breeding adult seabirds at a large sample of colonies in Britain and Ireland, data collected in 2010-2014 show median foraging trips from the colony of 13.2km (razorbill) and 10.5km (guillemot) and interquartile ranges for those species of 5.1 to 26.2 km (razorbill) and 3.2 to 19.1km (guillemot) (Wakefield et al. 2017).
10. This means that breeding season connectivity is extremely improbable for these species at the Flamborough and Filey Coast SPA. Individuals of these species observed on the East Anglia TWO windfarm site during the breeding season are therefore likely to be non-breeding birds, including immatures, associated with a large number of North Sea colonies from eastern England to Norway (Furness 2015). This conclusion is evidence-based: ringing studies have shown that many younger immature birds remain in their winter quarters through their first summer (Wernham et al. 2002; Furness 2015), and many immature birds from northern populations are known to winter in the southern North Sea, so these birds are likely to be predominantly immatures from northern populations rather than adults from the Flamborough and Filey Coast SPA. During the nonbreeding period auks from many breeding populations are present in the southern North Sea (Furness 2015). Therefore, it was considered more appropriate to assess auk displacement effects against appropriate BDMPS through the EIA process (as has been undertaken in the EIA). Nonetheless, following Natural England Advice, potential impacts on guillemot and razorbill have been assessed in full.
11. Puffins were recorded in very low numbers in only one survey across two years, therefore the potential for this species to be affected by the proposed East Anglia TWO project can be ruled out and no assessment is presented. This conclusion is consistent with those for East Anglia ONE (DECC 2014) and for East Anglia THREE (Planning Inspectorate 2016), for both projects LSE were ruled out, in agreement with Natural England.
12. In addition, herring gull from the Alde Ore Estuary SPA was considered likely to be at risk of an LSE due to collision risk. This inclusion was made prior to undertaking the project impact assessment for the PEIR. During the assessment of impacts it was found that there was no predicted collision mortality for herring gull (median annual risk was 0, with an upper 95% confidence estimate of 3.4). Therefore, it is appropriate to conclude that there is no potential for a LSE on the

breeding herring gull population at the Alde Ore Estuary SPA and this species has been screened out of further assessment.

13. These conclusions were agreed by Natural England in their response to Screening (Natural England 2018, see **Appendix 4**).
14. Three SPAs designated for overwintering wildfowl and waders have also been included in the assessment: Breydon Water SPA, Broadland SPA and North Norfolk Coast SPA. These sites were included post-screening on the basis that some of the designated species undertake seasonal migrations which may cross the East Anglia TWO windfarm with the consequence that individuals may be at risk of collision and LSE could not therefore be ruled out.

2.2 SAC Sites and Features to be Considered

2.2.1 Marine Mammals

15. The classes of designations considered within this HRA for marine mammals are:
 - Special Areas of Conservation (SACs);
 - Possible SACs (pSACs);
 - o A site which has been identified and approved to go out to formal consultation.
 - Candidate SACs (cSACs);
 - o Following consultation on the pSAC, the site is submitted to the European Commission (EC) for designation and at this stage it is called a cSAC.
 - Sites of Community Importance (SCI);
 - o Once the EC approves the site it becomes a SCI, before the national government then designates it as a SAC.
16. For marine mammals, the approach to HRA screening focused on the potential for connectivity between individual marine mammals from designated sites and the proposed East Anglia TWO project (i.e. demonstration of a clear source-pathway-receptor relationship). This is based on the distance of the offshore development area from the designated site, the range of each effect and the potential for animals from the designated site to be within range of an effect.
17. The HRA screening (**Appendix 1**) identified the marine mammal species listed under Annex II of the Habitats Directive likely to occur in the proposed East Anglia TWO project, based on data collected during aerial surveys of the site and a review of existing data sources. These species were agreed through the consultation process (see **Appendix 4**). Therefore, the species assessed as part of the HRA process are:
 - Harbour porpoise *Phocoena phocoena*;

- Grey seal *Halichoerus grypus*; and
 - Harbour seal *Phoca vitulina*.
18. The HRA screening (**Appendix 1**) identified the following potential effects during construction, operation, maintenance and decommissioning to be considered in the HRA process:
- Underwater noise, including unexploded ordnance (UXO) clearance, piling and other construction activities, vessels, operation and maintenance activities, operational turbines and decommissioning activities;
 - Vessel interactions (increased collision risk);
 - Changes to prey resources;
 - Changes to water quality; and
 - Any in-combination effects of (i) underwater noise; (ii) vessel interactions; and (ii) changes to prey resources.
19. These potential effects were agreed as part of the consultation process (see **Appendix 4**).

2.2.1.1 Designated Sites for Harbour Porpoise

20. For harbour porpoise, connectivity was considered potentially possible between the proposed East Anglia TWO project and any designated site within the North Sea Management Unit (IAMMWG 2015).
21. The HRA screening considered any designated site within the harbour porpoise North Sea MU, where the species is considered as a grade A, B or C feature. Grade D indicates a non-significant population (JNCC 2017c). All designated sites outwith the harbour porpoise North Sea MU area were screened out from further consideration.
22. Designated sites were screened on the basis of the following:
- The distance between the potential impact range of the proposed project and any sites with a marine mammal interest feature which are within the range for which there could be an interaction e.g. the pathway is not too long for significant noise propagation.
 - The distance between the proposed project and resources on which the interest feature depends (i.e. an indirect effect acting through prey or access to habitat) and which is within the range for which there could be an interaction i.e. the pathway is not too long.

- The likelihood that a foraging area or a migratory route occurs within the zone of interaction of the proposed project (applies to mobile interest features when outside the SAC).
23. In total, 31 sites were initially considered in the screening process for harbour porpoise and these sites were assessed for any potential effects from indirect impacts through effects on prey species; underwater noise; and vessel interactions. Of the 31 sites, one site, the Southern North Sea Special Area of Conservation (SNS SAC) was screened in for further assessment.
24. The East Anglia TWO offshore development area is located wholly within the SNS SAC (**Figure 11**). Therefore, any harbour porpoise affected by the proposed East Anglia TWO project would be within or in close proximity to the SNS SAC.

2.2.1.2 Designated Sites for Grey Seal

25. For grey seal, the screening process considered any designated site where the species is a grade A, B or C feature and there is the potential for connectivity between grey seals from the designated site and the offshore development area (i.e. demonstration of a clear source-pathway-receptor relationship).
26. To take the wide range and movements of grey seal into account, initially all designated sites in the Greater North Sea OSPAR region II were considered. All designated sites outwith this region were screened out from further consideration.
27. The HRA screening initially considered a total of 51 European designated sites where grey seal is a qualifying feature and which could have theoretical connectivity with the East Anglia TWO offshore development area. This list was refined based upon field data to a list of 27 sites with potential connectivity, which were then assessed in terms of the potential for LSE of the project. Based upon this process, all sites for grey seal, with the exception of the Humber Estuary SAC, which is 172km at its closest point to the cable corridor route, were screened out from further assessment in the HRA for grey seal (**Appendix 1**).
28. Since the HRA screening the data has been reviewed and taking into account the consultation responses (see **Appendix 4**), all designated sites within 100km, based on the typical foraging range of grey seal (SCOS 2017), have also been considered further in the HRA for any potential effects of changes to prey resources for foraging grey seal. These sites include:
- Vlaamse Banken SAC in Belgium, located approximately 59km from the East Anglia TWO windfarm site and 72km from the cable corridor;
 - SBZ 1 / ZPS 1 SPA in Belgium, located approximately 94km from the East Anglia TWO windfarm site and 107km from the cable corridor;

- SBZ 2 / ZPS 2 SPA in Belgium, located approximately 84km from the East Anglia TWO windfarm site and 100km from the cable corridor;
- SBZ 3 / ZPS 3 SPA in Belgium, located approximately 92km from the East Anglia TWO windfarm site and 108km from the cable corridor;
- Vlakte van de Raan SCI in Belgium, located approximately 89km from the East Anglia TWO windfarm site and 107km from the cable corridor;
- Bancs des Flandres SAC in France, located approximately 82km from the East Anglia TWO windfarm site and 93km from the cable corridor;
- Vlakte van de Raan SAC in the Netherlands, located approximately 82km from the East Anglia TWO windfarm site and 99km from the cable corridor; and
- Voordelta SAC and SPA in the Netherlands, located approximately 84km from the East Anglia TWO windfarm site and 101km from the cable corridor.

2.2.1.3 Designated Sites for Harbour Seal

29. For harbour seal, the screening process considered any designated site where the species is a grade A, B or C feature and there is the potential for connectivity between harbour seals from the designated site and the offshore development area (i.e. demonstration of a clear source-pathway-receptor relationship).
30. To take the wide range and movements of harbour seal into account, initially all designated sites in the Greater North Sea OSPAR region II were considered. All designated sites outwith this region were screened out from further consideration.
31. The HRA screening initially considered a total of 74 European designated sites where harbour seal is a qualifying feature and which could have theoretical connectivity with the proposed East Anglia TWO project. This list was refined based upon field data to a list of 20 sites with potential connectivity which was then assessed in terms of the potential for LSE of the project.
32. Based upon this process, all sites for harbour seal, with the exception of the Wash and North Norfolk Coast SAC (94km at its closest point to the offshore cable corridor), were screened out from further assessment in the HRA for harbour seal.
33. Since the HRA screening, the data has been reviewed, taking into account the consultation responses (see **Appendix 4**). All designated sites within 80km, to take into account the typical foraging range of 50km for harbour seal (SCOS 2017) and the average foraging range of 80km for harbour seal tagged at The Wash (Sharples *et al.* 2012), were also considered further for any potential effects of changes to prey resources for foraging harbour seal. One additional site has been included:

- Vlaamse Banken SAC in Belgium, located approximately 59km from the East Anglia TWO windfarm site and 72km from the cable corridor.

2.3 Summary of Designated Sites and their Features Screened into the Assessment

34. **Table 2.1** outlines the designated sites that have been screened into the assessment as agreed through the HRA Screening Report (**Appendix 1**). It should be noted that 'Designated Site' includes all types of designations treated as Natura 2000 sites by legislation and policy, including Ramsar sites. **Figures 1, 2 and 3** show the sites screened into the assessment for onshore ornithology, offshore ornithology and marine mammals respectively for the proposed East Anglia TWO project.

Table 2.1 List of Designated Sites Screened into the Assessment

Receptor	Designated Sites Screened In
Onshore Ornithology	• Sandlings SPA
Offshore Ornithology	• Outer Thames Estuary SPA • Greater Wash SPA • Alde-Ore Estuary SPA • Flamborough and Filey Coast SPA • Breydon Water SPA • Broadland SPA • North Norfolk Coast SPA
Marine Mammals	• Southern North Sea SAC • The Wash and North Norfolk Coast SAC • Humber Estuary SAC • Vlaamse Banken SAC • SBZ 1 / ZPS 1 SPA • SBZ 2 / ZPS 2 SPA • SBZ 3 / ZPS 3 SPA • Vlakte van de Raan SCI • Bancs des Flandres SAC • Vlakte van de Raan SAC • Voordelta SAC and SPA

35. The features and the potential impact pathways considered in the assessment of each designated site are provided in **Table 2.2**.

Table 2.2 Receptors Considered in the Assessment for Each Designated Site

Designated Site	Feature / Receptor	Impact Pathways Assessed
Sandlings SPA	- Nightjar - Woodlark	- Habitat loss - Disturbance
Outer Thames Estuary SPA	Red throated diver	- Barrier effects - Collision risk - Displacement (both due to construction activities and from the physical presence of the array)
Greater Wash SPA	- Red throated diver - Little gull	- Barrier effects (red throated diver) - Collision risk (red throated diver, little gull) - Displacement (little gull)
Alde-Ore Estuary SPA	Lesser black-backed gull	Collision Risk
Flamborough and Filey Coast SPA	- Gannet - Kittiwake - Razorbill - Guillemot	- Collision risk (gannet, kittiwake) - Displacement (gannet, kittiwake, razorbill, guillemot)
Breydon Water SPA	Overwintering wildfowl and waders	Collision Risk
Broadland SPA	Overwintering wildfowl and waders	Collision Risk
North Norfolk Coast SPA	Overwintering wildfowl and waders	Collision Risk
Southern North Sea SAC	Harbour porpoise	- Underwater noise - Vessel interactions - Indirect impacts through effects on prey species
The Wash and North Norfolk Coast SAC	Harbour seal	- Underwater noise - Vessel interactions - Indirect impacts through effects on prey species
Humber Estuary SAC	Grey seal	- Underwater noise - Vessel interactions - Indirect impacts through effects on prey species

Designated Site	Feature / Receptor	Impact Pathways Assessed
Vlaamse Banken SAC	• Harbour seal • Grey seal	• Underwater noise
SBZ 1 / ZPS 1 SPA	• Grey seal	• Underwater noise
SBZ 2 / ZPS 2 SPA	• Grey seal	• Underwater noise
SBZ 3 / ZPS 3 SPA	• Grey seal	• Underwater noise
Vlakte van de Raan SCI	• Grey seal	• Underwater noise
Bancs des Flandres SAC	• Grey seal	• Underwater noise
Vlakte van de Raan SAC	• Grey seal	• Underwater noise
Voordelta SAC and SPA	• Grey seal	• Underwater noise

3 Onshore Ornithology Assessment of Effects

3.1 Approach to Assessment

36. This section provides information to determine whether there is likely to be an adverse effect on the integrity of the conservation objectives of the Sandlings SPA due to the potential effects of the proposed East Anglia TWO project. **Section 2.1** of **Appendix 1** provides a description of the HRA methodology. This section takes the following structure:

- A summary of proposed East Anglia TWO project onshore infrastructure details, outlining the worst-case scenario and embedded mitigation for the onshore ornithology assessment.
- A description of the Sandlings SPA, its conservation objectives, and baseline onshore ornithology information gathered to aid the assessment.
- For each qualifying feature of the Sandlings SPA:
 - o A summary of the ecology of the species and condition of the SPA population;
 - o A description of potential effects associated with the proposed East Anglia TWO project on the qualifying feature;
 - o An assessment of habitat loss and disturbance impacts during construction and operation of the proposed East Anglia TWO project;
 - o An assessment of in-combination effects when considering the proposed East Anglia TWO project alongside the proposed East Anglia ONE North project, and other developments;
 - o Proposed mitigation measures to avoid an adverse effect on the SPA population, over and above embedded mitigation; and
 - o Conclusions on adverse effects on the integrity of the Sandlings SPA.

3.2 Project Details

3.2.1 Worst-Case Scenario

37. The worst-case scenario for each category of potential effect on Sandlings SPA qualifying features has been determined (**Table 3.1**). The worst-case scenarios identified here also apply to the in-combination assessment. Worst case parameters have been presented for both the open-cut or horizontal directional drilling (HDD) crossing technique to cross the SPA.

Table 3.1 Realistic Worst Case Scenarios

Impact	Parameter	Notes
Construction		
Impacts related to the landfall	There is not considered to be any potential for impacts on qualifying species of the SPA from onshore works associated with the landfall location due to the location of the works and species distribution (section 3.3.2.2 and section 3.3.3.2). Therefore, impacts associated with the landfall location on the SPA have been screened out of this assessment.	
Impacts related to the onshore cable route SPA crossing (open-cut crossing methodology)	Onshore cable route (crossing the SPA): 1,932m² (120m x 16.1m) No jointing bays would be located within the SPA. Onshore cable route haul road (crossing the SPA): 1,020m² (120m x 8.5m). Temporary road matting to be used rather than imported road stone for access Duration of construction: Open trench works associated with crossing the SPA (including works within 200m of the SPA boundary) will be undertaken within approximately three months of excavation works commencing (comprising approximately one month within the boundary of the SPA and approximately two months within 200m of the boundary of the SPA). Working hours: Construction activities would normally be conducted during Monday to Friday working hours of 7am to 7pm and Saturday working hours of 7am to 1pm. Working hours are not proposed for Sundays or Bank Holidays.	Worst case for habitat loss impacts on the SPA are associated with the open cut trenching methodology
Impacts related to the onshore cable route SPA crossing (HDD crossing methodology)	Length of HDD crossing: 407m HDD temporary working areas: Entrance pit temporary working area (x1): 6,300m² (90m x 70m)	Worst case for disturbance impacts on the SPA are associated with the HDD crossing

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Impact	Parameter	Notes
	Exit pit temporary working area (x1): 2,700m² (90m x 30m) Both HDD temporary working areas would be located outside of the SPA Duration of construction: HDD works associated with crossing the SPA (including the establishment and subsequent removal of HDD entry pit and exit pit working areas) will be undertaken over a two year period with works restricted to up to six months per year due to the seasonal restriction. Working hours: Once onshore HDD drilling has commenced it cannot stop which means that the technique requires 24-hour working. This includes requirements for health and safety security and lighting; and construction personnel to be on site throughout this period.	
Impacts related to the onshore cable route (away from the SPA crossing)	Depending on siting of the onshore cable route, some construction activity associated with open-cut trenching may occur within 200m of the SPA. Working hours: Construction activities would normally be conducted during Monday to Friday working hours of 7am to 7pm and Saturday working hours of 7am to 1pm. Working hours are not proposed for Sundays or Bank Holidays.	No potential for habitat loss. Disturbance impacts will be monitored through the Breeding Bird Protection Plan.
Impacts related to the onshore substation	There is not considered to be any potential for impacts on qualifying species of the SPA from onshore works associated with the onshore substation due to the location of the works and species distribution (section 3.3.2.2 and section 3.3.3.2). Therefore, impacts associated with the onshore substation on the SPA have been screened out of this assessment.	
Impacts related to the National Grid Infrastructure	There is not considered to be any potential for impacts on qualifying species of the SPA from onshore works associated with the National Grid infrastructure due to the location of the works and species	

Impact	Parameter	Notes
	distribution (section 3.3.2.2 and section 3.3.3.2). Therefore, impacts associated with the National Grid infrastructure on the SPA have been screened out of this assessment.	
Operation		
Impacts related to the landfall	No above ground infrastructure	
Impacts related to the onshore cable route	No above ground infrastructure	
Impacts related to the onshore substation	There is not considered to be any potential for impacts on qualifying species of the SPA associated with the operational onshore substation due to the type of works and species distribution (section 3.3.2.2 and section 3.3.3.2). Therefore, operational impacts associated with the onshore substation on the SPA have been screened out of this assessment.	
Impacts related to the National Grid Infrastructure	There is not considered to be any potential for impacts on qualifying species of the SPA associated with the operational National Grid infrastructure due to the type of works and species distribution (section 3.3.2.2 and section 3.3.3.2). Therefore, operational impacts associated with the National Grid infrastructure on the SPA have been screened out of this assessment.	

Impact	Parameter	Notes
Decommissioning		
No decision has been made regarding the final decommissioning policy for the onshore infrastructure as it is recognised that industry best practice, rules and legislation change over time. An Onshore Decommissioning Plan will be provided, as secured under the requirements of the draft DCO. It is anticipated that the onshore cable would be decommissioned (de-energised) and either the cables and jointing bays left <i>in situ</i> or removed depending on the requirements of the Onshore Decommissioning Plan approved by the Local Planning Authority. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and agreed with the regulator. As such, for the purposes of a worst-case scenario, impacts no greater than those identified for the construction phase are expected for the decommissioning phase.		

3.2.2 Embedded Mitigation and Best Practice

38. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process. Where embedded mitigation measures have been developed into the design of the proposed East Anglia TWO project with specific regard to qualifying features of the Sandlings SPA, these are described in **Table 3.2**. Any further mitigation measures suggested within this chapter are therefore considered to be additional.

Table 3.2 Embedded Mitigation and Best Practice Measures for Onshore Ornithology

Parameter	Mitigation Measures Embedded into the Project Design
General	
Outline Landscape and Ecological Management Strategy	An Outline Landscape and Ecological Management Strategy (OLEMS) has been submitted with this DCO application. The OLEMS outlines the requirement for landscape and ecological (including ornithological) mitigation measures that are reflective of the surveys and impact assessment carried out for the onshore infrastructure of the proposed East Anglia TWO project. A final detailed Landscape Management Plan (LMP) and Ecological Management Plan (EMP) will be produced post-consent in order to discharge the relevant draft DCO requirements, prior to construction of the proposed East Anglia TWO project, and will be in line with the OLEMS. The final LMP and EMP will provide a key mechanism, required to discharge relevant DCO requirements, through which the relevant regulatory authorities can be assured that ecological management and provision of landscaping associated with the construction of the onshore infrastructure will be formally controlled and implemented.
Onshore development area	Refinements to the onshore cable route and location of associated infrastructure have taken place throughout the design and refinement process, taking into consideration the locations of target species' nest sites, and distribution of suitable habitat for target species. The onshore development area has also been designed to avoid locating infrastructure within a 200m buffer of the SPA where possible. This is in order to achieve a suitable distance between the designated site and construction works associated with the proposed East Anglia TWO project to minimise disturbance and habitat loss to sensitive ornithological receptors. For further details please refer to ES Chapter 4 Site Selection and Assessment of Alternatives.
Construction disturbance	A final Code of Construction Practice (CoCP) will be developed for the construction activities and will adhere to construction industry good practice guidance, as secured under the requirements of the draft DCO. This will incorporate a Breeding Bird Protection Plan (BBPP) which will ensure that the nests, eggs and young of any bird species are protected. Detail with regard to mitigation measures and the content of the BBPP is given in the OLEMS submitted with this DCO application, as secured under the requirements of the draft DCO.

Parameter Mitigation Measures Embedded into the Project Design	
General	
Habitat reinstatement	Following reinstatement of soil and subsoil, final restoration would commence where possible. Pasture and arable land would be reseeded, fences would be reinstated, and suitable hedgerow species replanted. Hedges and any replacement planting would be carried out during the first appropriate planting season following site restoration. In ecologically sensitive areas special restoration may be necessary. Detail is given in the OLEMS submitted with this DCO application, as secured under the requirements of the draft DCO
Onshore Cable Corridor	
Designated Sites	The route of the onshore cable corridor was influenced from the onset of the project design process by the location of designated sites, specifically The Sandlings SPA. The project design minimises the overlap of the onshore cable corridor with these designated sites, choosing a crossing at the narrowest point. Where the onshore cable corridor crosses these designated sites, an open-cut crossing technique is the preferred crossing methodology. When using an open-cut methodology associated with the crossing of the SPA, the Applicant has committed to a reduced onshore cable route working width of 16.1m (reduced from 32m) within the Sandlings SPA for a length up to 300m depending on the detailed design when crossing the Sandlings SPA. The Applicant will not undertake onshore cable route construction works to cross the Sandlings Special Protection Area (SPA) / Leiston – Aldeburgh Site of Special Scientific Interest (SSSI) within the SPA/SSSI boundary or within 200m of the SPA/SSSI boundary during the breeding bird season unless otherwise agreed with Natural England that bird breeding activities within 200m of the SPA/SSSI crossing works area have ceased. The timing of this seasonal restriction will be based on monitoring information provided by the Ecological Clerk of Work (likely to be mid-February to end of August). Works to cross the SPA may be undertaken in phases. Open trench works associated with crossing the SPA (including works within 200m of the SPA boundary) will be undertaken within approximately three months of excavation works commencing (comprising approximately one month within the boundary of the SPA and approximately two months within 200m of the boundary of the SPA). HDD works associated with crossing the SPA (including the establishment and subsequent removal of HDD entry pit and exit pit working areas) will be undertaken over a two year period with works restricted to up to six months per year due to the seasonal restriction. Landscaping works such as hedgerow replanting may be undertaken outside these periods to ensure optimal planting conditions are achieved.

3.3 The Sandlings SPA (habitat loss and disturbance)

39. The Sandlings SPA, location shown in **Figure 1**, was designated in August 2001. It lies near the Suffolk coast between the Deben Estuary and Leiston and covers an area of 3,391.80ha. The SPA is made up of lowland heathland, acid grassland and forestry plantations on sandy soils which once supported extensive

heathland. The main conservation interest lies in the open areas including young plantation and rotational clearfell which provide suitable breeding habitat for the two qualifying species: nightjar and woodlark. These species have adapted to breeding in large blocks of conifer forest, using areas that have recently been felled and recent plantation, as well as areas managed as open ground (Natural England 2001; JNCC 2001).

40. As per Natural England's SPA citation¹, this site qualifies under Article 4.1 of the Directive (79/409/EEC) (the Birds Directive) by supporting populations of European importance during the breeding season, of the following species listed on Annex I of the Directive:
- Nightjar, 109 pairs representing at least 3.2% of the breeding population in Great Britain (count as at 1992); and
 - Woodlark, 154 pairs representing at least 10.3% of the breeding population in Great Britain (count as at 1997).
41. After Screening (Stage 1), Stage 2 of the HRA process requires the consideration of effects on the integrity of the SPA, either alone or in combination with other plans and projects, with regard to the designated site's structure and function and its conservation objectives. Where there are unmitigated adverse effects predicted, an assessment of mitigation options is carried out to determine adverse effect on the integrity of the site.
42. With regard to the Sandlings SPA and the individual qualifying features for which the site has been classified, and subject to natural change, the SPA conservation objectives are:
- Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring:
 - o The extent and distribution of the habitats of the qualifying features;
 - o The structure and function of the habitats of the qualifying features;
 - o The supporting processes on which the habitats of the qualifying features rely;
 - o The population of each of the qualifying features; and
 - o The distribution of the qualifying features within the site.

¹ <http://publications.naturalengland.org.uk/publication/6690828793675776>

3.3.1 Baseline Surveys

43. **Figure 5** shows the extent of onshore ornithology study area in proximity to the Sandlings SPA. The onshore ornithology study area is based on the onshore development area, which includes the landfall, onshore cable corridor, onshore substation and National Grid Infrastructure. From scientific evidence (e.g. Ruddock & Whitfield 2007) and professional judgement, a 400m buffer was included around the onshore development area, which is considered to be the uppermost spatial extent of potential disturbance-displacement impacts around nest sites associated with any ornithological feature likely to be present. The actual extent of potential impacts is likely to be species-specific, with some species having smaller extents of potential impact than 400m from source. The onshore ornithology study area was agreed with stakeholders as part of the Expert Topic Group (ETG) meetings and publication of the Onshore Ornithology Method Statement (SPR 2018) (see **Appendix 4**).
44. It should be noted that at the time of undertaking baseline ornithology surveys in 2018, the onshore development area was yet to be finalised, and therefore surveying was completed on a larger scoping area (of which the onshore development area is a refined (smaller) version of) plus a 400m buffer from this scoping area boundary. The data collected in 2018 are therefore considered to be robust and applicable to the onshore development area. The information presented in this document is described in terms of the onshore development area, as shown on the figures accompanying this chapter.
45. Further breeding bird surveys have been undertaken in 2019, and preliminary results (**Confidential Figure 10**) suggest that numbers and distribution of nightjar and woodlark are consistent with those recorded in 2018 (**Confidential Figures 6 and 8**), and since 2009, as recorded in data provided by RSPB (**Confidential Figures 7 and 9**).

3.3.2 Nightjar

3.3.2.1 Status and Ecology

46. Nightjar is a migrant species, and is only present in Britain from April to August. The species is primarily crepuscular and nocturnal in behaviour, being most active around dusk and dawn. It is insectivorous and nests on the ground, preferring open habitats. Historically, nightjars occurred primarily on heathland, in woodland clearings and on downland, at the interface between woodlands and the open-ground habitats. Nightjars in Suffolk have been observed to prefer to nest on heathlands and young coniferous plantation up to five years old (Ravenscroft 1989).
47. In forested areas, nightjars prefer areas with a ground cover of litter (dead leaves, twigs, etc.), moss, short grass, bracken and shrubs (Bowden & Green 1991). These conditions prevail in clear-fells and young restocks, which are readily

colonised by nightjars and provide a combination of nest clearings, nest cover, scattered song posts and foraging habitat, notably in restocks of 3–5 years old and less than 2m in height (Ravenscroft 1989, Bowden & Green 1991). Thereafter, nightjar density declines with forest stand age.

48. Birds may forage short distances from the nest, particularly when they have eggs or young (Cross et al. 2005), although distances have been recorded up to 3.1km (Alexander & Cresswell 1990). A study of radio-tracked nightjars in southeast England by Sharps et al. (2015) showed that nightjars travelled a mean maximum distance of 747m from their territory centre each night. When leaving their smaller song territories, individuals preferred pre-closure canopy forest and newly planted forest as well as open grazed grass heath.
49. The British nightjar population was estimated to be 4,606 males in 2004, representing a 36% increase in 12 years (Conway et al. 2007). The 2004 survey did however reveal a decline in the Suffolk population (284 males) by around 11% albeit with a relatively low confidence in results. According to Natural England's (2015b) Site Improvement Plan for the Sandlings, the nightjar population on the Suffolk coast has declined by 66% since Sandlings SPA notification in 2001. The main pressures identified within the SPA are inappropriate scrub control, deer, air pollution and public access/disturbance Natural England (2015b).
50. Assuming that the Sandlings SPA population is representative of Suffolk coastal population trends, based on a 66% reduction since citation in 2001, the SPA population may have declined from 109 to around 37 pairs.

3.3.2.2 Potential impacts of the proposed East Anglia TWO project on the SPA feature

51. The key aspects of the proposed East Anglia TWO project with respect to breeding nightjar within the Sandlings SPA are the excavation works (and supporting activities) associated with the onshore cable route during the construction phase. Based on the proposed East Anglia TWO project information presented in **Table 3.1**, and nightjar distribution in **section 3.3.2**, there is not considered to be any potential for impacts on nightjar associated with the landfall, onshore substation or National Grid infrastructure.
52. There is the potential for direct impacts where the footprint of the onshore development area overlaps with nightjar habitat (either inside the SPA, or outside of the SPA but used by SPA birds), leading to loss or fragmentation of habitat, which could be short- to medium-term (e.g. CCS and temporary working area, excavation works). This could impact on nesting or foraging individuals. Further details of the realistic worst case parameters can be found in **Table 3.1**.

53. Displacement and disruption of nesting and foraging nightjars as a result of construction-related noise and general disturbance may occur over a short-term period (the duration of a particular construction activity within working hours) or over the medium-term (the duration of the whole construction period).
54. During the operational period routine maintenance, emergency repairs and associated lighting may potentially affect breeding nightjar.
55. Details of survey observations in 2018 are shown on **Confidential Figure 6**. Expert professional judgement has been used to define the number of territories based on the survey observations. The number of territories are then presented in this report. Historic data for nightjar from 2009 to 2018 provided by RSPB is shown in **Confidential Figure 7**. Results from the initial nightjar survey in 2019 are shown in **Confidential Figure 10**.

3.3.2.3 Assessment of Habitat Loss to Nightjar due to Onshore Cable Infrastructure

3.3.2.3.1 During Construction

56. Baseline surveys within the onshore ornithology study area in 2018 recorded six nightjar territories, signified by the presence of churring males that were regularly distributed in dry heath habitats within the Sandlings SPA, outside of the onshore development area (**Confidential Figure 6**).
57. Historic RSPB records from 2009 to 2018 (**Confidential Figure 7**), and preliminary results from 2019 (**Confidential Figure 10**), show a consistent pattern of distribution within the heath habitats, closely resembling that of the 2018 survey results. In 2017 the RSPB recorded four churring males within the North Warren reserve (overlapping with the Sandlings SPA), in similar locations to the churring males recorded in 2018. Numbers from 2009 to 2017 varied between zero and five males. Up to two males may be present within Thorpeness Golf Course, outside of the North Warren reserve.
58. Two territory centres within the Sandlings SPA were within 200m of the onshore development area in 2018 (see **Confidential Figure 6**), and this is likely to be the maximum number in any year, based on historic RSPB data (**Confidential Figure 7**). In 2018, two further territories were within 500m of the onshore development area, and two further territories were within 750m, suggesting that there may be some potential for these foraging ranges to overlap with the onshore development area (based on a mean maximum foraging range of 747m described by Sharps et al. (2015)).
59. The results of the Extended Phase 1 Habitat Survey in **ES Figure 22.3.3** however show that there is no suitable nightjar habitat (taken to be heath, coniferous woodland or scattered trees) within the onshore development area, apart from a small amount of scrub in the part where it overlaps with the northernmost part of

the Sandlings SPA, which is dominated in parts by bracken. The proposed East Anglia TWO project design has minimised the overlap of the onshore cable route with the SPA, choosing a crossing at the narrowest point.

60. Where the onshore cable corridor crosses this part of the SPA, an open cut crossing technique is the preferred crossing methodology. When using an open cut methodology, the Applicant has committed to a reduced onshore cable route working width of 16.1m (reduced from 32m) within the Sandlings SPA for a length up to 300m depending on the detailed design when crossing the Sandlings SPA (see **Table 3.2** outlining embedded mitigation measures). This would be microsituated to minimise the risk of impacts on SPA qualifying features, based on the results of baseline and pre-construction surveys.
61. Crossing the SPA using an open cut methodology will last an estimated one month in duration. The Applicant has further committed to conducting this estimated one month of open cut trenching through the SPA outside of the breeding bird season, therefore minimising potential impacts to the features of the SPA (see **Figure 5**). The breeding bird season is considered to be mid-February to August inclusive. This will be confirmed through the EMP.
62. If an HDD technique were to be employed the Applicant has committed to undertaking work crossing the SPA outside of the breeding bird season (see **Table 3.2**). Boring operations would be completed within approximately six months and HDD entrance and exit pit temporary working areas would be located outside of the SPA. The HDD works may be undertaken over two years to comply with the seasonal restriction associated with crossing the SPA.
63. Taking into consideration these embedded mitigation measures for the SPA crossing, and since no nightjars have previously been recorded within the area of the SPA where the open-cut trenching would be located (at least since 2009 according to RSPB data), it is unlikely that any suitable nightjar habitat for nesting or foraging would be lost due to open-cut trenching or HDD work associated with the proposed East Anglia TWO project. As such it can be reasonably concluded that the relevant conservation objectives would not be compromised, i.e:
 - Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring:
 - o The extent and distribution of the habitats of the qualifying features;
 - o The structure and function of the habitats of the qualifying features;
 - o The supporting processes on which the habitats of the qualifying features rely;

64. Therefore, there would be no adverse effect on the integrity of the SPA due to habitat loss on nightjar.

3.3.2.3.2 During Operation

65. Following construction, all habitats along the onshore cable corridor will be fully re-instated, including any affected habitats within the SPA. During the operational period, the onshore substation and National Grid infrastructure would be present. These would however be in unsuitable habitat over 2km from the SPA, meaning there will be no permanent SPA habitat loss.
66. Based on the information provided above, no habitat for nesting or foraging nightjars would be lost due to the operation of the onshore infrastructure associated with the proposed East Anglia TWO project. As such it can be reasonably concluded that the SPA's conservation objectives (see **paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational habitat loss on nightjar.

3.3.2.4 Assessment of Disturbance to Nightjar due to Onshore Infrastructure

3.3.2.4.1 During Construction

67. Breeding nightjars may be disturbed by construction activities while at their nest sites, or elsewhere within their territory when foraging. In their review of expert literature, Ruddock & Whitfield (2007) indicated an active disturbance (e.g. taking flight, moving away from the observer) upper limit of <10m for nesting nightjar during incubation and 50–100m during chick rearing. Murison (2002) however found a significant negative impact on nightjar density within 500m of a path, suggesting that failures could be linked to predation by corvids and dogs operating in conjunction with human disturbance. Furthermore, FCS (2006) advocated a safe working distance of forestry operations from nightjar nest sites of 50-200m, based on Currie & Elliott (1997) who advocated set-back working distances of 200m at egg stage and 50-100m at chick stage.
68. Recently, Shewring & Carrington (2017) reported on nightjar monitoring during the construction period of the Pen y Cymoedd Wind Farm in Wales over a three year period. They found no significant difference detected between chick numbers or nest success at nests within and outside 200m disturbance buffers, and suggested that the current standard 200m disturbance is buffer likely to be excessive.
69. Based on the information presented above, any disturbance impacts on nightjar within the onshore development area beyond a 200m buffer from a nest would likely to be those related to increased access for predators, dogs or humans, rather than noise or visual disturbance associated with any construction activities within the landfall area. The level of access within and surrounding the Sandlings SPA is not however anticipated to change as a result of construction of the

- proposed East Anglia TWO project, suggesting no additional adverse disturbance impacts would occur beyond 200m from a disturbance source.
70. When considering the 200m potential disturbance buffer for nesting nightjars, as a worst-case, two territory centres recorded in the Sandlings SPA in 2018 were within 200m of the onshore development area which may potentially be affected by unmitigated construction activities during the construction period. This is likely to be the maximum amount of territories within this range, based on historic RSPB data. One of these territories is in proximity to the area demarcated for turtle dove mitigation (see **ES Chapter 23 Onshore Ornithology** and **ES Figure 23.5** for details), and so the risk of construction-related disturbance to breeding birds within this territory is low. Remaining unmitigated disturbance risks are therefore likely to be associated with the other regularly-occupied territory closer to the part of the onshore cable corridor that is near to, and crosses the SPA.
71. The likelihood and extent of the territory within proximity to the SPA crossing area being affected would depend on the seasonal and spatial restrictions of open-cut trenching or HDD crossing techniques (see **Table 3.2** outlining embedded mitigation measures).
72. Where the onshore cable corridor crosses the SPA, an open-cut crossing technique is the preferred crossing methodology. Crossing the SPA using this methodology will last an estimated one month in duration, which would take place outside of the breeding bird season, therefore avoiding potential disturbance impacts to breeding nightjar. As a migratory species, no individuals would be present when open-cut trenching through the SPA would take place.
73. If an HDD technique is used to cross the SPA, seasonal restrictions within 200m of the SPA would again mean that nightjars would not be present within this area when works were carried out, and therefore would not be at risk of disturbance. This includes works associated with the establishment of a HDD entry pit working area and HDD exit pit working area, HDD boring operations and reinstatement of the HDD entry pit and HDD exit pit working areas, which may be split over two non-breeding seasons to avoid overlap with breeding activity (as per **Table 3.1**).
74. Given the seasonal and spatial restrictions associated with the SPA crossing, as described above, it is considered unlikely that any nesting nightjars would be subject to disturbance during the construction period. Although works along the remainder of the onshore cable corridor (beyond 200m from the SPA crossing) could take place within the nightjar breeding season, it is considered unlikely that any breeding nightjars would be disturbed by this, occurring beyond 200m from any probable nest site locations, in unsuitable foraging habitat. It is therefore predicted that there would be no loss of any nightjar breeding territories under either the open-cut trenching or HDD scenarios. As such it can be reasonably

concluded that the relevant conservation objectives would not be compromised, i.e:

- Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring:
 - o The population of each of the qualifying features; and
 - o The distribution of the qualifying features within the site.

75. Therefore, there would be no adverse effect on the integrity of the SPA due to disturbance of nightjar.

3.3.2.4.2 During Operation

76. During the operational period, routine maintenance is not anticipated for the onshore cable route. Emergency repairs are expected to be infrequent and short-term in duration. Temporary task lighting may be used in any area in which maintenance or repair works are being undertaken, but due to the distance from the nearest territories within the SPA (likely to be over 200m), this would be unlikely to affect any nightjars, even over a short-term period.

77. Operational lighting will be required for maintenance activities at the onshore substation and National Grid substation only, and under normal conditions the onshore and National Grid substations would not be permanently lit. An Artificial Light Emissions Management Plan will be developed for the final design for the permanent infrastructure, as secured under the requirements of the draft DCO, which will include measures to minimise light spill. As the infrastructure is over 2km from the SPA, no nightjars would be affected by this lighting.

78. As such it can be reasonably concluded that the SPA's Conservation Objectives (see **paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.3.2.5 In-combination Impacts

79. This section assesses the potential for in-combination effects on the Sandlings SPA nightjar population, when considering firstly the proposed East Anglia ONE North project, and then all relevant proposed developments alongside the proposed East Anglia TWO project.

80. According to Natural England's (2015b) *Site Improvement Plan* for the Sandlings, the pressures on the Sandlings SPA nightjar population are likely to be more related to levels of public access rather than loss of habitat associated with proposed or existing developments. In general, it is anticipated that the mainly agricultural landscape surrounding the SPA will remain largely unchanged over the medium term at least. However, three planned projects within a potential zone of influence for SPA nightjars have been identified: the proposed East

Anglia ONE North offshore windfarm project (the proposed East Anglia ONE North project); the proposed Sizewell C New Nuclear Power Station, and the proposed Sizewell B Power Station Complex and adjoining land (see **Table 23.22 of ES Chapter 23 Onshore Ornithology** for details on these projects).

3.3.2.5.1 In-combination Impact with proposed East Anglia ONE North Project

81. The proposed East Anglia ONE North project is also in the application phase, and has a separate DCO which has been submitted at the same time as the proposed East Anglia TWO project. The two projects share the same landfall location and onshore cable corridor and the two onshore substations are co-located, and connect into the same National Grid substation.
82. The proposed East Anglia TWO project in-combination assessment therefore initially considers the cumulative impact with only the East Anglia ONE North project, under two construction scenarios:
 - Scenario 1 - the proposed East Anglia TWO project and proposed East Anglia ONE North project are built simultaneously; and
 - Scenario 2 - the proposed East Anglia TWO project and the proposed East Anglia ONE North project are built sequentially.
83. The worst case (based on the assessment of these two construction scenarios) for each impact is then carried through to the wider in-combination assessment which considers other developments which have been screened into the CIA of the proposed East Anglia TWO project. The operational phase impacts will be the same irrespective of the construction scenario. For a more detailed description of the assessment scenarios please refer to **ES Chapter 5 EIA Methodology**.
84. A detailed cumulative assessment of scenario 1 and scenario 2 within an EIA context can be found in **ES Appendix 23.2**. The following sections discuss which of the two scenarios detailed above will be the worst case in terms of in-combination construction impacts relating to nightjar.

3.3.2.5.1.1 Assessment of In-combination Habitat Loss to Nightjar During Construction

85. The results from baseline surveys presented in **Confidential Figures 6 and 7** show that the onshore development area, which would be shared by the proposed East Anglia ONE North project and proposed East Anglia TWO project, has little suitable habitat for nightjar, with nesting and foraging activity likely to take place within the confines of the Sandlings SPA (see **section 3.3.2.3** for details).

86. If open-cut trenching techniques are used across the SPA for the construction of both the proposed East Anglia TWO and proposed East Anglia ONE North project, the cable route working width within the Sandlings SPA would be reduced to 16.1m for each project, therefore 32.2m in total. This would represent a temporary loss of up to 0.966ha of the SPA designation, or 0.03% of the whole SPA (3,405ha). Where the onshore cable route crosses the SPA however, as noted in **section 3.3.2.4**, and as **Confidential Figure 7** demonstrates, there have been no records of nightjar using this area since at least 2009, and the habitat is unlikely to be of any importance to the species.
87. If HDD techniques are used, no SPA habitat, or habitat suitable for foraging outside of the SPA, would be lost during the construction period of both the East Anglia TWO and East Anglia ONE North projects.
88. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to in-combination habitat loss on nightjar.

During Operation

89. Following construction of both projects, all habitats within the SPA will be fully re-instated meaning there will be no permanent SPA habitat loss.
90. Based on the information provided above, no habitat for nesting or foraging nightjars would be lost due to the operation of the onshore infrastructure associated with the proposed East Anglia TWO project and East Anglia ONE North project (onshore substation and National Grid infrastructure being over 2km from the SPA).
91. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.3.2.5.1.2 Assessment of In-Combination Disturbance to Nightjar due to Onshore Infrastructure

During Construction

92. Although temporary, unmitigated construction disturbance has the potential to affect nightjar over a wider spatial extent than direct habitat loss, and therefore in this case has a greater potential to result in an adverse effect. It is considered that scenario 2 would have a greater potential for an unmitigated in-combination effect due to the increased duration of construction activities. The impacts of the increased duration of construction activities described under scenario 2 (as per **Appendix 23.2 of ES Chapter 23 Onshore Ornithology**) would mean that breeding nightjar could theoretically be affected for two breeding seasons, which

would increase the possibility of territories being abandoned beyond the construction period and over the longer-term.

93. As outlined in **section 3.3.2.4.1**, similar embedded mitigation measures in the vicinity of the SPA, for both the proposed East Anglia ONE North project and East Anglia TWO project would reduce the likelihood that nightjars would be disturbed by construction activities. Under either scenario 1 or scenario 2, both projects would be subject to the breeding season restriction (i.e. construction undertaken outside of the breeding bird season) for both open-cut trenching and HDD techniques used to cross the SPA, meaning that nightjars would not be present when works take place in this area. As described above in **section 3.3.2.4.1**, although construction activities within the onshore development area beyond 200m from the SPA crossing section may take place during the breeding season, this would be in unsuitable habitat, and no disturbance to any nightjars is therefore likely. No adverse effects on the integrity of the SPA due to in-combination disturbance are therefore predicted.

During Operation

94. Operational impacts on nightjar will be the same irrespective of construction scenario. See **Table 3.1** for a summary of operational impacts. Based on the information presented in **section 3.3.2.4.2** it is considered very unlikely that there would be any unmitigated adverse effects associated with the operational phase of the proposed East Anglia TWO project on nightjar, and this would also be true for the proposed East Anglia ONE North project.
95. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.3.2.5.2 In-combination Impact with Other Developments

96. This section assesses the potential for in-combination effects on the Sandlings SPA nightjar population, when considering all identified proposed developments (the proposed East Anglia ONE North project, Sizewell C New Nuclear Power Station and Sizewell B Power Station Complex) alongside the proposed East Anglia TWO project.

3.3.2.5.2.1 Assessment of In-Combination Habitat Loss to Nightjar

During Construction

97. The main development site for Sizewell C New Nuclear Power Station would be located directly to the north of the existing Sizewell B Power Station, approximately 1.3km from the onshore development area, and 1.6km from the Sandlings SPA at its closest point.

98. The Sizewell B Power Station Complex project comprises the relocation and consolidation of nineteen of the existing Sizewell B Power Station Complex facilities. Several of the facilities would need to be relocated from the area of land that is nominated as being part of the site proposed for the development of the Sizewell C New Nuclear Power Station. There will be two main areas of expansion associated with these plans: a car park, laydown area and training centre to the west of the existing Sizewell A power station in an area of mixed plantation woodland and scrub; and the creation of an outage car park and access, to the south of Sizewell A within an area of semi-improved grassland ('Pillbox Field'). The Pillbox Field car park is the closest point of the Sizewell B and C developments to the onshore development area, being around 450m to the east, and approximately 650m east of the Sandlings SPA at its closest point.
99. According to the Sizewell C PEIR (EDF Energy 2019), there was no evidence to suggest that nightjar is currently breeding within the Sizewell C New Nuclear Power Station study area. Adjacent land to the SPA where the closest infrastructure would be located comprises unsuitable agricultural habitats, and so no territory for SPA nightjars is likely to be lost due to either development.
100. No additional in-combination habitat loss effects are therefore predicted, over and above those predicted for the proposed East Anglia TWO project alone, or when also including the proposed East Anglia ONE North project. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to construction effects on nightjar.

During Operation

101. No in-combination operational impacts are predicted because there would be no habitat loss associated with the operational phase of the proposed East Anglia TWO and East Anglia ONE North project. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.3.2.5.2.2 Assessment of In-Combination Disturbance to Nightjar due to Onshore Infrastructure

During Construction

102. The construction of the Sizewell C New Nuclear Power Station is predicted to take between 9 and 12 years. The construction period associated with Sizewell B is expected to approximately four and a half years which would therefore overlap with four to five breeding seasons.
103. According to the Sizewell C PEIR (EDF Energy 2019), there was no evidence to suggest that nightjar is currently breeding within the Sizewell C New Nuclear

Power Station study area. As part of the ornithology assessment, a number of mitigation measures have been explored for Sizewell C New Nuclear Power Station, including the maintenance of habitat corridors, the management of public access to sensitive sites (including the SPA), and the inclusion of environmental buffers and acoustic fencing to help protect neighbouring habitats and species from light, noise and visual disturbance.

104. With the closest nightjar territory within the SPA likely to be outside of foraging range (over 750m) from the proposed Sizewell B Power Station Complex and Sizewell C New Nuclear Power Station projects, and potential mitigation measures described above implemented, no additional in-combination disturbance impacts are predicted over and above any associated with the proposed East Anglia ONE North and proposed East Anglia TWO projects. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to disturbance effects on nightjar.

During Operation

105. No in-combination operational impacts are predicted due to the lack of likely disturbance impacts arising from the operational phase associated with the proposed East Anglia ONE North and East Anglia TWO projects. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.3.2.6 Mitigation Measures

106. Beyond the embedded design measures outlined in **Table 23.3** of **ES Chapter 23 Onshore Ornithology**, the following mitigation is planned for the duration of the construction period, which is designed to reduce the effects on breeding birds, including nightjar, to a non-significant level.
107. The Ecological Management Plan (EMP), developed post-consent to discharge the requirements of the DCO, would include an SPA crossing Method Statement, developed for working within and / or in proximity to the Sandlings SPA.
108. Although no adverse effects on the SPA are predicted, based on known nightjar breeding distribution and habitat requirements, onshore cable corridor work beyond 200m from the SPA crossing area may take place during the breeding season. In order to safeguard breeding individuals from disturbance, a BBPP would ensure compliance with the Wildlife & Countryside Act 1981. This will be developed post-consent in consultation with the relevant regulating authorities and is secured under the requirements of the draft DCO. Further detail on the BBPP is provided in the OLEMS submitted with this DCO application, as secured under the requirements of the draft DCO.

109. When undertaking construction works (excluding personnel and vehicle use of haul roads) within 200m of the SPA boundary during the breeding bird season (mid-February to August) the following examples of mitigation measures may be employed:

- The BBPP will highlight the risks to breeding birds and detail measures to ensure the protection of their nests;
- Pre- and during construction bird surveys will be undertaken to establish the presence of breeding birds;
- Measures will be adopted to minimise noise, light and disturbance on identified breeding birds, such as visual screening (e.g. opaque fencing) where necessary;
- Construction activities would be monitored by an Environmental Clerk of Works (ECoW) or suitably qualified ornithologist, who would seek to ensure compliance with the Wildlife & Countryside Act 1981 by avoiding destruction of nests, eggs or young, and affording increased protection from disturbance to Schedule 1 species breeding birds; and
- Where breeding bird activity within the SPA is recorded within 200m of construction works, such construction works would be halted immediately until a disturbance risk assessment is undertaken by a suitably qualified ecologist. The risk assessment would consider the nature of construction activity, likelihood of disturbance, and possible implications of the construction activities on the breeding attempt and set out measures to ensure that no disturbance occurs. Where it is determined that breeding birds are not likely to be affected, construction works will continue. Where it is determined that breeding birds may be affected, additional mitigation works will be implemented to prevent disturbance. Where, in the opinion of the suitably qualified ecologist, disturbance cannot be avoided by mitigation, construction works within the area of disturbance will be suspended until chicks have fledged.

3.3.2.7 Conclusion

110. The Sandlings SPA nightjar population is likely to be in unfavourable conservation status, compared to the cited SPA population. Any unmitigated reduction in breeding numbers is therefore likely to further impact on the restoration of favourable conservation status of the site. The main potential impacts on nightjar associated with the proposed East Anglia TWO project that were identified are habitat loss and disturbance during the construction phase.

111. No permanent SPA habitat loss will result from installation of the onshore cable, and any medium-term habitat loss inside or outside the SPA during construction

- is considered to be unimportant to the SPA nightjar population, due to its low suitability for nesting or foraging, and lack of historic breeding records.
112. To avoid the possible unmitigated loss of a nightjar territory and an adverse effect on the integrity of the SPA due to construction disturbance, spatial and temporal restrictions of open-cut trenching and HDD works to cross the SPA would be deployed.
 113. The spatial and temporal embedded mitigation measures would remove the possibility that nightjars would be disturbed by construction activities within the SPA, and it is therefore predicted that there would be no loss of any nightjar breeding territories under the open-cut trenching or HDD scenarios. Beyond the area of seasonal restrictions, the BBPP would ensure that construction works within 200m of the SPA would not disturb breeding birds.
 114. During the operational period, there would be no habitat loss, disturbance and lighting impacts.
 115. On the basis of the assessment detailed above, taking into account relevant mitigation measures, it can be concluded with confidence that for nightjar that there will be no adverse effects on the integrity of the Sandlings SPA as a result of the proposed East Anglia TWO project acting alone.
 116. When considering the proposed East Anglia ONE North and East Anglia TWO projects in-combination, and assuming mitigation measures would be similar for both projects, no adverse effects on the integrity of the Sandlings SPA are predicted, regardless of whether scenario 1 or scenario 2 is selected.
 117. Baseline surveys to date for Sizewell C New Nuclear Power Station suggest that the area around the Sizewell C New Nuclear Power Station and Sizewell B Power Station Complex is not used by nightjar. Mitigation measures outlined for the proposed East Anglia TWO and East Anglia ONE North projects would minimise the risk of an in-combination effect on the SPA nightjar population occurring.
 118. For the proposed East Anglia TWO (and East Anglia ONE North) project, the potential mitigation measures outlined in **section 3.3.2.3.1** would be required during the construction period only, after which there would be no contribution of the proposed East Anglia TWO project to in-combination effects during the operational periods. Hence, no adverse effect on the integrity of the SPA as a result of in-combination effects is predicted.

3.3.3 Woodlark

3.3.3.1 Status and Ecology

119. Woodlark breeding habitat includes heaths, scrubland, woodland edges, neglected farmland and golf courses, avoiding areas of intensive agriculture. In

England, the largest population is in the Breckland region of Suffolk and Norfolk, where most pairs breed in areas of pine forest that have been felled and replanted (Forrester et al. 2007). The species is resident, feeding on seeds and insects, and moves to farmland stubbles in autumn and early winter. Woodlark is an early breeder, potentially beginning in mid-February within the SPA.

120. Since the early 1990s there have been significant changes to core woodlark habitat types in England (Conway et al. 2007). The age structure and species composition of forestry plantations has changed due to different management regimes and the ageing of forestry plantations. Between 1997 and 2006 in the Suffolk Sandlings, a substantial shift in habitat association for woodlarks meant a large decline in plantations/woodland, but a two-fold increase on heathland (mainly grass-heathland) and a three-fold proportional increase on farmland (especially non-cropped habitats). Woodlarks now occupy both planted forests and heathland, including grass heaths, in similar proportions (Langston et al. 2007).
121. The national woodlark population was last estimated at 3,064 territories in 2006, which represented an increase of 88% since 1997 (Conway et al. 2009). Of this, it was estimated that 209 territories were within the Suffolk Sandlings (which includes a larger area than the Sandlings SPA), which represented a decline in numbers, contrary to the national trend.
122. According to Natural England's (2015b) *Site Improvement Plan* for the Sandlings, the woodlark population on the Suffolk coast has declined by 65% since the Sandlings SPA notification in 2001. The main pressures identified within the SPA are inappropriate scrub control, deer, air pollution and public access/disturbance Natural England (2015b).
123. Assuming that the Sandlings SPA population is representative of wider Suffolk coastal population trends, based on a 65% reduction since citation in 2001, the SPA population may have declined from 154 to around 54 pairs.

3.3.3.2 Potential impacts of the proposed East Anglia TWO project on the SPA feature

124. The key aspects of the proposed East Anglia TWO project with respect to breeding woodlark within the Sandlings SPA are the excavation works (and supporting activities) associated with the onshore cable route during the construction phase. Based on the proposed East Anglia TWO project information presented in **Table 3.1**, and woodlark distribution in **section 3.3.3**, there is not considered to be any potential for impacts on nightjar associated with the landfall, onshore substation or National Grid infrastructure.
125. There is the potential for direct impacts where the footprint of the onshore development area overlaps with woodlark habitat (either inside the SPA, or

outside of the SPA but used by SPA birds), leading to loss or fragmentation of habitat, which could be short- to medium-term (e.g. CCS, excavation works). This could impact on breeding or foraging individuals. Further details of the worst case parameters can be found in **Table 3.1**.

126. Displacement and disruption of breeding and foraging woodlark as a result of construction-related noise and general disturbance may occur over a short-term period (the duration of a particular construction activity within working hours) or over the medium-term (the duration of the whole construction period).
127. During the operational period routine maintenance, emergency repairs and associated lighting may potentially affect breeding woodlark.
128. Details of survey observations of woodlark in 2018 are shown on **Confidential Figure 8**. Expert professional judgement has been used to define the number of territories based on the survey observations. The number of territories are then presented in this report. Historic data for woodlark from 2009 to 2018 provided by RSPB is shown in **Confidential Figure 9**. Preliminary results from 2019 breeding bird surveys, which are broadly consistent with previous years, are shown in **Confidential Figure 10**.

3.3.3.3 Assessment of Habitat Loss to Woodlark due to Onshore Cable Installation

3.3.3.3.1 During Construction

129. Approximately six woodlark territories were located within suitable heath, scrub and forestry habitats within the Sandlings SPA in 2018 (**Confidential Figure 8**). Of these territories, up to three may overlap in part with the onshore development area.
130. The RSPB provided survey data from 2008 to 2018 for the Sandlings SPA (**Confidential Figure 9**). No further woodlark territories that may overlap with the onshore development area were recorded by RSPB in 2018. Historic distribution was similar to that recorded in 2018, with the species showing a strong preference for the open heath habitats. Results showed that six woodlark territories were recorded in 2017, in broadly similar areas locations to those found in 2018, and from preliminary results in 2019 (**Confidential Figure 10**). Woodlark numbers appear to be reasonably stable since 2012.
131. The results of the Extended Phase 1 Habitat survey (conducted to inform **ES Chapter 22 Onshore Ecology**) show that there is a lack of suitable habitat (taken to be heath, woodland, scrub or neglected farmland) surrounding the SPA, with land comprising improved grassland and arable fields, with only small, isolated patches of scrub and woodland. Woodlarks are therefore likely to remain largely, if not exclusively, within the SPA when breeding.

132. Where the onshore cable corridor crosses the northernmost part of the SPA, an open cut crossing technique is the preferred crossing methodology. When using an open cut methodology, the Applicant has committed to a reduced onshore cable route working width of 16.1m (reduced from 32m) within the Sandlings SPA for a length up to 300m depending on the detailed design when crossing the Sandlings SPA (see **Table 3.2** outlining embedded mitigation measures). This would be micro-sited to minimise the risk of impacts on SPA qualifying features, based on the results of baseline and pre-construction surveys.
133. Some habitat within the northern part of the SPA would therefore be lost during the construction phase should open-cut trenching be conducted. However, from 2018 baseline survey data, and historic RSPB data since 2008, woodlarks were not recorded in this area of the SPA, showing that it is not likely to be part of any territories. Indeed, the habitat here mainly comprises dense scrub, dominated by bracken in places, which is less suited to woodlarks.
134. If a HDD technique were to be employed to cross the SPA, the HDD entrance and exit pit temporary working areas would be located outside of the SPA. No SPA habitat would therefore be lost, with any non-SPA habitats affected by HDD works likely to be unsuitable for woodlark.
135. No habitat loss impact from within the SPA is therefore predicted, regardless of whether open-cut trenching or HDD techniques are used to cross the SPA.
136. The other two territories from 2018 that may have been at least partially overlapping with the onshore development area to the west of the SPA crossing, were located beside the area allocated for turtle dove mitigation (see **Confidential Figure 5**) rather than construction activities. Therefore, no habitat would be lost to onshore infrastructure in this area, and indeed the habitat may become more suitable for woodlark than at present.
137. Based on the information provided above, it is therefore considered unlikely that any habitat for nesting or foraging woodlark would be lost due to the construction of infrastructure associated with the proposed East Anglia TWO project and that the temporary loss of habitat within the SPA.
138. As such it can be reasonably concluded that the relevant conservation objectives would not be compromised, i.e:
- Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring:
 - o The extent and distribution of the habitats of the qualifying features;
 - o The structure and function of the habitats of the qualifying features;

- o The supporting processes on which the habitats of the qualifying features rely;

139. Therefore, there would be no adverse effect on the integrity of the SPA due to habitat loss on woodlark.

3.3.3.3.2 During Operation

140. Following construction, all habitats along the onshore cable corridor, including within the SPA, will be fully re-instated. During the operational period, the onshore substation and National Grid infrastructure would be present. These would however be in unsuitable habitat over 2km from the SPA, meaning there will be no permanent SPA habitat loss.

141. Based on the information provided above, no habitat for nesting or foraging woodlarks would be lost due to the operation of the onshore infrastructure associated with the proposed East Anglia TWO project. As such it can be reasonably concluded that the SPA's Conservation Objectives would not be compromised and that there would be no adverse effect (see **paragraph 42**) on the integrity of the SPA due to operational habitat loss on woodlark.

3.3.3.4 Assessment of Disturbance to Woodlark due to Onshore Cable Installation

3.3.3.4.1 During Construction

142. Breeding woodlark may be disturbed by construction activities while at their nest sites, or elsewhere within their territory when foraging. In relation to studies of disturbance effects on woodlark, Mallord et al. (2006) found that the distribution of woodlarks on Dorset heaths was significantly affected by the presence of people and dogs. Heavily disturbed areas were still used for foraging, even though the habitat was suitable for both foraging and nesting. However, there was no effect of disturbance on nest survival or productivity. Dolman (2015) conducted a study of 147 woodlark nests in Breckland Forest, which showed strong evidence that neither woodlark nest success, nor the productivity of successful nests, were affected by the levels of recreational activity observed. Analysis of broods from 54 successful nests gave no evidence that recreational activity affected post-fledging survival.

143. Activities associated with construction within the onshore development area are likely to be more predictable and less intrusive than those associated with recreational access described in the above studies, and indeed those currently occurring in the local area, as they would take place in a clearly defined zone outside of the SPA. Even if there remains a small risk of short- or medium-term disturbance to foraging birds away from nest sites and outside of the SPA caused by construction activities, scientific studies suggest a loss of territories, or significant reduction in productivity to the SPA population is unlikely.

144. Of the three territories identified in proximity to the onshore development area in 2018, one was within 200m of the northernmost part of the SPA where a crossing of the cable corridor is required. The likelihood and extent of this territory being affected would depend on the seasonal and spatial restrictions of open-cut trenching or HDD crossing techniques.
145. Works associated with open-cut trenching of the SPA crossing would take an estimated one month to complete, and occur outside of the woodlark breeding season. The closest breeding territory would therefore be unaffected by any disturbance impacts. Disturbance to any woodlarks present within the SPA during the non-breeding season when open-cut trenching would take place, are considered to be unlikely due to the low suitability of habitat, and would not impact on an individual's fitness or survival, based on the literature evidence provided above.
146. If a HDD technique is used to cross the SPA, associated works within 200m of the SPA crossing area would also take place outside of the breeding season, although the phases of construction (see **Table 3.2**) may be undertaken over two years to comply with the seasonal restriction. No breeding woodlarks would be disturbed by this work.
147. Although construction activity may take place outside the area of seasonal open-cut trenching/ HDD restrictions during the breeding season, because the other two territories potentially overlapping with the onshore development area are located beside the area demarcated for turtle dove mitigation, which would be free of any cable installation infrastructure, it is considered unlikely that these territories would be affected by construction disturbance, which would occur beyond potential disturbance distances (likely over 200m from any nest sites)..
148. It is therefore predicted that there would be no loss of any woodlark breeding territories under either the open-cut trenching or HDD scenarios.
149. As such it can be reasonably concluded that the relevant conservation objectives would not be compromised, i.e:
- Ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring:
 - o The population of each of the qualifying features; and
 - o The distribution of the qualifying features within the site.
150. Therefore, there would be no adverse effect on the integrity of the SPA due to disturbance of woodlark.

3.3.3.4.2 During Operation

151. During the operational period, routine maintenance is not anticipated for the onshore cable route. Emergency repairs are expected to be infrequent and short-term in duration. Temporary task lighting may be used in any area in which maintenance or repair works are being undertaken, but due to the distance from the nearest territories within the SPA (likely to be over 200m), this would be unlikely to affect any woodlarks, even over a short-term period.
152. Operational lighting will be required for maintenance activities at the onshore substation and National Grid substation only, and under normal conditions the onshore and National Grid substations would not be permanently lit. An Artificial Light Emissions Management Plan will be developed for the final design for the permanent infrastructure, as secured under the requirements of the draft DCO, which will include measures to minimise light spill. As the infrastructure is over 2km from the SPA, no woodlarks would be affected by this lighting.
153. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.3.3.5 In-combination Impacts

154. This section assesses the potential for in-combination effects on the Sandlings SPA woodlark population, when considering firstly the proposed East Anglia ONE North project, and then all relevant proposed developments alongside the proposed East Anglia TWO project.
155. According to Natural England's (2015b) *Site Improvement Plan* for the Sandlings, the pressures on the Sandlings SPA woodlark population are likely to be more related to levels of public access rather than loss of habitat associated with proposed or existing developments. As noted above in **section 3.3.2.5**, the proposed East Anglia ONE North project, the Sizewell C New Nuclear Power Station and Sizewell B Power Station Complex projects are likely to be the only other proposed developments with the potential for an in-combination effect with the proposed East Anglia TWO project.

3.3.3.5.1 In-combination Impact with proposed East Anglia ONE North Project

156. The two scenarios for the construction of the proposed East Anglia ONE North and East Anglia TWO projects outlined in **section 3.3.2.5.1** for nightjar is also applicable for woodlark.

3.3.3.5.1.1 Assessment of In-Combination Habitat Loss to Woodlark During Construction

157. The results from baseline surveys presented in **Confidential Figure 8** show that the onshore development area, which would be shared by the proposed East

Anglia TWO project and proposed East Anglia ONE North project, has little suitable habitat for woodlark, with nesting and foraging activity likely to take place mainly within the confines of the Sandlings SPA (see **section 3.3.3.3** for details).

158. If open-cut trenching techniques are used across the SPA for the construction of both the proposed East Anglia TWO and proposed East Anglia ONE North project, the cable route working width within the Sandlings SPA would be reduced to 16.1m for each project, therefore 32.2m in total. This would represent a temporary loss of up to 0.966ha of the SPA designation, or 0.03% of the whole SPA (3,405ha). Where the onshore cable route crosses the SPA however, as noted in **section 3.3.3.3**, and as **Confidential Figure 8** demonstrates, there have been no records of woodlark using this area since at least 2008, and the habitat is unlikely to be of any importance to the species.
159. If HDD techniques are used, no SPA habitat, or habitat suitable for foraging outside of the SPA, would be lost during the construction period of both projects.
160. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect

During Operation

161. Following construction of both projects, all habitats within the SPA will be fully re-instated meaning there will be no permanent SPA habitat loss.
162. Based on the information provided above, no habitat for nesting or foraging woodlark would be lost due to the operation of the onshore infrastructure associated with the proposed East Anglia ONE North and East Anglia TWO projects.
163. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.3.3.5.1.2 Assessment of In-Combination Disturbance to Woodlark due to Onshore Infrastructure

During Construction

164. As with nightjar, it is considered that scenario 2 would have a greater potential for an unmitigated adverse effect due to the increased duration of construction activities. The impacts of the increased duration of construction activities described under scenario 2 (as per **Appendix 23.2** of **ES Chapter 23 Onshore Ornithology**) would mean that breeding woodlark may be affected for two breeding seasons, which would increase the possibility of a territory being abandoned beyond the construction period and over the long-term. Under either

scenario 1 or scenario 2, both projects would however be subject to the seasonal restrictions for crossing the SPA (i.e. construction undertaken outside of the breeding bird season), removing the likelihood of any disturbance to the closest woodlark breeding territory. With the other two 2018 territories within 200m of the onshore development area located in proximity to the turtle dove mitigation area, and over 200m from any infrastructure, disturbance is unlikely, and so no in-combination adverse effects on the integrity of the SPA are predicted.

During Operation

165. Operational impacts on woodlark will be the same irrespective of construction scenario. See **Table 3.1** for a summary of operational impacts. As outlined above it is considered very unlikely that there would be any unmitigated adverse effects associated with the operational phase of the proposed East Anglia TWO project on woodlark, and this would also be true for the proposed East Anglia ONE North project.
166. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.3.3.5.2 In-combination Impact with Other Developments

167. This section assesses the potential for in-combination effects on the Sandlings SPA woodlark population, when considering all identified projects (the proposed East Anglia ONE North project, Sizewell C New Nuclear Power Station and Sizewell B Power Station Complex) alongside the proposed East Anglia TWO project.

3.3.3.5.2.1 Assessment of In-Combination Habitat Loss to Woodlark

During Construction

168. The main development site for Sizewell C New Nuclear Power Station would be located directly to the north of the existing Sizewell B Power Station Complex, approximately 1.3km from the onshore development area, and 1.6km from the Sandlings SPA at its closest point. The Pillbox Field car park is the closest point of the Sizewell B Power Station Complex and Sizewell C New Nuclear Power Station projects to the onshore development area, being around 450m to the east, and approximately 650m east of the Sandlings SPA at its closest point.
169. According to the Sizewell C PEIR (EDF Energy 2019), there was no evidence to suggest that woodlark is currently breeding within the Sizewell C New Nuclear Power Station study area. Adjacent land to the SPA where the closest infrastructure would be located comprises unsuitable agricultural habitats, and so no territory for SPA woodlarks is likely to be lost due to either development.

170. No additional in-combination habitat loss effects are therefore predicted, over and above those predicted for the proposed East Anglia TWO project alone, or when also including the proposed East Anglia ONE North project. As such it can be reasonably concluded that the SPA's Conservation Objectives would not be compromised and that there would be no adverse effect on the integrity of the SPA due to construction effects on woodlark.

During Operation

171. No cumulative operational impacts are predicted because there would be no habitat loss associated with the operational phase of the proposed East Anglia ONE North and East Anglia TWO projects. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.3.3.5.2.2 Assessment of In-Combination Disturbance to Woodlark due to Onshore Infrastructure

During Construction

172. According to the Sizewell C PEIR (EDF Energy 2019), there was no evidence to suggest that woodlark is currently breeding within the Sizewell C New Nuclear Power Station study area. As part of the ornithology assessment, a number of mitigation measures have been explored for Sizewell C New Nuclear Power Station, including the maintenance of habitat corridors, the management of public access to sensitive sites (including the SPA), and the inclusion of environmental buffers and acoustic fencing to help protect neighbouring habitats and species from light, noise and visual disturbance.
173. With the closest woodlark territory within the SPA likely to be well outside of foraging range from the Sizewell B Power Station Complex and Sizewell C New Nuclear Power Station projects, and potential mitigation measures described above implemented, no additional in-combination disturbance impacts are predicted over and above any associated with the proposed East Anglia ONE North and East Anglia TWO projects. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to disturbance effects on nightjar.

During Operation

174. No cumulative operational impacts are predicted due to the lack of likely disturbance impacts arising from the operational phase associated with the proposed East Anglia ONE North and East Anglia TWO projects. As such it can be reasonably concluded that the SPA's Conservation Objectives (**paragraph 42**) would not be compromised and that there would be no adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.3.3.6 Mitigation Measures

175. The EMP, developed post-consent to discharge the requirements of the DCO, would include a SPA crossing Method Statement, developed for working within and / or in proximity to the Sandlings SPA.
176. Although no adverse effects on the SPA are predicted, based on known nightjar breeding distribution and habitat requirements, onshore cable corridor work beyond 200m from the SPA crossing area may take place during the breeding season. In order to safeguard breeding individuals from disturbance, the mitigation measures outlined for nightjar in **section 3.3.2.6** are also applicable for woodlark. These comprise the presence of an ECoW to oversee construction activities, pre- and during construction surveys, and the formulation and implementation of a BBPP.

3.3.3.7 Conclusion

177. The current Sandlings SPA woodlark population is likely to be in unfavourable conservation status, when compared to the cited SPA population. Any unmitigated loss of breeding pairs is therefore likely to further impact on the restoration of favourable conservation status of the site. The main potential impacts on woodlark associated with the proposed East Anglia TWO project were identified as habitat loss and disturbance during the construction phase.
178. No permanent SPA habitat loss would result from installation of the onshore cable, and any short-term habitat loss inside or outside the SPA is considered to be unimportant to the SPA woodlark population, due to the habitat generally being unsuitable in the onshore development area, both outside, and within the SPA, and lack of historic breeding records.
179. To avoid the possible unmitigated loss of a woodlark territory closest to the onshore development area, and an adverse effect on the integrity of the SPA due to construction disturbance, spatial and temporal restrictions of open-cut trenching and HDD works through the SPA would be deployed, with works taking place outside of the woodlark breeding season.
180. During the operational period, there would be no habitat loss, disturbance and lighting effects.
181. On the basis of the assessment detailed above, when considering mitigation, it can be concluded with confidence that for woodlark that there will be no adverse effects on the integrity of the Sandlings SPA as a result of the proposed East Anglia TWO project acting alone.
182. When considering the proposed East Anglia TWO and East Anglia ONE North projects in-combination, and assuming mitigation measures would be similar for

both projects, no adverse effects on the integrity of the Sandlings SPA are predicted, regardless of whether Scenario 1 or Scenario 2 is selected.

183. Baseline surveys to date for Sizewell C New Nuclear Power Station suggest that the area around the Sizewell C New Nuclear Power Station and Sizewell B Power Station Complex is not used by woodlark. Mitigation measures outlined for the proposed East Anglia TWO and East Anglia ONE North projects would minimise the risk of an adverse in-combination effect on the SPA woodlark population occurring.
184. For the proposed East Anglia TWO project (and the proposed East Anglia ONE North project), the potential mitigation measures set out in **section 3.3.2.6** would be required during the construction period only, after which there would be no contribution of the proposed East Anglia TWO project to in-combination effects during the operational periods. Hence, no adverse effect on the integrity of the SPA as a result of in-combination effects is predicted.

4 Offshore Ornithology Assessment of Effects

4.1 Approach to Assessment

185. This section provides information to determine whether there is an adverse effect on the integrity of the conservation objectives of the Outer Thames Estuary, Greater Wash, Alde Ore Estuary, Flamborough and Filey Coast, Breydon water, Broadland and North Norfolk Coast SPAs due to the potential effects of the proposed East Anglia TWO project. **Section 2.1** of **Appendix 1** provides a description of the HRA methodology. This section takes the following structure:

- A summary of proposed East Anglia TWO project offshore infrastructure details, outlining the worst-case scenario and embedded mitigation for the onshore ornithology assessment.
- Then for each SPA
 - o A description of each SPA, its conservation objectives, and baseline offshore ornithology information gathered to aid the assessment.
 - o For each feature of the each SPA:
 - A summary of the ecology of the species and condition of the SPA population;
 - An assessment of the effects during construction and operation of the proposed East Anglia TWO project; and
 - An assessment of in-combination effects when considering the proposed East Anglia TWO project alongside other developments.

4.2 Project Details

4.2.1 Worst-Case Scenario

186. The worst-case scenario for each category of potential effect on offshore ornithology receptors has been determined (**Table 4.1**). The worst-case scenarios identified here also apply to the in-combination assessment. The in-combination assessments are presented using a tiered approach, whereby other windfarms are categorised according to their status, with 1 used for operational sites, 2 for projects in construction, 3 for projects which are consented but not yet under construction, 4 for projects whose applications are submitted but not yet determined and 5 for projects in the planning process but not yet submitted.

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Table 4.1 Project Design: Realistic Worst Case Scenarios for the Proposed East Anglia TWO Project

Impact	Parameter	Rationale
Construction		
Disturbance and Displacement from increased vessel activity	It is anticipated that the installation of the offshore elements will take approximately 27 months. Construction works would be undertaken 24 hours a day and seven days a week offshore, dependent upon weather conditions. The maximum number of all types of vessels operating simultaneously within the offshore development area during construction would be 74. There would be up to three foundation installation vessels (i.e. Dynamic Positioning Heavy Lift Vessels) on site at any one time. Maximum of 1,005 helicopter round trips per annum assumed Speed of cable laying vessels – maximum speed of 300m per hour for ploughing or jetting and 80m per hour if trenching (see Chapter 6 Project Description).	The worst case scenario is based on the longest construction period and the maximum numbers of plant on site and operational at a given time.
Indirect effects as a result of displacement of prey species due to increased noise and disturbance to sea bed	Spatial worst case impact– maximum hammer energy of 4,000 kilo Joules (kJ). Up to three foundation installation vessels (i.e. Dynamic Positioning Heavy Lift Vessels) on site at any one time. Temporal worst case impact No concurrent piling, 75 wind turbine foundations, five offshore electrical and construction operation and maintenance platforms, and one operational met mast.	See Chapter 10 Fish and Shellfish Ecology for a full breakdown of the maximum disturbed area of sea bed. Piling durations based on the worst-case scenario of pin-piles for wind turbines (up to 33.2 days) plus platforms (up to 6 days). See Chapter 11 Marine Mammals for further details.

East Anglia TWO Offshore Windfarm

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Impact	Parameter	Rationale
	Maximum total active piling time for wind turbines and platforms - 938hrs (39.2 days) No concurrent piling, 75 wind turbine foundations, five offshore platforms, and one operational met mast.	
	The maximum worst case area of disturbance to benthic habitats during construction would be 11,330,050.5m ² across the offshore development area, equivalent to 3.18% of the maximum offshore development footprint.	Breakdown is given in Chapter 9 Benthic ecology .
	Disturbance / displacement from increased suspended sediment concentration from the excavation of up to 4,091,222.5m ³ of sediment in the offshore development area over the approximate 27 month construction period.	Total sediment release over the construction period is given in Chapter 9 Benthic Ecology and Chapter 7 Marine Geology and Physical Processes . However, the release on a daily basis would be temporary and localised with sediment settling out quickly.
Operation		
Disturbance and displacement from offshore infrastructure and due to increased vessel and helicopter activity (Includes barrier effect)	A windfarm area of 255km ² plus 4km buffer with maximum of 75 wind turbines, with a minimum spacing of 800m in row x 1200m between rows Maximum of 687 vessel round trips per annum to support windfarm operations.	Maximum density of turbines and structures across the offshore project area, which maximises the potential for avoidance and displacement.

East Anglia TWO Offshore Windfarm

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Impact	Parameter	Rationale
	Maximum of 1,005 helicopter round trips per annum for scheduled and unscheduled maintenance. Lighting requirements for the offshore windfarm will need to be consistent with maritime and aviation safety requirements, and are expected to consist of: • Obstruction lighting compliant with CAA aviation safety requirements, as a minimum, requiring turbines on the periphery of the windfarm to be lit; • Maritime navigational safety lighting compliant with Trinity House Light House service safety requirements which requires navigational lighting to be visible at a distance of at least 5nm, lights would be required to be placed low on the turbines and electrical platforms. • Search and Rescue (SAR) lighting consistent with MCA safety requirements. These are most likely to be infra-red lighting which would only be activated during search and rescue operations.	
Collision risk	Maximum of 75 x 250m wind turbines, other scenario is 60 x 300m.	CRM has been carried out for all turbine scenarios based on the turbine specifications in Appendix 12.2, Annex 3, Table 5 of the ES . The worst case scenario in terms of the highest collision risk varies between bird species. For each species, the turbine scenario which produces the highest collision risk has been used in the assessment.
Indirect effects due to habitat loss / change for key prey species	The maximum possible sea bed footprint of the project, and therefore habitat loss, would be:	The maximum possible above sea bed footprint of the project including scour or scour protection plus any cable protection.

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Impact	Parameter	Rationale
	Windfarm Site Infrastructure 1,914,471m² which constitutes 0.55% of the windfarm site (75 wind turbine foundations, five offshore platforms, one meteorological mast, cable protection for platform link cables and inter-array cables). Export Cable 108,800m², 0.08% of the northern offshore cable corridor which has been used a worst case as it has the largest area of the two cable route options. Total The overall total footprint which could be subject to permanent habitat loss would therefore be 2,023,271.46m² (0.57% of the offshore development area).	See Chapter 9 Benthic Ecology and Chapter 10 Fish and Shellfish Ecology .
Decommissioning		
Disturbance and Displacement from increased vessel activity	Assumed similar to construction and therefore a worst case would be as above in impact 1.	
Indirect effects as a result of displacement of prey species due to increased noise and disturbance to sea bed	Any area affected would be less than or at worst equal to the areas of disturbance during construction. There would be limited noise disturbance to prey (as no piling and no use of explosives).	See Chapter 9 Benthic Ecology and Chapter 10 Fish and Shellfish Ecology .

4.3 Outer Thames Estuary SPA

187. The Outer Thames Estuary SPA was designated in August 2010. It covers 379,268.14ha of marine habitat with part in English territorial waters (0-12 nautical miles) and part in UK offshore waters (12 to 200 nautical miles), with the Annex 1 species red-throated diver as the sole feature (Natural England and JNCC 2010; JNCC 2011c).
188. Extensions were proposed to the SPA in 2015 to include coastal and riverine areas used for foraging by breeding terns (the tern colonies are already designated at other locations). The extension areas are not in close proximity to the East Anglia TWO offshore development area, and terns were not identified as at risk of LSE (since the windfarm is beyond the maximum foraging ranges of these species). Therefore, it is only the original feature (red-throated diver) that is considered here.
189. An estimated 6,466 red-throated divers wintered in the SPA from 1989-2006/07 (JNCC and Natural England 2013). However, the population appears to have increased substantially since then, with an estimate in February 2013 of 14,161 (Goodship et al. 2015) and in February 2018 of 21,997 (Irwin et al. 2019). The relevant conservation objective for the Outer Thames Estuary SPA is “*subject to natural change, maintain or enhance the red-throated diver population and its supporting habitats in favourable condition*” (JNCC and Natural England 2013). The interest feature red-throated diver will be considered to be in favourable condition only when both of the following two conditions are met (JNCC and Natural England 2013):
- The size of the red-throated diver population is at, or shows only non-significant fluctuation around the mean population at the time of designation of the SPA to account for natural change; and
 - The extent of the supporting habitat within the site is maintained.
190. JNCC and Natural England (2013) advise that to fulfil the conservation objectives for the Annex I feature red-throated diver and its supporting habitat, the relevant and competent authorities for this area should manage human activities within their remit such that they do not result in deterioration or disturbance, or impede the restoration of this feature through loss of habitat by removal (e.g. capital dredging, harvesting, coastal and marine development), damage by physical disturbance or abrasion of habitat (e.g. extraction), non-physical disturbance through noise or visual disturbance (e.g. shipping, wind turbines), toxic contamination by introduction of synthetic and/or non-synthetic compounds (e.g. polychlorinated biphenyls (PCBs), pollution from oil and gas industry, shipping), non-toxic contamination to prey species only by changes in e.g. turbidity (e.g. capital and maintenance dredging), biological disturbance by selective extraction

of species (e.g. commercial fisheries) and non-selective extraction (e.g. entanglement with netting and wind turbine strike).

191. The Outer Thames Estuary SPA contains several constructed or consented offshore windfarms. There are proposals for extensions to several such windfarms. Furthermore, there is the probability that the cable routes for new windfarms which may be consented under Round 3 could cross the SPA and the proposed Sizewell C power station which will be constructed on the coast adjacent to the SPA. The northernmost extent of the SPA also contains some areas licenced for aggregate extraction and other prospecting areas. Certain shipping channels within the site have been and will continue to be subject to maintenance dredging. There may be a requirement for capital dredging in association with newly developed and future port developments (Natural England and JNCC 2010).
192. The Thames supports important commercial fisheries, estuarine and marine recreational angling. There is also a well-established cockle harvesting industry. The potential effects of many of these existing or future activities will be addressed through relevant licence requirements and under the provision of the Habitats Regulations (including the review of consents process). Ongoing research associated with offshore windfarm development will improve understanding of the environmental factors influencing red-throated diver distribution and the extent of apparently suitable seabed habitat within the site (Natural England and JNCC 2010).

4.3.1 Red-throated diver

4.3.1.1 Status and ecology

193. In the UK and in other European countries, wintering red-throated divers are associated with shallow inshore waters (normally between 2 and 20m deep), often occurring within sandy bays (Poot et al. 2009), firths and sea lochs, although open coastline is also frequently used (Skov et al. 1995; Stone et al. 1995). The bulk of the UK distribution of wintering red-throated divers is found off the coast of east England, with the area between Kent and North Yorkshire supporting 59% of the UK total, with 38% of the UK total in the Outer Thames Estuary SPA (JNCC and Natural England 2013; Natural England and JNCC 2016). The distribution and concentrations of red-throated divers will at least in part be determined by the presence, abundance, and availability of their prey fish species (Poot et al. 2009), especially sprats and young herring in winter, although a wide variety of small fish species can be taken (Guse et al. 2009).
194. The Outer Thames Estuary SPA has a designated population of wintering red-throated divers of 6,466 individuals, representing 38% of the GB nonbreeding population, as estimated between 1986 and 2006/7 (JNCC and Natural England 2013).

195. Red-throated divers arrive in the Outer Thames Estuary SPA area from September to November and depart towards breeding areas from February to April (Brown and Grice 2005). Small numbers, mostly of birds in their first year of life, remain in the wintering areas through summer (Furness 2015). Recent tracking studies suggest that red-throated divers wintering in the southern North Sea mostly originate from breeding grounds in Russia (Dierschke et al. 2017, German tracking study²), and that some of the adult birds wintering in UK southern North Sea waters join those in the German Bight to stage before their spring migration back to breeding grounds.
196. Red-throated divers are highly sensitive to non-physical disturbance by noise and visual presence during the winter (Garthe and Hüppop 2004, Furness et al. 2013). Petersen et al. (2006) reported a marked post-construction avoidance of the Horns Rev offshore windfarm, including also the 2km and 4km zones around it. A similar, though less pronounced avoidance response to the Nysted offshore windfarm by red-throated divers was also recorded (Petersen et al. 2006). Data from Kentish Flats offshore windfarm suggest a decreasing displacement effect with distance from the wind turbine footprints (Percival 2010). Analysis of diver survey data collected in the Outer Thames to investigate windfarm effects identified shipping activity as one of only two covariates which explained significant amounts of the variation in the species' spatial distribution (bathymetry was the second; APEM 2016). This study found evidence for decreases in diver densities during windfarm construction compared with those observed prior to construction, but also indicated that following construction diver densities rapidly returned to previous levels (although this was caveated as a preliminary result). Recent studies in the German Bight also show very strong avoidance by red-throated divers of operational offshore windfarms and of associated ships in that area (Mendel et al. 2019). A report on the results of more recent surveys of the Outer Thames Estuary SPA (Irwin et al. 2019) proposed similar avoidance of shipping and wind turbines, although this conclusion was based on preliminary observations rather than analytical estimates.
197. Disturbance and displacement effects from shipping (including recreational boating) and boat movements includes activity associated with marine aggregate extraction and fishing activities. Marine aggregates activities tend to be temporary and localised. Dredging and shipping activities are expected to be confined to existing shipping channels, which are already known to be avoided by divers (Natural England and JNCC 2010). In all these cases it is expected that activity will be lowest during the winter months (when the birds are present) due to the limitations imposed by poor weather conditions. The effects of existing or future activities will be addressed through the relevant licence requirements and under

² www.divertracking.com

the provision of the Habitats Regulations (Natural England and JNCC 2010). Ship traffic associated with maintenance of operational offshore windfarms will also be likely to displace red-throated divers.

4.3.1.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

198. Vessel traffic associated with windfarm construction work in the East Anglia TWO windfarm site will either follow existing shipping routes from port through inshore areas or establish new direct routes to the East Anglia TWO windfarm site. The volume of shipping traffic associated with windfarm construction work will be similar in comparison to baseline shipping activity in the area during the summer months and slightly less than baseline shipping activity during winter months, when most red-throated divers are present (see **ES Chapter 14 Shipping and Navigation**). Therefore, only a very minor increase in disturbance of red-throated divers would be expected, since shipping routes within this SPA are already avoided by red-throated divers (Natural England and JNCC 2010).

199. Export cables from the East Anglia TWO windfarm site are planned to run through part of the Outer Thames Estuary SPA (see **ES Chapter 12 Offshore Ornithology, Figure 12.1**). The offshore cable corridor extends from the landfall approximately 5km north of Aldeburgh in a North-East orientation, passing through approximately 25km of the SPA in areas that are predominantly not shipping routes so could represent more important habitat for red-throated divers. Although, based on the 2018 surveys, Irwin et al. (2019) described the northern section of the SPA (containing the cable corridor) as 'low-density', particularly when compared with the southern section which encompasses the outer reaches of the Thames. Through the SPA, the offshore cable corridor (effectively an area of search) width is between 2km and 4km, giving a total potential overlap between the export cable corridor and the SPA of approximately 132km² which represents an overlap with the SPA of approximately 3.5%, although the actual cable route itself will be much smaller. Cable-laying operations, utilising up to two vessels, have the potential to displace red-throated divers from an area around each vessel.

4.3.1.2.1 Assessment of barrier effects and collision risk to migrating red-throated divers

200. The additional distances travelled by birds avoiding windfarms whilst on migration (i.e. up to twice per year) have been found to be negligible when compared to the total migration distances (Masden et al. 2009). Therefore, the energetic costs of such diversions are also negligible. Red-throated divers fly very low to the water and consequently collision risks on migration will also be very small (total annual collision prediction <1 individual; **Appendix 12.2 Annex 4** of the ES). Consequently, the risks of a likely significant effect due to either barriers to movement or collision risk are sufficiently small that they can be ruled out.

4.3.1.2.2 Assessment of displacement of red-throated divers by offshore cable-laying activity

201. There is potential for disturbance and displacement of non-breeding red-throated divers resulting from the presence of up to two cable laying vessels installing the export cable through the Outer Thames Estuary SPA. Cable laying vessels move at a very slow rate (average 300m/hour) and therefore move only short distances as cable installation takes place. Offshore cable installation activity is a relatively low noise emitting operation, particularly when compared to activities such as piling, but it is the presence of vessels rather than associated noise that causes disturbance (Schwemmer et al. 2011).
202. The magnitude of disturbance to red-throated divers has been estimated on a 'Worst Case' basis. This assumes that there would be 100% displacement of birds in a 2km buffer surrounding the cable laying vessel(s). This 100% displacement is consistent with Garthe and Hüppop (2004) and Schwemmer et al. (2011) since they suggested that all red-throated divers present fly away from approaching vessels at a distance of normally more than 1km but normally less than 2km (see also Bellebaum et al. 2006).
203. In order to calculate the number of red-throated divers that would potentially be at risk of displacement from the offshore cable corridor during cable laying, the density of red-throated divers in the SPA and along the offshore cable corridor was estimated. This was carried out by overlaying the offshore cable corridor, buffered by 2km, on to the observed distribution of red-throated divers in the area.
204. Data was obtained to allow two separate estimates of red-throated diver density in the vicinity of the East Anglia TWO cable corridor. The two density estimates used were 0.74 birds/km² (using JNCC/Natural England data, 2000/01-2009/10) and 0.91 birds/km² (using Natural England survey data collected in 2013; Goodship et al. 2015). These compared with the overall density within the SPA which was estimated to be 1.7 birds per km² (designated population of 6,466 divided by the total SPA area of 3,792.7km²). Using the 2018 survey (Irwin et al. 2019) the two density estimates across the relevant section of the SPA were 0.62 and 3.77 birds per km² respectively.
205. The 'worst case' area from which birds could be displaced was defined as a circle with a 2km radius around each cable laying vessel, which is 25.2km² (area round each vessel being 12.6km²). Assuming a worst case of 100% displacement around each vessel with the range of densities between 0.62 and 3.77 birds per km², between 15.6 and 95.0 divers could be displaced at any given time (but only if both vessels are within the SPA at the same time and this also coincides with the late winter peak in diver density). Assuming that displacement was local so that birds remained within the SPA, which seems likely, this would lead to a maximum 2.1% increase in diver density in the portion of the SPA the cable route

traverses (i.e. the section between Great Yarmouth and Felixstowe). As the vessels move it is assumed that displaced birds return and therefore any individual will be subjected to only a brief period of effect. It is considered reasonable to assume that birds will return following passage of the vessel since the cable laying vessels will move at a maximum speed of 400m per hour if surface laying, 300m per hour for ploughing and 80m per hour if trenching (**ES Chapter 6 Project Description**). This represents a maximum speed of 7m per minute. For context, a modest tidal flow rate for the Outer Thames would be in the region of 30m per minute (0.5m per second; derived from DECC 2009). The tide would therefore be flowing at least four times faster than the cable laying vessel, which is therefore effectively stationary (as far as the birds are concerned). Consequently, for the purposes of this assessment it can be assumed that the estimated number displaced represents the total number displaced over the course of a single winter.

206. Mortality rates associated with displacement for any seabird are not known and precautionary estimates have to be used. There is no evidence that birds displaced from windfarms, or by vessels, suffer any mortality as a consequence of displacement; any mortality due to displacement would be most likely a result of increased density in areas outside the affected area, resulting in increased competition for food where density was elevated. Displacement of birds from areas where they are present at low density is particularly unlikely to have consequences for survival since these areas are likely to be of low habitat quality. Given the small number of individuals potentially affected and the size of the SPA, such effects are most likely to be negligible, and below levels that could be quantified.
207. Effects of displacement are also likely to be context-dependent. In years when food supply has been severely depleted, as for example by unsustainably high fishing mortality of sandeel stocks as has occurred several times in recent decades (ICES 2013), displacement of sandeel-dependent seabirds from optimal habitat may increase mortality. In years when the food supply is good, displacement is unlikely to have any negative effect on seabird populations. Red-throated divers feed to an extent on sandeels, but take a wide diversity of small fish prey, so would be buffered from fluctuations in abundance of individual fish species.
208. For recent windfarm assessments Natural England have advised that a highly precautionary 10% maximum mortality rate should be used for birds displaced by cable laying vessels. This magnitude of impact is not supported in the literature and given that this would equate to more than half the natural annual adult mortality rate (16%) as a result of what is effectively a single occasion of disturbance (as described above), it is highly improbable that such a large

magnitude of effect would occur. To illustrate this, it is worth considering the existing level of vessel traffic through the region which has been ongoing for decades. Given the widespread nature of vessel movements it seems likely that most individual red-throated divers would encounter at least one vessel per winter. If this species is as susceptible to mortality following individual instances of vessel disturbance, the designated population of 6,466 would be reduced by 10% per year (e.g. 647 in the 'first year') over and above natural declines, and would be less than 2,300 after 10 years. This should be considered against recent survey results (Irwin et al. 2019) which provide no indication that the population has decreased and potentially that the SPA population has increased since designation by almost three and a half times (from 6,466 to almost 22,000). It therefore appears to be highly unlikely that the magnitude of effect from vessel disturbance is anything approaching as high as Natural England suggest, and in fact there may be no discernible effect attributed to this potential source of impact.

209. In addition, a review of available evidence for red-throated diver displacement was submitted for the Norfolk Vanguard assessment (Vattenfall 2019a) which concluded there would be little or no effect of displacement on diver survival. Consequently, a maximum, and hence precautionary, displacement caused mortality rate of 1% was identified as appropriate for this assessment.
210. This leads to a highly precautionary assumption that a single instance of displacement, as described above, will result in a maximum of 1 individual being expected to die across the entire winter period (September to April) as a result of any potential displacement effects from the offshore cable installation activities. However, owing to the Rochdale Envelope approach to the assessment and the nature of the calculations employed, this almost certainly over-estimates the duration of cable laying by a factor of around three, since even travelling at the minimum speed of 30m per hour, the vessel would traverse the SPA in approximately 75 days from a winter period of around 240 days³. From these considerations it is clear that the assumption of 1% mortality is highly precautionary in relation to disturbance by cable laying vessels.
211. Baseline annual mortality ranges from about 12% for adults, up to about 40% for juveniles (Dierschke et al. 2017). With an assumed proportion of juveniles of 30% (based on Furness 2015), the estimated natural mortality for the designated SPA population (6,466), would be approximately 1,319 while for the 2018 population estimate of 22,000 would be approximately 4,500 (calculated using a composite all age class mortality rate of 0.2). The addition of a maximum of 1 individual to

³ Travelling at the minimum speed of 30m per hour with a working day of 12 hours, the vessel would traverse the SPA in approximately 75 days (assuming the offshore cable route through the SPA is around 25km)

these totals during a single year would increase the mortality rate in that year by approximately 0.02 to 0.07%.

212. Natural England advised that they did not consider the above assumptions to be sufficiently precautionary and that assessment should also consider their advised rates of 100% displacement and 10% mortality. At these rates, up to 9.5 individuals would be at risk of mortality (if two vessels are operating within the SPA at the same time) in a single year. This would increase the background mortality in that year by a maximum of 0.21 to 0.72%.
213. Thus, even using these highly precautionary rates, this magnitude of effect is less than the SNCB advised 1% threshold of detectable change in mortality. Therefore, it is reasonable to conclude that there will be no adverse effect on the integrity of the Outer Thames Estuary SPA as a result of red-throated diver displacement due to cable laying for the proposed East Anglia TWO project alone.

4.3.1.2.3 In-combination effects

214. The Outer Thames Estuary SPA contains shipping channels within the site that will continue to be subject to maintenance dredging. There may also be a requirement for capital dredging in association with newly developed and future port developments (Natural England and JNCC 2010). The SPA also contains several constructed or consented offshore windfarms. These projects are all considered part of the baseline.
215. There is a possibility that extensions will be made to some of these windfarms, or that new windfarms will be consented. However, at the time of writing, there is no certainty as to when or if further projects will be brought forward, therefore only projects in planning are considered here. The proposed Sizewell C power station is expected to be constructed on the coast adjacent to the SPA. The northernmost extent of the SPA also contains some areas licenced for aggregate extraction and other prospecting areas.
216. Shipping already affects the distribution of red-throated divers within the SPA, these birds tending to avoid shipping lanes due to disturbance by boats (Natural England and JNCC 2010; Irwin et al. 2019). This represents a background established situation following many decades of shipping activity in the area. However, any increase in shipping activity will constitute an in-combination effect on divers, as will capital dredging.
217. There do not appear to be data in the public domain indicating the likely disturbance effect of Sizewell C power station construction activity on red-throated divers.

218. The offshore cable corridor for the proposed East Anglia ONE North project will pass through the Outer Thames estuary SPA (potentially using exactly the same offshore cable corridor). However, for any in-combination impact to occur, installation of cables would need to be simultaneous with those of the proposed East Anglia TWO project. This is highly unlikely due to the practicalities of construction, and even in this case would not represent a significant effect unless the most precautionary mortality assumptions were used.
219. While any increase in shipping activity will constitute an in-combination impact on divers, the low level of project alone risk, absence of other developments in the vicinity of the East Anglia TWO offshore cable corridor (other than the East Anglia ONE North project discussed above) and lower level of existing shipping traffic in this section of the SPA (see Irwin et al. 2019) indicate that the likelihood of an in-combination disturbance effect is extremely small. Therefore, the in-combination effect on the red-throated diver population due to the proposed East Anglia TWO project and other plans and projects can be assessed as negligible.
220. There is potential for offshore windfarms in the southern North Sea to present a combined barrier to movement of red-throated divers whilst on migration to and from the SPA. However, whilst such a situation appears to be a possibility from an overview of windfarm lease areas it is important to remember the large scale of such maps, and that the gaps between many of the windfarms are in excess of 10km in most cases. Furthermore, GPS tracking of red-throated divers⁴ indicates that individuals tend to migrate to the SPA area to the north or south of the majority of the windfarm sites (almost all of which are not currently constructed). It is thus very unlikely that the proposed East Anglia TWO project would contribute to an in-combination barrier or collision effect on the Outer Thames Estuary SPA red-throated diver population.

4.3.1.3 Conclusion

221. The relevant conservation objective is the maintenance of red-throated diver numbers within Outer Thames Estuary SPA at a level similar to that at designation, subject to natural change. Surveys conducted since those on which the designation was based have found no evidence for a decline, and indicate a potential increase by a factor of three (e.g. Goodship et al. 2015 found 14,161 birds within the SPA in February 2013 and Irwin et al. 2019 reported a population of almost 22,000 in February 2018). It seems clear that the population is therefore in favourable conservation status. On the basis of the assessment detailed above, it can be concluded with confidence for red-throated diver that there will be no adverse effect on the integrity of Outer Thames Estuary SPA as a result of the proposed East Anglia TWO project acting alone.

⁴ www.divertracking.com

222. At a predicted maximum mortality level of one (using evidence based methods) or 9.5 (using Natural England's precautionary methods), the potential for the proposed East Anglia TWO project to contribute to an in-combination effect on the red-throated diver population of the Outer Thames Estuary SPA is also considered to be negligible. Hence, no adverse effect on the integrity of the SPA as a result of in-combination effects is predicted.

4.4 Greater Wash SPA

223. The Greater Wash SPA was designated in March 2018 following the completion of consultations in January 2017. The Greater Wash SPA is located off the coast of Eastern England, extending seaward from mean high water to a maximum of approximately 30km offshore. The SPA covers the marine environment from Bridlington Bay in the north to approximately Great Yarmouth in the south. The Greater Wash SPA has been proposed to protect areas of importance for overwintering red-throated diver, little gull and common scoter during the winter period (October to April), and also to provide protection to important foraging areas for common, Sandwich and little tern, which breed along the adjacent coastline.
224. The seaward extent of the boundary is a composite of the seaward distribution of red throated diver and the tern species (Natural England and JNCC 2016). It encompasses the foraging areas of breeding little tern, breeding Sandwich tern and breeding common tern, all of which breed in colonies within existing SPAs (Humber Estuary, Gibraltar Point, North Norfolk Coast, Breydon Water and Great Yarmouth North Denes). The boundary also includes areas with high densities of common scoter and little gull, and so these two species are also included as features of the SPA.
225. The East Anglia TWO windfarm site does not overlap with the Greater Wash SPA and is approximately 37km away at its closest point.
226. The conservation objectives of the site include:
- Ensuring that the integrity of the site is maintained or restored as appropriate, and ensuring that the site contributes to achieving the aims of the Birds Directive, by maintaining or restoring:
 - o The extent and distribution of the habitats of the qualifying features;
 - o The structure and function of the habitats of the qualifying features;
 - o The supporting processes on which the habitats of the qualifying features rely;
 - o The populations of each of the qualifying features; and
 - o The distribution of the qualifying features within the site.
227. The features of this SPA for which assessment of potential effects due to the proposed East Anglia TWO project are considered necessary are nonbreeding

red-throated divers, and little gulls whilst on migration and while present in winter (little gull numbers during migration are generally much larger than during winter as most birds pass through the region during migration to overwinter elsewhere).

4.4.1 Red-throated diver

4.4.1.1 Status and ecology

228. The Greater Wash SPA has a designated population of wintering red-throated divers of 1,407 individuals, representing 8.3% of the GB nonbreeding population, as estimated between 2002/3 and 2005/6.

229. See **section 4.4.1.1** for details of red-throated diver ecology.

4.4.1.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

230. Red-throated divers are sensitive to disturbance due to vessel movements, windfarm construction and windfarm operation. The proposed East Anglia TWO project is outside the Greater Wash SPA, and the offshore cable corridor does not cross any part of the SPA. The East Anglia TWO site is also beyond the range at which any construction or operation activities could affect divers within the SPA, and the port likely to be used for operations and maintenance vessels is not within the SPA. Consequently, the potential effect would be on birds passing through the windfarm on migration to and from the SPA. This could include barrier effects and collision risk.

4.4.1.2.1 Assessment of barrier effects and collision risk to migrating red-throated divers

231. The additional distances travelled by birds avoiding windfarms whilst on migration (i.e. up to twice per year) have been found to be negligible when compared to the total migration distances (Masden et al. 2009). Therefore, the energetic costs of such diversions are also negligible. Red-throated divers fly very low to the water and consequently collision risks on migration will also be very small (total annual collision prediction <1 individual; **Appendix 12.2 Annex 4** of the ES). Consequently, no significant effect can be concluded from effects of this magnitude.

4.4.1.2.2 In-combination effects

232. There is potential for offshore windfarms in the southern North Sea to present a combined barrier to movement of red-throated divers whilst on migration to and from the SPA. However, whilst such a situation appears to be a possibility from an overview of windfarm lease areas it is important to remember the large scale of such maps, and that the gaps between many of the windfarms are in excess of 10km in most cases. Furthermore, GPS tracking of red-throated divers⁵ indicates that individuals tend to migrate to the SPA area to the north or south of

⁵ www.divertracking.com

the majority of the windfarm sites (almost all of which are not currently constructed). It is thus very unlikely that the proposed East Anglia TWO project would contribute to an in-combination barrier or collision effect on the Greater Wash SPA red-throated diver population.

4.4.1.3 Conclusion

233. The relevant conservation objective is the maintenance of red-throated diver numbers within the Greater Wash SPA at a level similar to that at designation, subject to natural change. On the basis of the assessment detailed above, it can be concluded with confidence for red-throated diver that there will be no adverse effect on the integrity of Greater Wash SPA as a result of the proposed East Anglia TWO project acting alone.
234. The very low risk of effects to red-throated divers whilst on migration due to the proposed East Anglia TWO project means the potential for the project to contribute to an in-combination effect on the red-throated diver population of the Greater Wash SPA is also considered to be negligible. Hence, no adverse effect on the integrity of the SPA as a result of in-combination effects is predicted.

4.4.2 Little gull

4.4.2.1 Status and ecology

235. Little gull is a species about which very little is known. The main breeding population is in central Asia but extends to western Europe where it has been increasing in numbers in recent decades. BirdLife International (2004) suggest that about 24,000 to 58,000 pairs breed in Europe and that this represents 25 to 49% of the global population; thereby implying a global population of 49,000 to 232,000 pairs.
236. Considerably increasing numbers of little gulls pass through UK waters on migration, perhaps reflecting a more westerly migration route developing in this species as well as increasing breeding numbers particularly in Finland (del Hoyo et al. 1996; Brown and Grice 2005). Musgrove et al. (2013) and British Trust for Ornithology (BTO) BirdFacts were unable to give an estimate of numbers occurring in the UK, but 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 through on migration.
237. Brown and Grice (2005) report that the little gull is most numerous in English waters during spring and autumn migration and that 'numbers passing through England have increased enormously since the 1950s'. They report also that 'outside the breeding season, little gulls are largely coastal'.
238. Large numbers of little gulls may occur on passage. For example, 4,100 were seen at Flamborough Head on 21 September 1995, 5,413 passed Flamborough

Head between 24 September and 7 October 1982 (Brown and Grice 2005), and 10,000 were seen off Spurn on 11 September 2003 (Hartley 2004). The species is recorded along the entire English coastline in autumn, winter and spring, with largest counts in autumn, and often associated with onshore gales (Balmer et al. 2013).

239. The population of little gull in the Greater Wash SPA in winter was estimated at 1,255 (mean of peak counts in the winter period for 2004/05 and 2005/06), however the population in the Area of Search was 2,153 (mean of peak counts in the winter period for 2004-05 and 2005-06; Natural England and JNCC 2016).
240. The SPA little gull population estimates are highly uncertain for several reasons. Firstly, little gull counts were made in late October or November. However, little gull numbers peak in autumn, with relatively few birds remaining in the North Sea during winter (Brown and Grice 2005, Skov et al. 2007). This is clearly demonstrated by the Trektellen data (downloaded from Trektellen web page) which show that numbers of little gulls seen at UK North Sea sea-watching sites (which are mostly in areas from Yorkshire to Kent and therefore highly relevant here) reported about 5 times as many little gulls in September as in late October or November. (**Plate 1**).
241. Therefore, numbers of little gulls within the Greater Wash SPA are likely to be much higher in September than in late October or November when JNCC's aerial surveys which were used to inform the designation of the SPA were carried out.

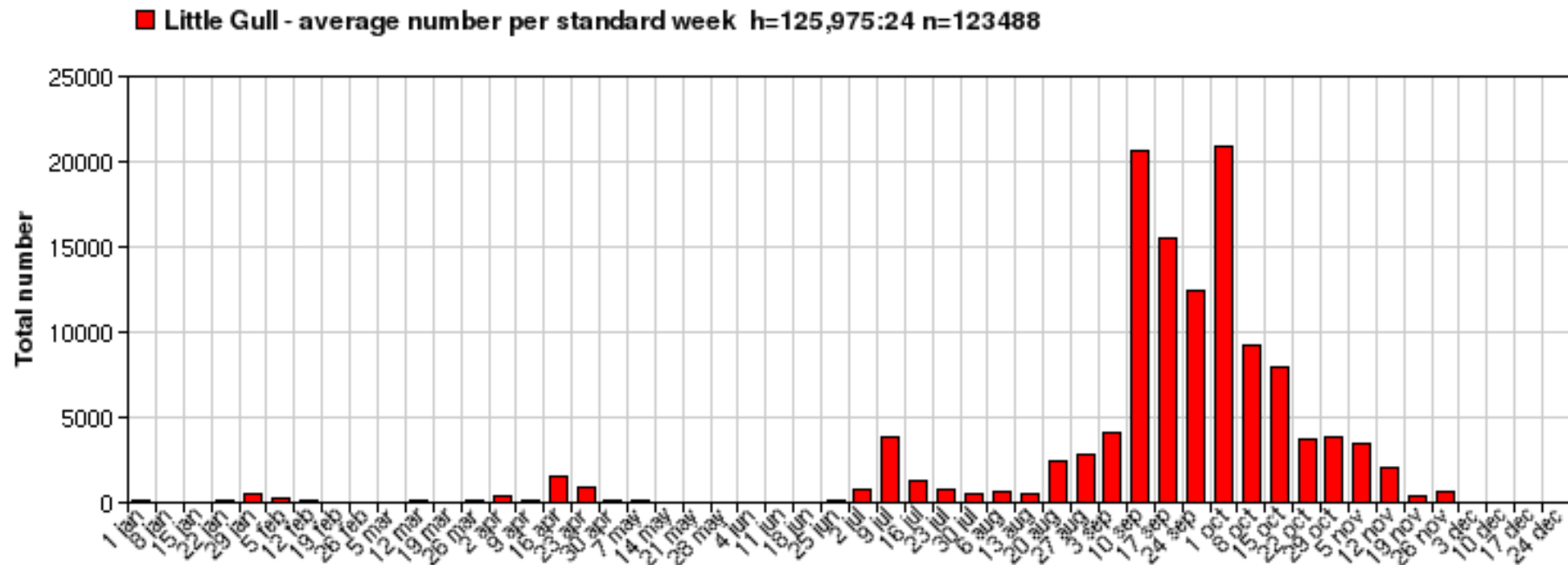


Plate 1 Counts of little gulls seen from sea watching vantage points on the east coast of England. Data from the Trektellen web page, summed for all years and sites

242. Secondly, little gull numbers and distribution show considerable variability between both years and days (Natural England and JNCC 2016), with birds apparently showing little site-fidelity (Brown and Grice 2005). Thus, a population estimate based on aerial surveys conducted across just two winters and covering what almost certainly represents a relatively small portion of their range is unlikely to provide a reliable estimate of population size.
243. Thirdly, it is evident that the aerial survey technique used by JNCC for the Greater Wash SPA designation was unable to provide an accurate count of little gulls. According to Natural England and JNCC (2016): *“Little gulls are difficult to distinguish from other small gull species on aerial surveys so many little gulls may have been recorded as ‘small gull species’ or the birds missed altogether by less experienced observers. Little gulls were certainly under recorded on some aerial surveys but it is impossible to estimate the proportion of birds recorded as ‘small gull species’ that were actually little gulls. Only birds identified as little gulls were included in the analyses”*. Use of this approach to assessment therefore means that little gull numbers are likely to be significantly underestimated. According to Natural England and JNCC (2016): *“The true numbers of little gull within the survey area may have been at least double that recorded”*.
244. Taken together, these factors therefore suggest that the winter population of little gulls in the Greater Wash Area of Search (a larger area than the SPA within which surveys were conducted, Lawson et al. 2016) is likely to be at least twice as large as that presented in the Greater Wash SPA citation (as acknowledged by Natural England and JNCC 2016), and so the actual population is likely to exceed 4,300 birds (area of search population, 2,153 multiplied by 2). Indeed, the little gull population during peak migration in autumn is likely to be even larger than this winter estimate (perhaps five times larger, based on coastal observations; i.e. between 10,000 and 20,000, estimated as five times 2,153 to 4,300). Combined with a high turnover of individuals, it is likely that several tens of thousands of little gulls pass through the Greater Wash SPA area each year, however the total cannot be estimated with any confidence. It should be noted that even a population estimate of 20,000 associated with the SPA therefore remains precautionary: Stienen et al. (2007) reported that the flyway population with potential connectivity to the southern North Sea was up to 75,000. However, the current assessment has been conducted on the basis of the more precautionary population sizes of 10,000 to 20,000.

4.4.2.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

245. Little gulls are mainly seen in the Greater Wash SPA in autumn during migration from east European breeding grounds to wintering grounds that are not yet well described (Wilson et al. 2009, Natural England 2015a). Small numbers of little gull may overwinter in the Greater Wash SPA, but most of the birds present in

autumn move on to other areas (Wilson et al. 2009). Aerial surveys suggest that little gulls are primarily concentrated in the area adjacent to the seaward edge of the Inner Wash (Wilson et al. 2009, Natural England 2015b, Lawson et al 2016). Birds in the Greater Wash SPA are unlikely to show regular connectivity with the East Anglia TWO windfarm site, although some may possibly pass through the windfarm site as little gulls are thought to be rather nomadic and unpredictable in their movements and distribution (Wilson et al. 2009). Given the high uncertainty about little gull population sizes, population origin and seasonal movements, it is difficult to assess with any certainty whether there is any connectivity between little gulls seen in the vicinity of the East Anglia TWO windfarm site and those seen in the Greater Wash SPA.

246. Little gulls tend to fly low over the water. According to Johnston et al. (2014), based on modelling data from numerous boat-based surveys at proposed offshore windfarm sites the mean percentage of little gull flying at collision risk height (defined as above 22m) is 12.5%.

4.4.2.2.1 Assessment of collision risk to little gull

247. The little gull collision mortality for the proposed East Anglia TWO project was 1.7 birds per year, derived from option 2 of the Band model. As described in **section 4.4.2.1**, a precautionary estimate of the population size of little gulls visiting the Greater Wash Area of Search is around 10,000 individuals per year, while a more realistic (but still precautionary) estimate is likely to be around 20,000 individuals per year. The only published estimate of little gull survival suggests a survival rate of adults of 0.8 (Horswill and Robinson 2015). At this survival rate, natural annual mortality for little gull will be between 2,000 and 4,000 birds. The estimated maximum proposed East Anglia TWO project collision mortality of 1.7 birds represents an increase in mortality of between 0.0425% to 0.085%. Following SNCB recommendations, an increase in mortality of less than 1% is considered to be undetectable against the range of background variation. Therefore, this increase, which is below the threshold at which increases in mortality are detectable, means that no significant effect can be attributed to this level of effect arising from the proposed East Anglia TWO project alone.
248. The Greater Wash SPA designated population of little gull is 1,255, which is 13% of a population of 10,000 or 6.5% of a population of 20,000. On this basis, and assuming collisions would be distributed uniformly throughout the population, this would imply that a maximum of 0.2 individuals from the Greater Wash SPA population of little gull could be killed by collisions (13% of 1.7), which would be even reduced further on the basis of the more realistic wider population (of 20,000).
249. Thus, it can be concluded that the maximum additional mortality from the SPA population will be undetectable and there will be no adverse effect on the integrity

of the Greater Wash SPA as a result of collisions at the East Anglia TWO windfarm site alone.

4.4.2.2.2 Displacement

250. There is very little consistent evidence regarding displacement of little gulls by offshore windfarms. Leopold et al. (2011) found significant displacement of little gulls by Dutch offshore windfarms in one survey but this was not observed in six other surveys at the same windfarms. Petersen et al. (2006) tentatively suggested that little gulls were attracted by Horns Rev offshore windfarm after construction, but the data are somewhat inconclusive. Vanermen et al. (2016) present evidence that little gull numbers increased significantly at Thorntonbank offshore windfarm post-construction, but that there was no change in little gull numbers at Blighbank offshore windfarm post-construction. Displacement of little gulls by offshore windfarms would therefore appear to be negligible and no adverse effect on integrity is predicted as a consequence.

4.4.2.2.3 In-combination effects

251. Given the extremely small potential project-only effect on little gull it is apparent that the likelihood of the proposed East Anglia TWO project contributing to an in-combination impact is extremely small.

252. However, following advice from Natural England the predicted mortality at windfarms with potential connectivity to the Greater Wash SPA has been collated and assessed.

253. The predicted mortality of little gull at East Anglia TWO in-combination with other windfarms with potential connectivity to the Greater Wash SPA little gull population was estimated to be 70 (**Table 4.2**).

Table 4.2 Assessed collision rates and updated little gull collision predictions for offshore wind farm sites with potential connectivity to the Greater Wash SPA.

Windfarm	Annual collisions	Avoidance rate (%)	Collisions updated for 99.2% avoidance rate
Triton Knoll	65	98	26
Race Bank	52	98	21
Sheringham Shoal	8	98	3
Hornsea Project One	10	98	4
Hornsea Project Two	1.3	98	0.5
Hornsea Project Three	0.5	99.2	0.5
Norfolk Vanguard	8.3	99.2	8.3

Windfarm	Annual collisions	Avoidance rate (%)	Collisions updated for 99.2% avoidance rate
Norfolk Boreas	3.9	99.2	3.9
East Anglia TWO	1.7	99.2	1.7
East Anglia ONE North	1.0	99.2	1.0
In-combination total			69.9

254. Given a regional little gull population of between 10,000 and 20,000 this figure (70) represents an increase in background mortality of between 1.7% and 3.5% (although as noted above the population may be as large as 75,000, further reducing the magnitude of potential impact, to an increase in mortality of less than 0.5%). The Greater Wash SPA designated population of little gull is 1,255, which is 12.6% of a population of 10,000 or 6.3% of a population of 20,000. On this basis, and assuming collisions would be distributed uniformly throughout the population, this would imply that a maximum of 8.8 individuals from the Greater Wash SPA population would be at risk of in-combination collisions (12.6% of 70), although adjusting impact magnitude for the actual built projects (or planned designs, for example Triton Knoll has reduced its capacity from 288 turbines to 90) this would reduce to 6 individuals. Furthermore, the in-combination collisions would be reduced to 3 individuals on the basis of the more realistic wider population (of 20,000). These would give rise to increases in mortality for the SPA population of between 1.2% (for built projects and the realistic population of 20,000) and 3.5% using the most precautionary combination of consented development predictions and the smallest regional population estimate of 10,000.

255. A very slightly lower total collision estimate of 7 individuals (cf. 8.8) was assessed by the Secretary of State (SoS) for the in-combination assessment for the Triton Knoll non-material change application (BEIS 2018). In relation to this estimate the SoS stated:

“Assuming collisions are attributed evenly amongst the regional population, this equates to 7 individuals from the Greater Wash population. Such a small impact would also be undetectable in the SPA population.”

And also:

“in view of the small impacts quantified above, the Secretary of State considers that an Appropriate Assessment is not required in this case.”

256. Thus, on the basis of an SPA in-combination mortality of 8.8, for the most precautionary interpretation of the potential risk to the population or a more

realistic total of 3, the likelihood of an adverse effect on the integrity of the Greater Wash SPA population of little gull can be ruled out for the proposed East Anglia TWO project in-combination with other plans and projects.

4.4.2.3 Conclusion

257. The relevant conservation objective is the maintenance of little gull numbers within the Greater Wash SPA at a level similar to that at designation, subject to natural change. On the basis of the assessment detailed above, it can be concluded with confidence for little gull that there will be no adverse effect on the integrity of Greater Wash SPA as a result of the proposed East Anglia TWO project acting alone.
258. The very low risk of effects to little gull due to the proposed East Anglia TWO project means the potential for the project to contribute to an in-combination effect on the little gull population of the Greater Wash SPA is also considered to be negligible. Hence, no adverse effect on the integrity of the SPA as a result of in-combination effects is predicted.

4.5 Alde Ore Estuary SPA

259. The Alde-Ore Estuary SPA covers 2,417ha and is located on and around the Suffolk coast, being 37km from the proposed East Anglia TWO windfarm site at its closest point. It comprises an estuarine complex of the rivers Alde, Butley and Ore. The Alde-Ore Estuary was also listed as a Ramsar site in October 1996 for its internationally important wetland assemblage. The SPA citation was published in January 1996 and the site was classified by the UK Government as an SPA under the provisions of the Birds Directive in August 1998. The site is coincident with the Alde-Ore Estuary SSSI, which was notified in 1952, with the SSSI boundary being identical to that of the SPA and Ramsar sites. The SPA/Ramsar site also forms part of the Alde-Ore and Butley European Marine Site.
260. There are several important habitats within the site, including intertidal mud-flats, saltmarsh, vegetated shingle (including the second-largest and best-preserved area in Britain at Orfordness), saline lagoons and semi-intensified grazing marsh. The diversity of wetland habitat types present is of particular significance to the birds occurring on the site, as these provide a range of opportunities for feeding, roosting and nesting within the site complex. At different times of the year, the site supports notable assemblages of wetland birds including seabirds, wildfowl and waders. As well as being an important wintering area for waterbirds, the Alde-Ore Estuary provides important breeding habitat for several species of seabird, wader and birds of prey. During the breeding season, gulls and terns feed substantially outside the SPA (JNCC 2011a). The Suffolk Wildlife Trust, the National Trust and the RSPB have nature reserves within the SPA.

261. JNCC's SPA site description (as published in 2001) indicates that the Alde-Ore Estuary qualifies as an SPA under Article 4.1 of the Birds Directive (79/409/EEC) by regularly supporting populations of Annex I species of European importance: breeding populations of little tern, marsh harrier and Sandwich tern, and avocet (both breeding and wintering). The site also qualifies under Article 4.2 of the Birds Directive by supporting two Annex II species - a wintering population of redshanks, and a breeding population of lesser black-backed gulls, the designation of the lesser black-backed gulls being based on 14,074 breeding pairs (4 year mean peak, 1994-1997). At designation, the site regularly supported 59,118 individual seabirds during the breeding season, including: herring gull, black-headed gull, lesser black-backed gull, little tern and Sandwich tern.
262. Following the 2001 UK SPA review (Stroud et al. 2001) additional Article 4.2 qualifying features were identified as needing protection: a breeding seabird assemblage of international importance (at least 20,000 seabirds) and a wintering waterbird assemblage of international importance (at least 20,000 waterbirds).
263. The conservation objectives of the site include:
- Avoid the deterioration of the habitats of the qualifying features, and significant disturbance of the qualifying features, ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive.
 - Subject to natural change, to maintain or restore [for each qualifying feature]:
 - a. The extent and distribution of the habitats of the qualifying features;
 - b. the structure and function of the habitats of the qualifying features;
 - c. the supporting processes on which the habitats of the qualifying features rely;
 - d. the populations of the qualifying features; and
 - e. the distribution of the qualifying features within the site.

4.5.1 Lesser black-backed gull

4.5.1.1 Status and ecology

264. The lesser black-backed gull breeds in large numbers in England, mostly in coastal areas but also in urban sites and some inland sites such as moorland (Mitchell et al. 2004). It is primarily a summer visitor, with most birds migrating to southern Europe or north Africa for the winter (Wernham et al. 2002). However, increasing numbers have taken to overwintering in the southern North Sea in recent decades (Wernham et al. 2002). Breeding numbers increased considerably during the 20th century, probably in part due to provision of fishery discards (Camphuysen 2013). Male lesser black-backed gulls forage mostly at

sea, whereas females forage more in terrestrial habitats (Camphuysen et al. 2015). Habitat use is also seasonal, with greater use of inland foraging early and late in the breeding season, and peak marine foraging activity during chick-rearing (Thaxter et al. 2015). Lesser black-backed gulls sometimes fly at heights that make them vulnerable to collision with turbine blades, especially during the day (Ross-Smith et al. 2016). Although they do not show macro-avoidance of offshore windfarms, tracking data suggest a high level of meso-avoidance of turbines (Thaxter et al. 2018).

265. The changing fortunes of gulls at the Alde-Ore Estuary SPA and reasons for the current unfavourable declining status have been documented in the Appropriate Assessment for Galloper Offshore Wind Farm (Department of Energy and Climate Change 2013) and elsewhere, for example, Mason (2010). The colony was first formed in the early 1960s, when a few pairs nested (Stroud et al. 2001). Numbers then increased rapidly, apparently due to immigration of birds from elsewhere (Stroud et al. 2001). Although most of the colony was at Orfordness, numbers there have declined since 2000. As numbers declined at Orfordness, numbers increased at Havergate Island (RSPB reserve and also part of the Alde-Ore Estuary SPA), suggesting that colony relocation was in part related to effects of predators or disturbance. Counts of breeding pairs at these two sites are available from the JNCC Seabird Colony Monitoring database and are summarised in **Table 4.3**.

Table 4.3 Numbers of Breeding Pairs of Lesser Black-Backed Gulls Counted at the Colonies at Orfordness and at Havergate Island (Data from JNCC Seabird Colony Monitoring database).

Year	Colony		Year	Colony	
	Orfordness	Havergate		Orfordness	Havergate
1961	No data	2	2004	6000	264
1968	140	No data	2005	4500	208
1969	150	No data	2006	5000	325
1986-93	5000-9043	0-7	2007	1678	768
1994	9981	27	2008	1584	1185
1995	11221	35	2009	900	1074
1996	14814	3	2010	550	1053
1997	20216	2	2011	550	1030
1998	21700	4	2012	640	1267
1999	22500	14	2013	No data	1747

Year	Colony		Year	Colony	
	Orfordness	Havergate		Orfordness	Havergate
2000	23000	400	2014	No data	2070
2001	5500	290	2015	No data	2399
2002	6500	338	2016	No data	1668
2003	6000	249			

4.5.1.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

266. No works for the proposed East Anglia TWO project will take place within the SPA site boundary therefore the main concern with lesser black-backed gull is in relation to collision risk when they are outside of the SPA site boundary, since these gulls fly partly within the height range where they may encounter rotating turbine blades.
267. Alde-Ore Estuary SPA is 37km from the closest point of the East Anglia TWO windfarm site. The lesser black-backed gull is estimated to have a mean breeding season foraging range of 72km from colonies, a mean maximum range of 141km, and a maximum recorded range of 181km (Thaxter et al. 2012a). Therefore, breeding adults from Alde-Ore Estuary SPA may forage over an area that includes the East Anglia TWO windfarm site.
268. Non-SPA colonies of lesser black-backed gulls are also located within foraging range of the East Anglia TWO windfarm site, including rooftop nesting gulls in several towns in Suffolk and Norfolk. As there is a high likelihood that birds from these populations will also be present at the East Anglia TWO windfarm site it is appropriate to consider the relative population sizes and potential for connectivity. This is discussed below.
269. The national census of seabirds breeding in Britain and Ireland in 1985-86 found 37 pairs of lesser black-backed gulls breeding in Norfolk and fewer than 43 pairs in Suffolk at sites outside the Alde-Ore Estuary SPA (Lloyd et al. 1991). There were at least 5,000 pairs nesting at Orfordness in the Alde-Ore Estuary SPA and two or three pairs at Havergate (Lloyd et al. 1991 and JNCC Seabird Monitoring Programme (SMP) database), so the Alde-Ore Estuary SPA held 98% of the lesser black-backed gulls breeding in East Anglia in 1985-86. The national census of seabirds breeding in Britain and Ireland in 1998-2002 found 1,605 pairs of lesser black-backed gulls breeding in Norfolk and 1,166 pairs in Suffolk at sites outside the Alde-Ore Estuary SPA (Mitchell et al. 2004), so 2,771 pairs were found nesting at sites in East Anglia away from the Alde-Ore Estuary SPA. The JNCC SMP database shows a huge drop in breeding numbers at Orfordness and Havergate at that time after many years of colony growth (**Plate 2**). According to

JNCC, this was apparently caused by foxes which were entering the colony to kill adults and chicks and take gull eggs (Mavor et al. 2001). Numbers have declined further since 2001 (**Plate 2**), as the problem of depredations by foxes has apparently continued.

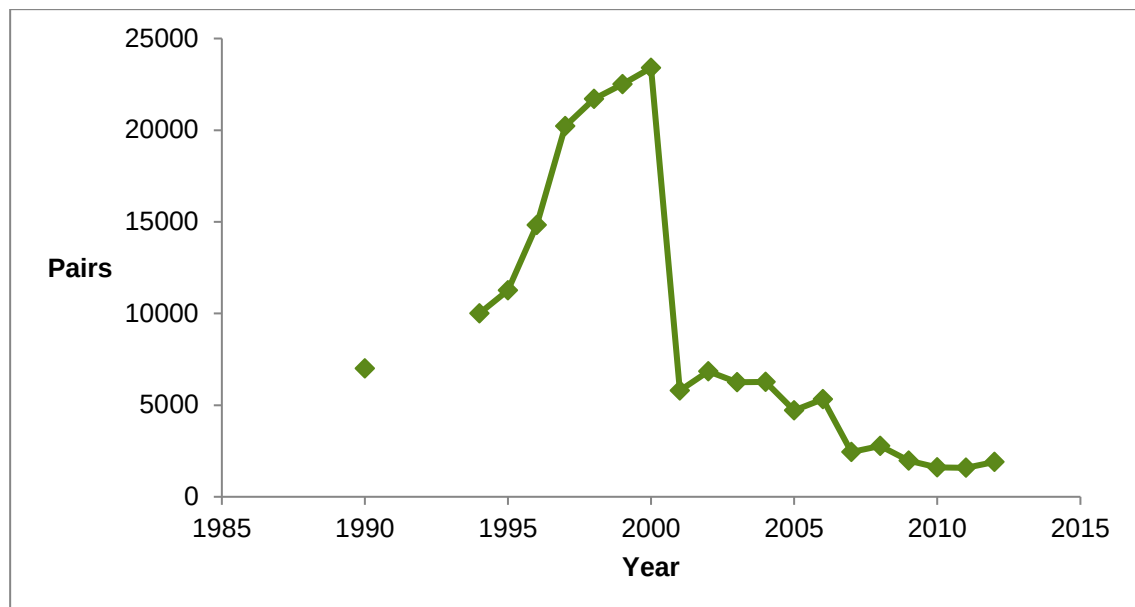


Plate 2 Number of breeding pairs of lesser black-backed gulls in the Alde-Ore Estuary SPA; Orfordness plus Havergate (data from JNCC SCM database).

270. There were estimated to be 23,000 pairs at Orfordness and 400 pairs at Havergate in 2000, so an estimated 89% of the lesser black-backed gulls breeding in Norfolk and Suffolk were in the Alde-Ore Estuary SPA in 2000. The colony at Orfordness held 5,500 pairs, and the colony at Havergate held 290 pairs in 2001 (JNCC SMP database). That means that 68% of the breeding population was within the Alde-Ore Estuary SPA in 2001.
271. The Alde-Ore population of lesser black-backed gulls has since decreased considerably, the most recent published counts being 640 pairs at Orfordness in 2012 and 1,668 pairs at Havergate in 2016. No counts have been entered into the JNCC SMP database for Orfordness since 2012 and that limits understanding of any changes that have occurred since 2012.
272. By comparison, numbers breeding elsewhere in East Anglia have increased. There were 743 pairs at urban colonies in Great Yarmouth in 2012, 467 pairs at Southtown/Gorleston in 2012, probably about 2,000-3,000 pairs at Lowestoft in 2008-2011, and a few hundred pairs at other sites in Norfolk and Suffolk (Piotrowski 2013). These urban colonies have only been censused a few times, and counts are not very accurate because many rooftops are impossible to view, so the numbers are likely to be underestimates (Ross et al. 2016), and the 2012 census of urban breeding gulls in Suffolk was carried out after adverse conditions

resulted in considerable breeding failure of many gulls (Piotrowski 2013) so is also likely to have underestimated numbers at urban sites. However, despite the relatively incomplete census data, it is clear that urban colonies have been growing very fast, as seen at Lowestoft (**Plate 3**), and Great Yarmouth (**Plate 4**).

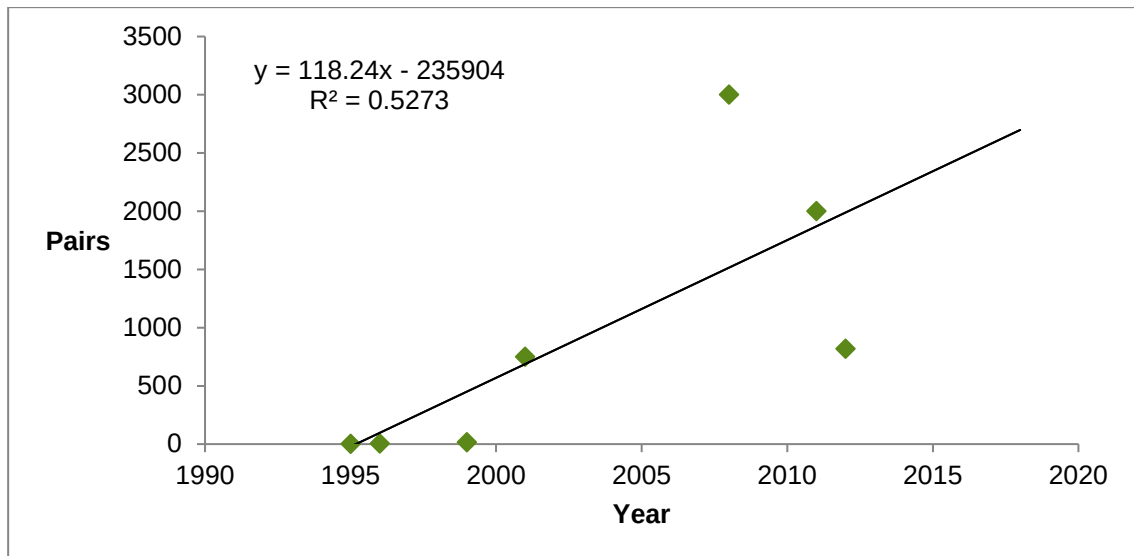


Plate 3 Number of breeding pairs of lesser black-backed gulls in Lowestoft (data from JNCC SCM database and Piotrowski 2013).

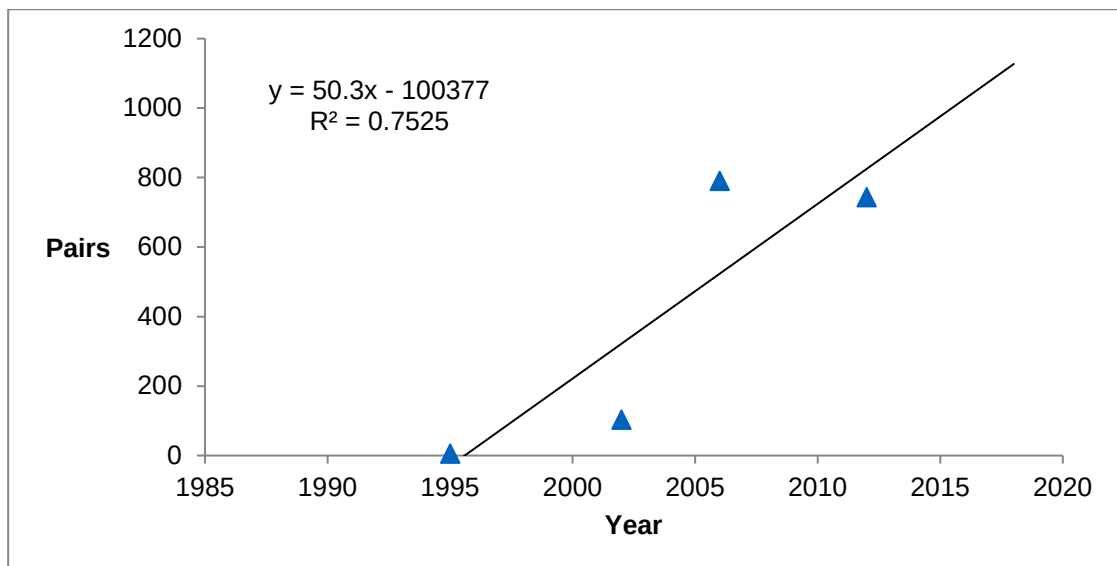


Plate 4 Number of breeding pairs of lesser black-backed gulls in Great Yarmouth (data from JNCC SCM database and Piotrowski 2013).

273. In addition, breeding numbers have increased at Felixstowe (1,401 pairs in 2013; **Plate 5**) and Ipswich (99 pairs in 2001, 262 pairs in 2012), which are also urban colonies, and at Outer Trial Bank (1,704 pairs in 2006, 1,457 pairs in 2009 and 1,294 pairs in 2018) (JNCC SCM database).

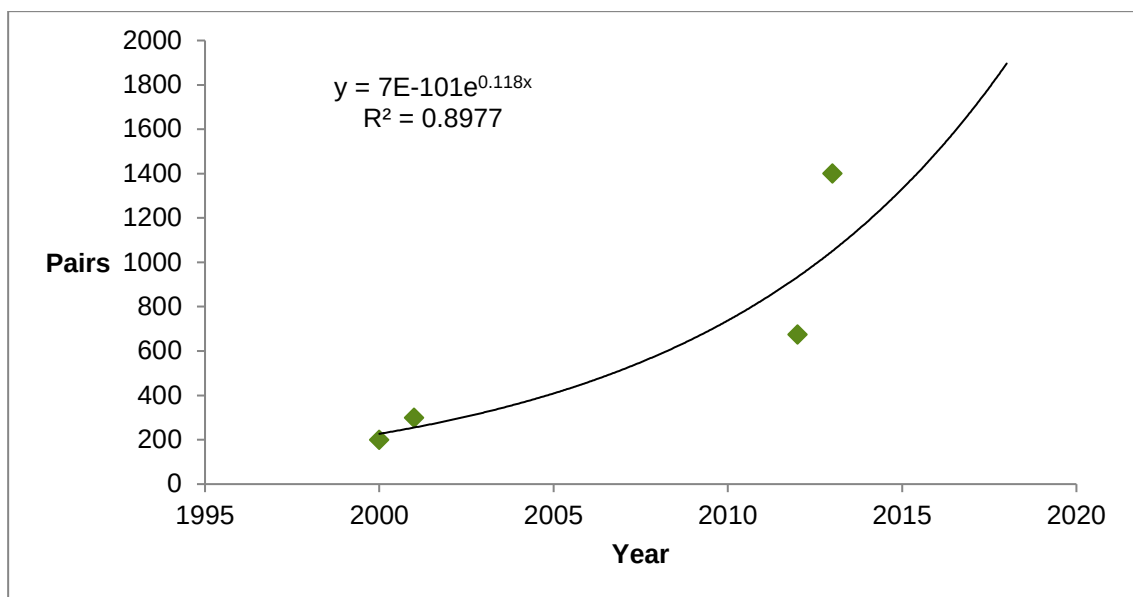


Plate 5 Numbers of breeding pairs of lesser black-backed gulls at Felixstowe (data from JNCC SCM database). For this colony an exponential growth curve is a better fit than a linear increase.

274. The numbers at Alde-Ore Estuary SPA colonies in 2012-2016 (ca. 2,300 pairs) compare with ca. 5,100 pairs at sites in Norfolk and Suffolk outside the SPA. This suggests that the percentage of Norfolk and Suffolk lesser black-backed gulls breeding within the SPA had fallen to about 31% of the population.
275. Concerted efforts to make urban areas 'gull-proof' can sometimes result in a reduction in breeding numbers of urban gulls of as much as 25% (Coulson and Coulson 2009) though such reductions may possibly only be temporary until gulls find other urban nest sites where they are tolerated. In general, urban nesting by gulls has increased throughout the UK much faster than total populations of gulls (Raven and Coulson 1997, Nager and O'Hanlon 2016) because the breeding success of gulls tends to be higher at urban sites than in rural colonies (chicks on rooftops are not exposed to predators such as foxes and are less at risk of disturbance or conflict with other gulls; Monaghan 1979, Monaghan and Coulson 1977), and survival of adults at urban colonies is at least as high, and probably higher, than at rural sites (Rock and Vaughan 2013, O'Hanlon and Nager 2018). Piotrowski (who carried out the census of breeding numbers at urban sites in Suffolk in 2012; pers. comm.) stated that efforts to deter urban nesting gulls in Suffolk have largely been ineffective and do not seem to have resulted in significant reductions in the population in urban sites overall.
276. Urban nesting lesser black-backed gull numbers in Suffolk increased by over 1000% between 1995 and 2012 (Piotrowski 2013) at a period when numbers breeding in the Alde-Ore Estuary SPA decreased by about 70%. If this trend has continued then the proportion of lesser black-backed gulls at East Anglia TWO

that originate from Alde-Ore Estuary SPA may be decreasing further below 31% since 2012, but this is uncertain. At a qualitative level, the picture shown quantitatively in 2012 appears not to be much changed since then. However, a repeat census of breeding gull numbers would be helpful to check on that, and may be carried out as part of the current national census of breeding seabirds, and could be made more accurate by use of drones to photograph inaccessible rooftops (Ross et al. 2016, Rush et al. 2018).

277. The available data show that the Alde-Ore Estuary SPA held about 98% of the East Anglia breeding population of lesser black-backed gulls in 1985-86, 89% of the East Anglia breeding population of lesser black-backed gulls in 2000, 68% in 2001, and about 31% in 2012-2016 (**Plate 6**). Since numbers at urban colonies in particular have been on an upward trend, it seems likely that the percentage of the population within the Alde-Ore Estuary SPA will have decreased further since 2012-2016.

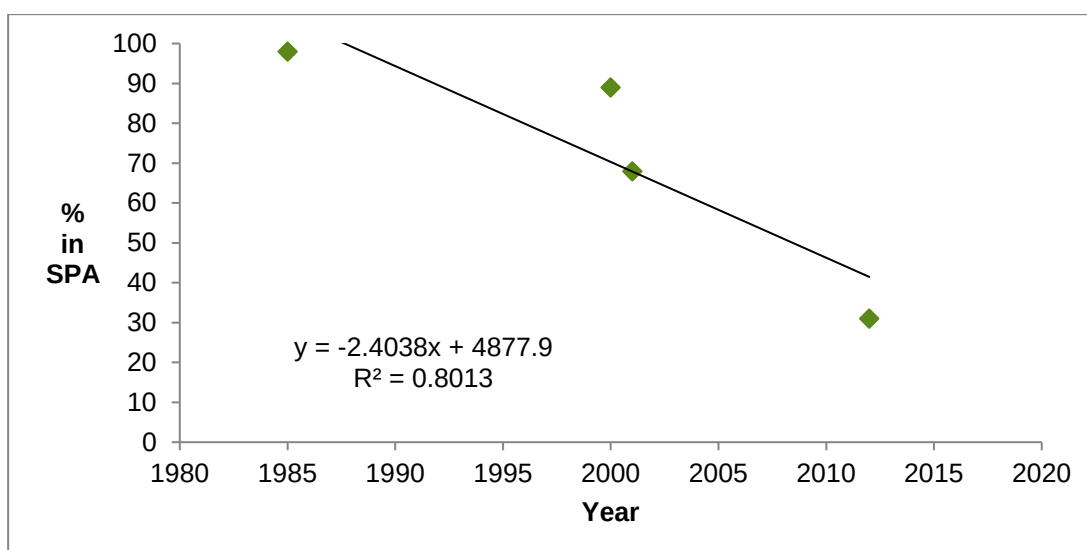


Plate 6 The percentage of lesser black-backed gulls breeding in East Anglia that were breeding within the Alde-Ore Estuary SPA in different survey years (based on JNCC SCM database and Piotrowski 2013).

278. It is likely that breeding adult lesser black-backed gulls visiting the East Anglia TWO site will tend to come from colonies within foraging range, and within that sample, may come more from colonies closer to the site than from colonies further away. In that context, it is worth noting that the SPA population at Alde-Ore Estuary is in the middle of the range of distances of East Anglian lesser black-backed gull colonies from East Anglia TWO (**Table 4.4**). Application of the simple population size – distance colony apportioning approach developed jointly by SNH and MacArthur Green indicates that around 41% of the birds recorded on the East Anglia TWO site would be expected to originate from the Alde Ore Estuary SPA (**Table 4.4**).

Table 4.4 Colonies of lesser black-backed gulls in East Anglia ranked according to the minimum distance from East Anglia TWO (noting the maximum foraging range of breeding lesser black-backed gulls is reported by Thaxter et al. (2012a) as 181 km) and estimated proportions of each present on the East Anglia TWO site based (calculated using SNH tool⁶).

Colony	Minimum distance to East Anglia TWO (km)	Approximate no. of breeding pairs in period 2008-2015	Colony weighting (population size / distance ²)	Colony proportion (colony weight / $\sum$ colony weights)
Great Yarmouth	50	750	0.3000	0.08
Southtown	50	450	0.1800	0.05
Lowestoft	37	2000	1.4609	0.39
Alde-Ore Estuary SPA	36	2000	1.5432	0.41
Felixstowe	57	700	0.2155	0.06
Ipswich	65	250	0.0592	0.02

279. On the basis of the population sizes and distances of all the breeding adults present on East Anglia TWO in the breeding season, 41% are expected to be breeding adults from Alde Ore Estuary SPA. However, since adults comprise around 58% of the total population (Furness 2015), and since immature birds are more likely to visit areas distant from the main foraging areas, with locations close to colonies used by breeding adults (Wakefield et al. 2017), the overall proportion of birds at East Anglia TWO during the breeding season that are breeding adults is likely to be at most 58%, and possibly much less. Therefore, the proportion of birds at East Anglia TWO that are breeding adults from the Alde-Ore Estuary SPA is likely to be 41% of, at most, 58% of the total (i.e. approximately 24% overall). However, tracking data from adults breeding at the Alde-Ore Estuary SPA provide a better approach to estimating numbers at East Anglia TWO originating from that SPA and so tracking data are considered below.
280. It is likely that the amount of foraging within the marine environment varies among colonies and among years, depending on the relative availability of different feeding opportunities (Garthe et al. 2016a). Lesser black-backed gulls are generalist feeders, able to exploit a wide range of foods from urban waste food to earthworms on rural pasture land to small mammals and insects in grassland to intertidal animals, marine fish caught at sea and fisheries waste (discards and offal) made available behind fishing boats (Corman et al. 2014). However, there

⁶ https://www.nature.scot/sites/default/files/2018-11/Guidance%20-%20Apportioning%20impacts%20from%20marine%20renewable%20developments%20to%20breeding%20seabird%20populations%20in%20SPAs_0.pdf

is evidence from diet studies and from tracking studies, that breeding adult lesser black-backed gulls tend to switch to feeding on marine fish when rearing chicks (Spelt et al. 2019). This is thought to be at least in part a strategy to provide chicks with nutritionally better food to support chick growth and development. That switch would therefore be just as appropriate for urban nesting gulls as for rural nesting gulls.

281. Tracking data (Hayley Douglas, pers. comm.) and diet data (Steve Piotrowski, pers. comm.) for urban nesting lesser black-backed gulls do indeed suggest that those birds feed to an extent in marine habitat, especially when rearing chicks, and do not suggest that urban nesting gulls are significantly less marine than those nesting in rural colonies (based on evidence reviewed below). Lesser black-backed gulls nesting in urban colonies in East Anglia include marine fish in their breeding season diet as well as earthworms, small mammals and urban food waste (Steve Piotrowski, pers. comm.). Those birds clearly forage at sea to some extent, just as some rural nesting gulls do.
282. Some rural nesting lesser black-backed gulls do not seem to feed at sea while breeding. Clewley et al. (2017) reported on tracking data from adult lesser black-backed gulls breeding at Bowland Fells SPA. Two individuals from this rural inland colony spent a small minority of their foraging time in the marine environment but less than 10km from the coast, whereas 14 others were never tracked over marine habitat (although three spent a small amount of time in estuarine habitat). Scragg et al. (2016) tracked ten adult lesser black-backed gulls breeding at the Ribble and Alt Estuary SPA and found that even for this coastal population, over 90% of their position fixes away from the colony occurred inland, with less than 0.5% occurring in marine habitat. Those studies indicate that rural nesting lesser black-backed gulls can have very low connectivity with marine habitat, even when the colony is at the coast.
283. Tracking of urban nesting gulls has only begun very recently (Rock et al. 2016), is based on small sample sizes, and is mostly not yet published. The 'tag-n-track' project has deployed GPS tags on lesser black-backed gulls breeding on rooftops in Strathclyde (Scotland). The data show that different individuals tend to have particular individual habits (as often found in gulls; Navarro et al. 2017), often returning regularly to the same location. However, birds nesting on rooftops include individuals that forage in the Clyde Estuary and Clyde Sea (Hayley Douglas, pers. comm.). Tracking of a small sample of breeding lesser black-backed gulls nesting in Bristol indicates that those birds do not forage in marine habitat, presumably because the sea is too distant and there are adequate foraging opportunities within closer range (Anouk Spelt, pers. comm.). Coulson and Coulson (2008) found that lesser black-backed gulls nesting in Dumfries did not forage in marine habitat, but fed mainly on agricultural land, especially on

earthworms. Thaxter et al. (2017) estimated that up to 41 birds would need to be tracked for about 145 days in order to describe 95% of area use by the population. On that basis, no clear conclusions can be reached about the relative importance of marine versus terrestrial habitat use from tracking studies based on deployment of very few tags for short periods of time, but the studies mentioned above do indicate that some urban nesting lesser black-backed gulls will forage at sea, and also indicate that birds from some rural colonies will forage almost exclusively inland. There is no evidence that urban nesting lesser black-backed gulls show lower connectivity with marine foraging habitat than rural nesting lesser black-backed gulls, although that possibility cannot be ruled out.

284. Tracking data (Thaxter et al. 2015) indicate moderate levels of connectivity between breeding lesser black-backed gulls at Orfordness (Alde-Ore Estuary SPA) and the East Anglia TWO windfarm site. Connectivity appears to vary between zero in some years (e.g. 2012) and low in others (e.g. 2010 and 2011), although only when total area usage (i.e. 95% of tag positions) is considered; core (50% of tag positions) and intermediate (75% of tag positions) cover much more restricted, coastal areas. These differences across years studied presumably reflect variations in food availability in different years.
285. Tracking data show a time budget overlap with the entire former East Anglia Zone of 3.7% in 2010, 1.1% in 2011 and 0.2% in 2012 (Thaxter et al. 2015 Supplementary material Appendix A), giving an average of 1.7%. The East Anglia TWO windfarm site forms a small part of the former East Anglia Zone, therefore the tracking data (Thaxter et al, 2015) suggest that much less than 1.7% of the total foraging time of lesser black-backed gulls was spent within the East Anglia TWO windfarm site. Indeed, on average only 2% of all lesser black-backed gull foraging time was spent in all windfarms in the region (i.e. including those outside the former East Anglia Zone).
286. For the population of about 2,000 breeding pairs at Alde-Ore Estuary SPA that indicates that an average of 34 birds (1.7% of the total number of pairs) were in the entire former East Anglia Zone at any point in time (assuming that under normal circumstances one adult is at the nest site while the other is away on a foraging trip).
287. Tracking data are for chick-rearing periods, so do not necessarily apply at other times during the breeding season. However, lesser black-backed gulls show more marine foraging behaviour during chick-rearing and more terrestrial foraging behaviour earlier in the breeding season, so the overlap with the East Anglia TWO windfarm site is likely to be highest during the latter part of the breeding season when birds have chicks to provision, and is probably lower than this during the early breeding season.

288. Given the low numbers indicated by tracking this raises the question of where birds observed at the East Anglia TWO windfarm site come from, if not Alde-Ore SPA. To be precautionary in relation to the SPA population of Alde-Ore Estuary, we have assumed that no breeding adults from the populations in the Netherlands visit the East Anglia TWO windfarm site because tracking data from birds in the Netherlands strongly indicate that connectivity for these birds is extremely low (Camphuysen 1995, 2013; Camphuysen et al. 2015). However, it is known that there are large numbers of immature lesser black-backed gulls in the populations (Furness 2015 estimated from demographic data that about 40% of the population will be immature birds and 60% will be breeding age adults). While younger immature birds may remain in the wintering area all year round, during spring and summer older immatures move towards breeding areas and may form a significant part of the population present at sea in areas such as the East Anglia TWO windfarm site. Consequently, a substantial part of the birds present at the East Anglia TWO windfarm site is likely to be immature birds from a variety of populations drawn from a much larger area than just East Anglia (as noted above, the Alde-Ore Estuary SPA population represents no more than 33% of the population of adult lesser black-backed gulls breeding in East Anglia, **Table 4.4**).
289. To conclude, during the breeding season, on the basis of relative population sizes and colony distance, combined with age ratios, the breeding adults from Alde-Ore Estuary SPA would comprise less than 24% of the on-site birds, while tracking data suggest this percentage would most likely be less than 2%. Both these values have been used in the assessment for the breeding season.
290. During migration, lesser black-backed gulls of all age classes will pass through the southern North Sea, with a small proportion of these passing through the East Anglia TWO windfarm site. Therefore, during migration, birds from many different local populations within the region may be at risk of collision mortality and the Alde-Ore Estuary SPA population represents only a very small fraction of the regional population potentially at risk. The lesser black-backed gull Biologically Defined Minimum Population Scales (BDMPS) population in UK North Sea and Channel waters in autumn (August-October) is estimated to be 209,000 birds, while the spring (March-April) population is estimated to be 197,000 birds (Furness 2015). The total Alde-Ore SPA lesser black-backed gull population has been estimated at around 6,700 individuals (assuming adults comprise 60% of the population, Furness 2015). This indicates that birds associated with the Alde-Ore SPA represent about 3.3% of these BDMPS populations. Therefore, it is likely that about 3.3% of the estimated collision mortality during the autumn and spring migration periods would affect birds associated with the Alde-Ore SPA population, of which around 60% would be breeding adults (i.e. 2% of the total collision mortality would be breeding adults from Alde-Ore Estuary SPA). This

percentage applies both for estimated mortality due to the proposed East Anglia TWO project alone, and to in-combination effects within the region.

291. During winter, lesser black-backed gulls are present in UK waters in smaller numbers than during migration; the estimated BDMPS winter population of lesser black-backed gulls in the UK North Sea and Channel waters is about 39,000 birds (Furness 2015). Adults from the Alde-Ore SPA lesser black-backed gull breeding population may represent a higher proportion of the winter BDMPS than they do during the migration seasons BDMPS populations because a higher proportion of the overwintering birds are likely to be adults (most immatures migrate further south). Furness (2015) considered that around 50% of breeding adults from the SPA remain in the region (a precautionary assumption), hence the proportion of birds from the Alde-Ore SPA will be approximately 5% (Furness 2015). Hence, no more than 5% of the estimated collision mortality on the lesser black-backed gull population during winter would be apportioned to the Alde-Ore SPA breeding population, either for estimated mortality due to the proposed East Anglia TWO project alone, or in-combination for the region. The true percentage is an unknown amount below 5% but is likely to be greater than the 3.3% estimated during migration seasons.

4.5.1.2.1 Assessment of collision risk to lesser black-backed gull

292. The predicted monthly numbers of lesser black-backed gull collision mortalities based on Band Option 2 (Band 2012), and an avoidance rate of 99.5% for the proposed East Anglia TWO project, are shown in **Table 4.5** (data taken from **ES Chapter 12 Offshore Ornithology**).

Table 4.5 Band Option 2 Predicted Monthly Numbers of Collision Mortalities of Lesser Black-Backed Gulls at the East Anglia TWO Site. Breeding Season Months (April-August) Shown in Bold

Month	Collisions
January	0 (0-0)
February	0 (0-0)
March	0.46 (0-1.37)
April	0.53 (0-1.6)
May	0 (0-0)
June	0.91 (0-2.72)
July	0 (0-0)
August	3.28 (1.1-6.0)
September	0 (0-0)

Month	Collisions
October	0 (0-0)
November	0 (0-0)
December	0 (0-0)
Total	5.18 (1.1-11.7)

293. On the basis of the seasonal percentages of Alde-Ore SPA birds predicted to be on the East Anglia TWO windfarm site, the attributable mortality is shown in **Table 4.6**.

Table 4.6 Mortalities of Lesser Black-Backed Gulls from Alde-Ore SPA at the East Anglia TWO Site

Season	Mortality	Range
Autumn (September-October)	$0 \times 3.3\% = 0$	0
Winter (November-February):	$0 \times 10\% = 0$	0
Spring (March)	$0.46 \times 3.3\% = 0.015$	0-0.04
Breeding season (April-August) @24%	$4.72 \times 24\% = 1.13$	0.26-2.48
Breeding season (April-August) @2%	$4.72 \times 2\% = 0.1$	0.02-0.21
Total for Alde-Ore SPA (@24% in the breeding season)	1.14	0.26-2.52
Total for Alde-Ore SPA (@2% in the breeding season)	0.11	0.02-0.25

294. Thus, the annual average mortality is estimated to be between 0.11 and 1.14 within a combined 95% confidence interval range of 0.02 to 2.52.

295. Natural mortality for the SPA population (assuming approximately 4,000 adults) would be around 460 individuals at an average adult mortality rate of 11.5% (Horswill and Robinson 2015). A total additional worst case mortality of up to 2.5 birds due to collisions at the East Anglia TWO windfarm site would increase the mortality rate by 0.5%.

296. Following SNCB recommendations, an increase in mortality of less than 1% is considered to be undetectable against the range of background variation. Therefore, this increase, which is below the threshold at which increases in mortality are detectable, means that no significant effect can be attributed to this level of effect arising from the proposed East Anglia TWO project alone.

297. It is, therefore, reasonable to conclude that there will be no adverse effect on the integrity of the Alde-Ore Estuary SPA as a result of lesser black-backed gull collisions at the proposed East Anglia TWO project alone.

4.5.1.2.2 In-combination effects

298. The cumulative lesser black-backed gull collision risk prediction for the nonbreeding season has been calculated using a 'tiered approach' (**Table 4.7**). Note that it was not possible to estimate mortality for each of the three non-breeding seasons (autumn, winter, spring) defined in Furness (2015) because the required breakdown of estimates by month is not available for this species for most windfarms. Hence it was necessary to consider mortality as either annual or non-breeding season and from these calculate the breeding season mortality. Cumulative lesser black-backed gull nonbreeding season mortality is estimated at 396.9 birds (of all age classes), of which the proposed East Anglia TWO project contributes 0.5. Cumulative breeding season mortality was estimated as 178 (giving an annual total of 573.4). However, during the breeding season only windfarms within 141km of the Alde-Ore SPA have been considered, on the grounds that only these windfarms have the potential to contribute to mortality on the SPA population at this time of year. Hence the breeding season mortality was summed for Greater Gabbard, Gunfleet Sands, Kentish Flats, London Array, Scroby Sands, Sheringham Shoal, Thanet, Dudgeon, East Anglia ONE, Galloper, East Anglia THREE, Thanet Extension, Norfolk Vanguard, Norfolk Boreas, East Anglia ONE North and East Anglia TWO project. The total breeding season mortality for these windfarms is 92.7. However, given the evidence from tracking studies (Thaxter et al. 2012b, 2015), it is questionable how realistic it is to include all of the windfarms within 141km. Windfarms within the mean range (72km; Greater Gabbard, East Anglia ONE, East Anglia ONE North, East Anglia TWO, Galloper and, London Array generate an estimate of 51.8 collisions.

Table 4.7 Lesser black-backed gull collision mortality for all windfarms (nonbreeding) and those with potential connectivity during the breeding season with the Alde-Ore SPA (see ES Appendix 12.3 for data sources).

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model option 1 or 2)			
		Annual	Nonbreeding	Breeding (Annual – nonbreeding)	Breeding within 141km of Alde Ore SPA
1	Beatrice	0	0	0	
1	Beatrice Demonstrator	0	0	0	
1	Blyth (NaREC Demonstration)	0	0	0	
1	Dudgeon	38.3	30.6	7.7	7.7

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model option 1 or 2)			
		Annual	Nonbreeding	Breeding (Annual – nonbreeding)	Breeding within 141km of Alde Ore SPA
1	EOWDC (Aberdeen OWF)	0	0	0	
1	Galloper	138.8	111.0	27.8	27.8
1	Greater Gabbard	62.0	49.6	12.4	12.4
1	Gunfleet Sands	2	1	1	1
1	Humber Gateway	1.3	1.1	0.2	
1	HyWind	0	0	0	
1	Kentish Flats	1.6	1.3	0.3	0.3
1	Lincs	8.5	6.8	1.7	
1	London Array (Phase 1)	0	0	0	
1	Lynn and Inner Dowsing	0	0	0	
1	Race Bank	54.0	10.8	43.2	
1	Rampion	7.9	6.3	1.6	
1	Scroby Sands	0	0	0	
1	Sheringham Shoal	8	6	2	2
1	Teesside	0	0	0	
1	Thanet	16.0	12.8	3.2	3.2
1	Westermest Rough	0.3	0.3	0	
2	East Anglia ONE	39.7	33.8	5.9	5.9
2	Hornsea Project 1	21.8	17.4	4.4	
2	Kincardine	0	0	0	
2	Moray Firth (EDA)	0	0	0	
3	Dogger Bank Creyke Beck A & B	13.0	10.4	2.6	
3	Dogger Bank Teesside A & B	12.0	9.6	2.4	
3	East Anglia THREE	9	7.4	1.6	1.6
3	Firth of Forth Alpha and Bravo	10.5	8.4	2.1	
3	Hornsea Project 2	4.0	2.0	2.0	
3	Inch Cape	0	0	0	
3	Moray Firth (WDA)	0	0	0	

Tier	Windfarm (source of annual data / source of autumn data)	Predicted collisions (@ 99.5% avoidance rate, Band Model option 1 or 2)			
		Annual	Nonbreeding	Breeding (Annual – nonbreeding)	Breeding within 141km of Alde Ore SPA
3	Neart na Goithe	0	0	0	
3	Triton Knoll	37	29.6	7.4	
4	Hornsea Project 3	17.3	0	17.3	
4	Thanet Extension	2.3	0.8	1.5	1.5
4	Norfolk Vanguard	23	7.5	15.5	15.5
4	Norfolk Boreas	39.8	31.8	8.0	8.0
4	East Anglia TWO	5.2	0.5	4.7	4.7
4	East Anglia ONE North	1.6	0.6	1.0	1.0
	Total	574.9	397.3	177.8	92.7

299. As discussed above, given the large geographical area from which lesser black-backed gulls migrating through the East Anglia TWO windfarm site originate, it is only possible to apportion mortality to the Alde-Ore SPA population on the basis of its size relative to the wider lesser black-backed gull population. Across all age classes the Alde-Ore Estuary SPA represents approximately 3.3% of the BDMPS autumn population, about 3.3% of the BDMPS spring population and a maximum of 5% of the BDMPS winter population. As noted above, for many windfarms there is insufficient information to determine in which months nonbreeding season collisions occur. Therefore, on the basis of the whole period a weighted Alde-Ore Estuary SPA percentage of 4% has been calculated (5 months at 3.3% and 4 months at 5%). This indicates that up to 16 birds (397 x 4%) from the Alde-Ore Estuary SPA population could die during the nonbreeding season.
300. The annual mortality of lesser black-backed gulls from the Alde-Ore SPA is therefore 16 during the nonbreeding season and 28 (92.7 x 30%, allowing for non-SPA birds in Norfolk and Suffolk, **Plate 6**) during the breeding season, 44 in total (of which the proposed East Anglia TWO project contributes up to 5).
301. In-combination mortality of 44 birds attributable to the Alde-Ore SPA population of lesser black-backed gulls compares with estimated natural mortality of about 460 birds per year. Thus, the predicted additional in-combination collision mortality represents an increase in the mortality rate of 9.5%, of which over 40% is attributable to the estimated collisions at the Galloper Wind Farm alone.

302. Recent work has highlighted the reduction in collisions which results from updating consented assessments to reflect as-built windfarm designs in comparison to the original full consent envelopes (MacArthur Green 2017, unpubl. report). Updating from the consented design to the as-built design (see **ES Appendix 12.3**) typically reduces predicted mortality by at least 40%, which would reduce the in-combination mortality prediction to around 26, equating to an increase in background mortality of 5.6% (although notably the reduction in collision risk for the Galloper Wind Farm would be even greater, at around 60%).
303. A population model has been developed to provide further interpretation of these potential in-combination impacts (Vattenfall 2019b). This model follows current Natural England guidance, utilising a matched-run approach to generate counterfactuals of population size (CPS) and counterfactuals of population growth rate (CPGR) and was run for a simulated period of 25 years. Summary results are provided in **Table 4.8**.

Table 4.8 Lesser black-backed gull Alde Ore Estuary SPA population modelling results (see MacArthur Green 2019 for details).

Model	Adult mortality	Counterfactual metric (after 25 years)	
		Growth rate	Population size
Density independent	25	0.994	0.860
	40	0.990	0.785
Density dependent	25	0.999	0.949
	40	0.998	0.918

304. Taking the modelled adult mortality of 40 (as the worst case), the population growth rate was predicted to be 1.0% lower (0.990) than the baseline using the density independent model, and 0.2% lower (0.998) using the density dependent model. At the lower modelled adult mortality of 25, the reduction in growth rate was 0.6% for the density independent model and 0.1% for the density dependent model.
305. Even with the most precautionary in-combination estimates these reductions in growth rate are small (no more than 1.0%) and therefore are not considered likely to result in a population decline. The more realistic collision estimates, accounting for the reduced impacts from built windfarms compared with the consented designs, predict a growth rate reduction of no more than 0.6% (density independent), which further reduces any concerns about the impact on the SPA population.
306. It is also worth noting that the in-combination collision total predicted for the consented Galloper Wind Farm was 85 (at a 99.5% avoidance rate), which is

double the more precautionary estimate of 44 above, and more than three times the more likely prediction of 26.

4.5.1.3 Conclusion

307. The relevant conservation objective is to restore breeding numbers of lesser black-backed gulls from the present level of about 2,000 pairs back to the population at designation which was about 14,000 pairs. The annual number of predicted lesser black-backed gull collisions at the East Anglia TWO windfarm site is very small (5.2 per year), and of that the proportion which can be attributed to the Alde Ore SPA is also small (1.5, after accounting for the presence of c. 70% non-SPA birds in the region) as to not materially alter the natural mortality rate for this population. Therefore, no adverse effect on the integrity of the Alde-Ore SPA lesser black-backed gull population is predicted as a result of the proposed East Anglia TWO project alone.
308. Given the degree of precaution in collision assessments, including the use of the much higher mortality predictions estimated for consented windfarm designs rather than for the as-built windfarm designs, there will be no adverse effect on integrity due to in-combination collisions.
309. Furthermore, the context for the status of this population is relevant to the significance of potential collision mortality. The breeding success, and hence the population trend, of lesser black-backed gulls in the Alde-Ore SPA population appears to be mainly determined by the amount of predation, disturbance and flooding occurring at this site (Department of Energy and Climate Change 2013a, Thaxter et al. 2015). Increased predation and disturbance by foxes has been considered the main factor causing reductions in breeding numbers. Management measures to reduce access by foxes has resulted in some recovery of numbers of gulls. The main driver of gull numbers in this SPA therefore appears to be suitable management at the colonies to protect gulls from predators (Department of Energy and Climate Change 2013a). It seems apparent that further efforts in this regard could readily improve this population's conservation status.

4.6 Flamborough and Filey Coast SPA

310. The Flamborough and Filey coast SPA was formally designated on 31st July 2018. The SPA represents a geographical extension to the former Flamborough Head and Bempton Cliffs SPA and adds several species to the citation list. Compared to its predecessor, Flamborough Head and Bempton Cliffs SPA, the Flamborough and Filey Coast SPA consists of a landward extension to the north west of the existing site to incorporate important breeding colonies of seabirds and marine extensions out to 2km in order to protect adjacent areas of water which are important to these species of breeding birds. There are also

modifications of the landward boundary of the existing SPA such that the features of the SPA are protected in the future, and the addition of the following migratory features to the SPA citation; gannet, common guillemot and razorbill. The SPA citation also incorporates an update to the published population figures for kittiwake.

311. The predecessor site, Flamborough Head and Bempton Cliffs SPA was designated in 1993 and holds what was at the time the only mainland breeding colony of gannets in the UK as well as supporting large numbers of other breeding seabirds, including kittiwake, common guillemot and razorbill. The seabirds feed and raft in the waters around the cliffs, and outside the SPA more distantly in the North Sea. The intertidal chalk platforms are also used as roosting sites, particularly at low water and notably by juvenile kittiwakes. The majority of the SPA comprises shingle and sea cliff habitat, with dry grassland and deciduous woodland (JNCC 2011b).
312. The Flamborough Head and Bempton Cliffs site qualified as a SPA under Article 4.2 of the Birds Directive (79/409/EEC) by supporting populations of European importance of breeding kittiwakes, and a seabird assemblage of international importance (at least 20,000 seabirds) including breeding gannet, kittiwake, herring gull, common guillemot and razorbill. At the time of citation, the site was thought to support 83,370 breeding pairs of kittiwakes (2.6% of the breeding Eastern Atlantic population) (count as of 1987) and 305,784 individual seabirds. However, there were 37,617 pairs or 75,234 breeding adults recorded in 2008 (JNCC Seabird Colony Register). The citation (JNCC 2011b) notes that the SPA designations were reviewed in 2000, at which point kittiwakes were the only notified feature of the site. The seabird assemblage of international importance was added in 2001 as part of the UK SPA Review (Stroud et al. 2001). There is some uncertainty as to whether there were ever as many as 83,370 pairs of kittiwakes at this site; this number has been challenged repeatedly by the world's leading expert on kittiwake biology (Coulson, 2011), most recently by noting that this colony should have been increasing in numbers based on monitoring data on its productivity. The apparent decline from 83,370 pairs in 1987 to 37,617 pairs in 2008 is out of line with population trajectories elsewhere based on the influence of productivity on population change (Coulson 2017). Recent counts by RSPB indeed show increases in kittiwake breeding numbers in the years since 2008 (RSPB data), as predicted by Coulson (2017), with an estimate of 45,329 pairs in 2017 (within the former Flamborough Head and Bempton Cliffs SPA). The Filey Cliffs had an additional 6,043 apparently occupied nests, giving a total for the Flamborough and Filey Coast SPA of 51,372 pairs.
313. The conservation objectives of the site include:
 - Avoid the deterioration of the habitats of the qualifying features,

- Avoid significant disturbance of the qualifying features,
- Ensuring the integrity of the site is maintained and the site makes a full contribution to achieving the aims of the Birds Directive.
- Subject to natural change, to maintain or restore [for each qualifying feature]:
 - o The extent and distribution of the habitats of the qualifying features;
 - o The structure and function of the habitats of the qualifying features;
 - o The supporting processes on which the habitats of the qualifying features rely;
 - o The populations of the qualifying features; and
 - o The distribution of the qualifying features within the site.

4.6.1 Gannet

4.6.1.1 Status and ecology

314. Gannets are the largest breeding seabird in the British Isles and are able to swallow fish up to at least the size of adult herring and mackerel (Nelson 1978). As a result, they can feed on a wide range of fish, from sandeels to mackerel, and also scavenge discards from behind fishing vessels (Nelson 1978, Garthe et al. 1996). They are also aggressive at sea, displacing smaller seabirds from food and so can access discards from fishing vessels more efficiently than other scavenging seabirds (Garthe et al. 1996). Gannets dive for fish, often from considerable height, and so can be at risk of collision with wind turbine blades, especially while foraging. Foraging activity is by sight and hence birds do not forage during the dark, but spend the night either in the colony or sitting on the sea surface (Nelson 1978, Hamer et al. 2000, Hamer et al. 2007, Garthe et al. 2012).
315. Gannets breed in a relatively small number of colonies, many of which are very large, and all of which are in locations relatively remote from human disturbance and from predatory mammals. Breeding gannets are easy to count, and counts have been undertaken at almost all colonies every ten years (and at many colonies more frequently). This means that the population size of this species is extremely well documented. About 60% of the entire population of the species breeds in Great Britain, and all of the larger colonies are designated as SPAs for breeding gannets; over 90% of gannets in Great Britain therefore breed in SPAs (Furness 2015).
316. Breeding adults have efficient commuting flight and can travel long distances while searching for food. Numerous tracking studies show foraging ranges of breeding adults and overwinter migrations from many different colonies. Breeding adults tend to remain within a foraging area that is discrete to the individual colony (i.e. birds rarely overlap in foraging distribution with birds from neighbouring

colonies; Wakefield et al. 2013). Gannet numbers have increased continuously from 1900 to the present, although the rate of population increase has been slowing in the last few years (Murray et al. 2015). Gannets migrate, with birds from Britain mainly wintering off west Africa and southern Europe, and many of the birds wintering in UK waters are adults from colonies in Norway or Iceland (Fort et al. 2012, Garthe et al. 2016b).

4.6.1.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

317. There is mounting evidence that gannets show strong macro-avoidance of offshore windfarms (Leopold et al. 2013, Vanermen et al. 2013, APEM, 2014, Dierschke et al. 2016, Vanermen et al. 2016, Garthe et al. 2017a,b, Skov et al. 2018) and therefore that the avoidance rate used in collision risk assessment is likely to be highly precautionary, overestimating numbers of gannets that might be killed by collision (Garthe et al. 2017b). Higher levels of avoidance could increase effects from displacement and barrier effects (Garthe et al. 2017b), however displacement and barrier effects are relatively unlikely for this species. Gannets travel very large distances when foraging meaning small additions to flight distance are trivial in the ecology of this species unless offshore windfarms are located close to breeding colonies and so require repeated avoidance by breeding birds (Masden et al. 2009, 2010). Modelling of barrier effects and displacement of breeding gannets commuting past offshore windfarms off east Scotland indicated that these effects would be negligible at the population level even in a situation where the windfarms are relatively close to the colony (Searle et al. 2014).
318. Gannets fly at a range of heights that includes the rotor swept area of wind turbines, and so there is concern over collision risk (Cook et al. 2012). Collisions appear to be much more likely when gannets are foraging rather than when they are commuting or migrating, as foraging gannets fly higher over the sea (Cleasby et al. 2015). There are suggestions that flight height also varies depending on the fish species gannets are hunting; for example, dives tend to be from a greater height when attacking mackerel, and from a low height when diving on sandeels (Nelson 1978). The collision risk is therefore likely to differ depending on whether gannets are foraging or commuting/migrating, and (if birds are engaged in foraging behaviour) which species are being targeted.
319. The East Anglia TWO windfarm site is located within the maximum foraging range of breeding gannets (590km, Thaxter et al. 2012a) from Forth Islands SPA (Bass Rock, 524km), Flamborough & Filey Coast SPA (Bempton, 247km), and colonies in Germany, France and the Channel Islands. However, tracking studies show that breeding birds from colonies in Germany, France and the Channel Islands do not visit the vicinity of the East Anglia TWO windfarm site while breeding (Stefan Garthe, pers. comm., Wakefield et al. 2013, Amelineau et al. 2014,

Garthe et al. 2017a, b). Breeding gannets from the Bass Rock, now the largest gannet colony in the world, show the longest breeding season foraging range, but do not normally visit the vicinity of the East Anglia TWO windfarm site, their long trips mostly tending to head into Norwegian waters rather than the southern North Sea (Wakefield et al. 2013). Therefore, it is likely that breeding gannets visiting the East Anglia TWO windfarm site, originate from the Bempton colony within Flamborough & Filey Coast SPA (see also RSPB 2012, Langston et al. 2013). It would, therefore, be appropriate to consider that some proportion of breeding season mortality will be of breeding adults from the Flamborough & Filey Coast SPA gannet population. However, it is likely that nonbreeding adult gannets and immature gannets forage during summer in areas distant from breeding colonies (such as the former East Anglia zone) in order to avoid competition for food with breeding adults (Wakefield et al. 2017) which are likely to be more experienced and possibly in better body condition so more competitive (Votier et al. 2017). Therefore, some proportion of gannets occurring in the East Anglia TWO windfarm site will most likely be nonbreeders or immatures from a variety of more distant colonies (Votier et al. 2017, Wakefield et al. 2017).

4.6.1.2.1 Assessment of displacement risk to gannet

320. The total predicted displacement mortality of gannet during the breeding season was estimated as between one and two individuals (calculated as the peak mean breeding season abundance of 192 multiplied by 60-80% displacement and 1% mortality) and with the highly precautionary assumption that all birds present on the windfarm site have originated from the SPA (note that the East Anglia TWO windfarm site is beyond the mean maximum foraging range of 229km from the SPA).
321. In the spring and autumn, using Natural England's preferred Flamborough and Filey Coast SPA apportioning rates of 6.2% and 4.8% respectively and the same range of displacement and mortality rates (60-80% and 1%) the total seasonal displacement mortalities were calculated as 1.1-1.5 and 5.3-7.1 respectively (peak mean seasonal abundance was 192 in spring and 891 in autumn). Of these, the SPA proportions in spring and autumn were 0.09 and 0.3, giving a maximum summed nonbreeding season SPA estimate was 0.4.
322. The worst case annual displacement mortality prediction was therefore 2.4 individuals (of all ages).
323. The SPA population at designation was 11,061 pairs (22,122 individuals, although this had increased to 13,391 pairs by 2017). These equate to total population sizes of approximately 40,222 and 48,700 (designated and 2017 count respectively; calculated as individuals divided by the adult proportion of 0.55 from Furness 2015). At an average natural mortality rate of 0.191 (see ES **Chapter 12 Offshore Ornithology, Table 12.22** for details), the natural annual

mortality of the population is between 7,682 (designated) and 9,300 (2017 count). The addition of up to 2.4 individuals would therefore increase the mortality rate by a maximum of 0.03% (designated population). Increases in mortality of less than 1% are considered to be undetectable against natural variation and therefore there is no risk of an Adverse Effect on the Integrity of the SPA population due to displacement from the proposed East Anglia TWO project alone.

4.6.1.2.2 In-combination displacement risk to gannet

324. Gannet has not been consistently included in displacement assessments for previous windfarm applications therefore it is difficult to collate comparative estimated for in-combination assessment. A review of windfarm assessments was conducted which yielded the following abundance estimates, which have been apportioned to the Flamborough and Filey Coast SPA using 6.2% in spring, 4.8% in autumn and either 100% or 0% in the breeding season using the mean maximum foraging range.

Table 4.9 Gannet in-combination abundance using the full breeding season and with apportioned values for Flamborough and Filey Coast SPA. (see ES Appendix 12.3 for data sources).

Wind farm	Buffer width (km)	Total abundance			Flamborough and Filey Coast SPA		
		Spring	Breeding	Autumn	Spring	Breeding	Autumn
Greater Gabbard	0	105	252	69	7	0	3
Gunfleet Sands	No data	9	0	12	1	0	1
Kentish Flats	No data available						
Kentish Flats Extension	2	0	0	13	0	0	1
Lincs	No data available						
London Array	No data available						
Lynn and Inner Dowsing	No data available						
Scroby Sands	No data available						
Sheringham Shoal	No data	2	47	31	0	47	1
Teesside	No data	0	1	0	0	1	0
Thanet	No data available						
Humber Gateway	No data available						
Westermest Rough	No data available						
Hywind	1	4	10	0	0	0	0

Wind farm	Buffer width (km)	Total abundance			Flamborough and Filey Coast SPA		
		Spring	Breeding	Autumn	Spring	Breeding	Autumn
Kincardine	1	0	120	0	0	0	0
Beatrice	0.5	0	151	0	0	0	0
Dudgeon	1	11	53	25	1	53	1
Galloper	4	276	360	907	17	0	44
Race Bank	1	29	92	32	2	92	2
Rampion	No data	0	0	590	0	0	28
Hornsea Project One	4	250	671	694	15	671	33
Blyth Demonstration Project	No data	0	0	0	0	0	0
Dogger Bank Creyke Beck A	2	176	518	916	11	518	44
Dogger Bank Creyke Beck B	2	218	637	1132	14	637	54
East Anglia ONE	4	76	161	3638	5	161	175
European Offshore Wind Deployment Centre	2	0	35	5	0	0	0
Seagreen Alpha	0	138	1716	296	9	0	14
Seagreen Bravo	0	194	1240	368	12	0	18
Inch Cape	4	212	2398	703	13	0	34
Moray Firth (EDA)	4	27	564	292	2	0	14
Neart na Gaoithe	2	281	1987	552	17	0	26
Dogger Bank Teesside A	2	226	968	379	14	968	18
Dogger Bank Teesside B	2	238	1282	508	15	1282	24
Triton Knoll	1	24	211	15	1	211	1
Hornsea Project Two	4	124	457	1140	8	457	55
East Anglia THREE	4	524	412	1269	32	0	61
Hornsea Project Three	4	1099	1203	1494	68	1203	72
Thanet Extension	4	384	27	324	24	0	16
Moray West	4	144	2827	439	9	0	21
Norfolk Vanguard East	2	419	176	1630	26	0	78

Wind farm	Buffer width (km)	Total abundance			Flamborough and Filey Coast SPA		
		Spring	Breeding	Autumn	Spring	Breeding	Autumn
Norfolk Vanguard West	2	18	95	823	1	95	40
Norfolk Boreas	2	526	1229	1723	32	1229	83
East Anglia ONE North	2	18	113	467	1	0	22
East Anglia TWO	2	192	192	891	13	0	43
Seasonal total		5944	20205	21377	370	7625	1027
Total		47526			9022		

325. Natural England advises presentation of a range of displacement rates of between 60% and 80% displacement and 1% mortality. Predictions using these rates are presented in **Table 4.10**.

Table 4.10 Gannet seasonal and annual displacement at North Sea wind farms and apportioned to Flamborough and Filey coast SPA (HRA) using the full breeding season.

Season	Total population at risk of displacement	Total impact, displacement and mortality rates:		Population apportioned to FFC SPA	FFC SPA impact, displacement and mortality rates:	
		60%-1%	80%-1%		60%-1%	80%-1%
Spring	5944	35.7	47.6	370	2.2	3.0
Breeding	20205	121.2	161.6	7625	45.8	61.0
Autumn	21377	128.3	171.0	1027	6.2	8.2
Annual	47526	285.2	380.2	9022	54.1	72.2

326. Of the total annual displacement mortality (285-380), the number apportioned to the Flamborough and Filey Coast SPA was between 54 and 72 (**Table 4.10**). The percentage increase in background mortality of the Flamborough and Filey Coast SPA all age class population (40,222 for the designated population and 48,700 for the 2017 population) is between 0.94% (designated) and 0.77% (2017 population). These increases are below the 1% threshold of detectability and therefore no Adverse Effect on Integrity is predicted for the Flamborough and Filey Coast SPA gannet population due to in-combination displacement mortality.

4.6.1.2.3 Assessment of collision risk to gannet

327. Collision mortality of gannets at the East Anglia TWO windfarm site based on Band Option 2 and an avoidance rate of 98.9% (as recommended by Natural England and other SNCBs) was estimated at 47 birds per year, with approximately 50% occurring in November (**ES Chapter 12 Offshore**

Ornithology). It is worth noting that recent analysis of gannet behaviour at an operational windfarm has indicated that a more realistic (and still precautionary) avoidance rate is 99.5% (Bowgen and Cook 2018), which would more than halve the estimated collisions (although noting that most of the data collected was outside the breeding season so this conclusion may not apply all year round).

328. Estimates of the proportion of birds present in the East Anglia TWO windfarm site which originate from Flamborough and Filey Coast SPA during the breeding season and on migration in autumn and spring have been calculated (MacArthur Green 2015a), making use of Furness (2015) and updated colony estimates in Murray et al. (2015). For the breeding season, a precautionary approach has been adopted with the assumption that all birds present on the East Anglia TWO windfarm site originate from Flamborough and Filey Coast SPA. During migration in autumn and spring, 4.8% and 6.2% (respectively) of the birds observed are predicted to originate from Flamborough and Filey Coast SPA (Natural England's recommended rates).
329. Applying these percentages to the collision estimates generates the following mortality estimates for the Flamborough and Filey Coast SPA population (Table 4.11).

Table 4.11 Gannet seasonal and annual total collisions at East Anglia TWO and apportioned to Flamborough and Filey coast SPA (HRA) using 100% in the breeding season, 6.2% in spring and 4.8% in autumn.

Month	Total collisions (mean and 95% c.i. using density)	FFC SPA using migration free breeding season (95% c.i.)	FFC SPA using full breeding season (95% c.i.)
January	0.36 (0-0.89)	0.02 (0-0.06)	0.02 (0-0.06)
February	0.62 (0-1.56)	0.04 (0-0.1)	0.04 (0-0.1)
March	0.8 (0-2)	0.05 (0-0.12)	0.8 (0-2)
April	0.85 (0-2.12)	0.85 (0-2.12)	0.85 (0-2.12)
May	0.46 (0-1.39)	0.46 (0-1.39)	0.46 (0-1.39)
June	0.51 (0-1.54)	0.51 (0-1.54)	0.51 (0-1.54)
July	1.01 (0-3.04)	1.01 (0-3.04)	1.01 (0-3.04)
August	9.83 (5.01-16.08)	9.83 (5.01-16.08)	9.83 (5.01-16.08)
September	1.3 (0.33-2.61)	0.06 (0.02-0.13)	1.3 (0.33-2.61)
October	4.24 (1.42-8.12)	0.2 (0.07-0.39)	0.2 (0.07-0.39)
November	23.2 (17.71-29.27)	1.11 (0.85-1.4)	1.11 (0.85-1.4)
December	3.82 (1.6-6.68)	0.24 (0.1-0.41)	0.24 (0.1-0.41)

Month	Total collisions (mean and 95% c.i. using density)	FFC SPA using migration free breeding season (95% c.i.)	FFC SPA using full breeding season (95% c.i.)
Total	47.02 (26.06-75.3)	14.38 (6.05-26.78)	16.37 (6.36-31.14)

330. The SPA population at designation was 11,061 pairs (22,122 individuals, although this had increased to 13,391 pairs by 2017, RSPB 2017). At an average natural adult mortality rate of 0.081, the natural annual mortality of the population is 1,792 (designated) to 2,169 (2017 count). The addition of between 14.4 and 16.4 individuals would therefore increase the mortality rate by 0.8% to 0.91% (designated) and 6.6% to 7.6% (2017 count). If the estimate for the upper 95% confidence estimate and the full breeding season (31.1) is used, the maximum increase would be between 1.7% and 1.4% (designated and recent counts, respectively). While if the lower 95% confidence estimate is used (6.4) these rates are 0.36% and 0.29%.
331. While the upper 95% confidence estimates are slightly above the 1% threshold for detection the mean and lower 95% estimates are all below the 1% threshold of detectability.
332. Furthermore, the collision predictions combine several sources of precaution. These include:
- The use of a nocturnal activity rate of 25% (Furness et al. 2018 recommended this should be 8% in the breeding season and 4% in the nonbreeding season). Using the evidence based nocturnal activity rates reduces the East Anglia TWO collision by 20%, and similar reductions would be obtained for all windfarms assessed using the previous standard of 25% (note that the actual difference is site specific due to latitudinal and seasonal variations in day/night length);
 - Application of the full breeding season, which makes no allowance for the presence of immature birds from a wide range of other colonies which are likely to be present at this time, or for the presence of late and early migrants; and,
 - The recent evidence in support of a higher avoidance rate of 99.5% (Bowgen and Cook 2018), which would reduce the number of predicted collisions by over 50%.
333. Taking all these aspects into consideration it is therefore reasonable to conclude that there will be no adverse effect on the integrity of the Flamborough and Filey Coast SPA as a result of gannet collisions at the East Anglia TWO windfarm site alone.

4.6.1.2.4 In-combination collision risk to gannet

334. The cumulative total collision mortality estimates for gannet during the breeding season, autumn migration and spring migration and the numbers assigned to Flamborough and Filey Coast SPA are presented in **Table 4.12**.

Table 4.12 Gannet collision mortality for all windfarms with potential connectivity to the Flamborough and Filey Coast SPA. (see ES Appendix 12.3 for data sources).

Tier	Windfarm	Predicted collisions (@ 98.9% avoidance rate, Band Model option 1 or 2)					
		Breeding season		Autumn migration		Spring migration	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
1	Beatrice	37.4	0	48.8	2.3	9.5	0.6
1	Beatrice Demonstrator	0.6	0	0.9	0.0	0.7	0.0
1	Blyth (NaREC Demonstration)	3.5	3.5	2.1	0.1	2.8	0.2
1	Dudgeon	22.3	22.3	38.9	1.9	19.1	1.2
1	EOWDC (Aberdeen OWF)	4.2	0	5.1	0.2	0.1	0.0
1	Galloper	18.1	0	30.9	1.5	12.6	0.8
1	Greater Gabbard	14	0	8.8	0.4	4.8	0.3
1	Gunfleet Sands	0	0	0	0.0	0	0.0
1	Humber Gateway	1.9	1.9	1.1	0.1	1.5	0.1
1	Hywind	5.6	0	0.8	0.0	0.8	0.0
1	Kentish Flats	1.4	0	0.8	0.0	1.1	0.1
1	Lincs	2.1	2.1	1.3	0.1	1.7	0.1
1	London Array (Phase 1)	2.3	0	1.4	0.1	1.8	0.1
1	Lynn and Inner Dowsing	0.2	0.2	0.1	0.0	0.2	0.0
1	Race Bank	33.7	33.7	11.7	0.6	4.1	0.3
1	Rampion	36.2	0	63.5	3.0	2.1	0.1
1	Scroby Sands	0	0	0	0.0	0	0.0
1	Sheringham Shoal	14.1	14.1	3.5	0.2	0	0.0
1	Teesside	4.9	4.9	1.7	0.1	0	0.0
1	Thanet	1.1	0	0	0.0	0	0.0
1	Westermest Rough	0.2	0.2	0.1	0.0	0.2	0.0
2	East Anglia ONE	3.4	0	131	6.3	6.3	0.4
2	Hornsea Project 1	5.0	5.0	14.1	0.7	9.9	0.6
2	Kincardine	3.0	0	0	0.0	0	0.0
2	Moray Firth (EDA)	80.6	0	35.4	1.7	8.9	0.6
3	Dogger Bank Creyke Beck A & B	66.7	66.7	68.7	3.3	44.7	2.8
3	Dogger Bank Teesside A & B	14.8	14.8	8.8	0.4	9.4	0.6
3	East Anglia THREE	5.7	5.7	31.1	1.5	9.0	0.6

Tier	Windfarm	Predicted collisions (@ 98.9% avoidance rate, Band Model option 1 or 2)					
		Breeding season		Autumn migration		Spring migration	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
3	Firth of Forth Alpha and Bravo	800.8	0	49.3	2.4	65.8	4.1
3	Hornsea Project 2	7	7	14	0.7	6	0.4
3	Inch Cape	46	0	1	0.0	1	0.1
3	Near na Goithe	93	0	7	0.3	7	0.4
3	Triton Knoll	26.8	26.8	64.1	3.1	30.1	1.9
4	Hornsea Project 3	18	18	12	0.6	8	0.5
4	Moray Firth West	10	0	2	0.1	1	0.1
4	Norfolk Boreas	54.1	54.1	48.5	2.3	15	0.9
4	Norfolk Vanguard	16.9	16.9	38.4	1.8	10.9	0.7
4	Thanet Extension	0	0	11.1	0.5	22.9	1.4
4	East Anglia TWO	12.7	0	28.7	0.6	5.6	0.2
4	East Anglia ONE North	11.0	0	12.8	1.4	3.4	0.3
	Total	1479.4	297.9	799.6	38.4	328	20.3

335. In autumn, the cumulative gannet collisions were estimated to be 800, in spring 328 and in the breeding season 1,479. Using the Flamborough and Filey Coast SPA proportions (as advised by Natural England) for all the windfarms with potential connectivity to the SPA, the proportions of the mortality attributed to the Flamborough and Filey Coast SPA population were 20 (spring), 298 (breeding) and 38 (autumn), an annual total of 357.
336. The increase in the background mortality for the estimated in combination collision mortality exceeded 1% therefore further assessment is provided below.
337. Outputs from the gannet PVA model for this population, presented for the Hornsea Project Three windfarm following current Natural England guidance (MacArthur Green 2018) for adult mortality levels of 350 and 375 (the nearest values to this impact prediction) are provided in **Table 4.13**.

Table 4.13 Gannet Flamborough and Filey Coast SPA population modelling results (see MacArthur Green 2018 for details).

Model	Adult mortality	Counterfactual metric (after 25 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	350	0.984	0.681	Table A2 1.1 & 1.3
	375	0.983	0.663	
Rate set 1, density dependent	350	0.990	0.752	Table A2 2.1 & 2.3
	375	0.989	0.736	
Rate set 2, density independent	350	0.984	0.682	Table A2 3.1 & 3.3
	375	0.983	0.663	
Rate set 2, density dependent	350	0.990	0.753	Table A2 4.1 & 4.3
	375	0.989	0.736	

338. The maximum reduction in the population growth rate, at a mortality of 375, using the more precautionary density independent model was 1.7% (0.983). Using the more realistic density dependent model the maximum reduction in growth rate was 1.1% (0.989).
339. On the basis of the observed rate at which this population has grown over the last 25 years, which has been at least 10% per year, a maximum reduction of 1.7% to this rate represents a negligible risk for the population.
340. The in-combination mortality of up to 357 individuals predicted for the Flamborough and Filey Coast SPA is less than the previously accepted threshold for collisions (for East Anglia ONE this was defined as 286-361; Natural England, 2013) and in the interim the population has almost doubled in size.
341. This conclusion is consistent with evidence from other gannet populations. Numbers are increasing at all gannet colonies in the North Atlantic, and new colonies are being founded every few years, including in areas not previously colonised by the species, such as Bear Island in the Norwegian Arctic. Furthermore, evidence clearly indicates that gannet colonies are relatively robust to human impacts compared to other UK seabirds. For example, at Sula Sgeir SPA, where breeding gannet is an SPA feature with a population size in 2013 estimated at 11,230 (note this is similar in size to the Flamborough and Filey Coast SPA population), numbers have continued to increase at a rate of 2.2% per annum from 2004 to 2014 (Murray et al. 2015) despite a licenced harvest from that colony of up to 2,000 fully grown chicks per year from that SPA (Trinder 2016). Population modelling (Trinder 2016) indicates that the breeding numbers there would continue to increase if the harvest there was increased to as many as 3,500 fledglings per year. While the impact of harvesting fledglings is less than

the impact of harvesting adults because survival rates of adults are higher, this example clearly shows how robust populations of gannets are to human impacts.

342. Recent work has highlighted the reduction in collisions which results from updating consented assessments to reflect as-built windfarm designs in comparison to the original full consent envelopes (MacArthur Green 2017; see also **ES Appendix 12.3**). Updating from the consented design to the as-built design typically reduces predicted mortality by at least 40%, which would reduce the in-combination mortality prediction to around 214, further reducing concerns for the potential impact on this population.
343. It is, therefore, reasonable to assess that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA as a result of gannet collisions at the proposed East Anglia TWO project in-combination with other projects.

4.6.1.2.5 Combined displacement and collision risk: in-combination assessment

344. Adding the in-combination annual gannet collision estimate of 357 (adults; estimated using Natural England's preferred methods) to the in-combination annual displacement prediction of 54 to 72 (using Natural England's preferred rates, but converted to adults), gives a combined SPA mortality estimate of 409 to 429. It is important to note that, on top of the precaution in the individual collision and displacement assessments, summing these two impacts adds another layer of precaution, since it implies that individuals can both be displaced (and suffer increased mortality as a consequence) and also be at risk of collision mortality.
345. However, the above over-precaution notwithstanding, the increase in the background mortality of the SPA population due to this combined in-combination collision and displacement risk exceeded 1%.
346. Outputs from a PVA model for this population were presented for the Hornsea Project Three wind farm (MacArthur Green 2018). This model was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from these models for mortality levels of 400 and 425 (the nearest values to this impact prediction) are provided in **Table 4.14**.

Table 4.14 Gannet Flamborough and Filey Coast SPA population modelling results (see MacArthur Green 2018 for details).

Model	Adult mortality	Counterfactual metric (after 25 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	400	0.982	0.646	Table A2 1.1 & 1.3
	425	0.981	0.628	
Rate set 1, density dependent	400	0.988	0.720	Table A2 2.1 & 2.3
	425	0.987	0.704	
Rate set 2, density independent	400	0.982	0.645	Table A2 3.1 & 3.3
	425	0.981	0.628	
Rate set 2, density dependent	400	0.988	0.720	Table A2 4.1 & 4.3
	425	0.987	0.704	

347. The maximum reduction in the population growth rate, at a mortality of 425, using the more precautionary density independent model was 1.9% (0.981). Using the more realistic density dependent model the maximum reduction in growth rate was 1.3% (0.987).
348. On the basis of the observed rate at which this population has grown over the last 25 years, which has been at least 10% per year, a maximum reduction of 1.9% to this rate represents a negligible risk for the population.
349. The gannet breeding numbers at the Flamborough and Filey Coast SPA have continued to increase in all counts conducted to date (most recent 2017) and the gannet population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the gannet population, subject to natural change.
350. On the basis of the population model predictions the number of predicted in-combination gannet collisions and mortality due to displacement attributed to the Flamborough and Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a slight reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.
351. These totals also include several sources of precaution, including over-estimated nocturnal activity for existing projects and the use of consented collision estimates for projects which have since been constructed to designs with much lower collision risks.

352. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA from impacts on gannet due to the proposed East Anglia TWO project in-combination with other plans and projects.

4.6.1.3 Conclusion

353. The gannet breeding numbers in the Flamborough and Filey Coast SPA are continuing to increase and the gannet population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the gannet population, subject to natural change.
354. In view of the small effect of predicted collision mortality of gannets at the East Anglia TWO windfarm site and the small proportion of individuals seen on the East Anglia TWO windfarm site during migration seasons which are estimated to originate from the Flamborough and Filey Coast SPA population it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from effects on gannets due to the proposed East Anglia TWO project alone.
355. The number of predicted in-combination gannet collisions attributed to the Flamborough and Filey Coast SPA remains below the sustainable levels estimated by Natural England and is not at a level which would trigger a risk of population decline. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA from effects on gannet due to the proposed East Anglia TWO project in-combination with other projects. Furthermore, population modelling indicates that the cumulative mortality predicted would only slow (by a small amount), rather than halt, the population increase currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.

4.6.2 Kittiwake

4.6.2.1 Status and ecology

356. The kittiwake is a small cliff-nesting gull. It breeds in a large number of colonies around the coast of the British Isles, though there are very few colonies along the coast of south east England owing to the lack of suitable nesting habitat (Coulson 2011). Kittiwake numbers increased dramatically between 1900 and 1985, however started to decline during the 1980s in Shetland when the local sandeel stock suffered recruitment failure (Mitchell et al. 2004). Numbers have declined considerably since the 1980s, although this decline has been less severe in England than in Scotland, and also less in the west of Great Britain than in North Sea colonies (Mitchell et al. 2004). A more recent assessment (Mitchell et al. 2018) has reported that between 2010 and 2015, nine out of ten sampled mainland colonies met the UK target for kittiwake breeding success, thus these regional patterns appear to have been maintained. Within regions, declines have been greatest in SPA populations (of which there are many) (Furness 2015)

because they are the largest colonies and furthermore, food shortage affects breeding success and recruitment at large colonies more than at small ones (Coulson 2011). In contrast to the declining trend in much of the UK, breeding numbers of kittiwakes have increased slightly at Flamborough and Filey Coast SPA between 2008 and 2017 (RSPB data).

357. Kittiwakes feed on marine invertebrates, small fish (especially sandeels), and fishing vessel waste (mostly fragments of offal and fish as they are unable to swallow large fish). Sandeels are a key prey during the breeding season (Furness and Tasker 2000, Coulson 2011) whereas fishery waste is taken mostly during winter (Garthe et al. 1996).
358. Breeding success of kittiwakes at North Sea colonies is closely linked with sandeel stock abundance in the area near the colony (Frederiksen et al. 2004, 2005, Cook et al. 2014). There is evidence that breeding success of kittiwakes at Flamborough and Filey Coast SPA has been reduced considerably in recent years as a consequence of unsustainably high fishing effort for sandeels on Dogger Bank which has depleted the stock size of sandeels (BirdLife International 2015, Carroll et al. 2017). Breeding kittiwakes mostly feed close to their colony; the mean foraging range is 25km, the mean maximum foraging range is 60km, and the longest published foraging range recorded up to 2011 was 120km (Thaxter et al. 2012a). Several tracking studies provide evidence on foraging ranges of breeding kittiwakes and winter movements from different populations. Tracking studies by RSPB show that chick-rearing kittiwakes from Flamborough and Filey Coast SPA mainly feed within 50km of that colony, but sometimes may travel as far as the Dogger Bank to forage (Carroll et al. 2017).
359. Kittiwakes disperse from colonies in late summer and may migrate from British colonies as far as Canada, the central North Atlantic the Bay of Biscay and the Barents Sea. In the nonbreeding season UK waters hold a mixture of birds from many breeding areas (Frederiksen et al. 2012).

4.6.2.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

360. The main concern regarding kittiwakes is risk of collision mortality, especially the in-combination mortality at offshore windfarms throughout the region. Displacement and barrier effects on kittiwakes are unlikely, as the East Anglia TWO site is far from breeding colonies and so will not regularly affect commuting foraging birds, and represents a relatively small barrier for birds that may migrate from UK colonies as far as Canada (Bogdanova et al. 2017).
361. During the breeding season, adult kittiwakes forage a mean of 25km from their colony, with a mean maximum foraging range of 60km and a maximum recorded foraging range of 120km (Thaxter et al. 2012a). Some more recent tracking studies of kittiwakes by RSPB (Future of the Atlantic Marine Environment (FAME)

and Seabird Tracking and Research (STAR) projects) have recorded longer foraging distances for kittiwakes of up to 231km, although the longer distances tended to be from colonies where breeding success was zero or close to zero due to food shortage; long trips therefore tend to represent abnormal conditions of severe food shortage.

362. More recently, preliminary analysis of data for kittiwakes tracked from Flamborough and Filey Coast SPA by the RSPB reported a mean foraging distance of 89km with a range of 3km to 323km (Wischnewski et al. 2018). Birds in this study were caught from the base of the cliffs using a 12m pole, therefore of necessity the tagged birds were ones nesting at the lower edge of the colony (although the total height of the cliffs at the specific study sites was not reported the cliffs at Flamborough and Filey Coast SPA are among the highest in England at up to 130m). This study reported that tagging itself did not appear to influence breeding success, however there was evidence that nest location (height within the colony) was closely related to the probability of failure (i.e. nests on the lower edge of the colony have lower success rates). Thus, it seems probable that tagged individuals were lower quality individuals which, on average, are more likely to suffer breeding failure. Failed breeders will be expected to undertake longer duration trips due to the absence of a need to return to the colony to feed chicks. Ponchon et al. (2015) showed that kittiwakes that lose their eggs or chicks tend to make large scale prospecting movements far from their breeding site, which are qualitatively different from the foraging trips of birds that are breeding successfully.
363. Many tracking studies have deployed loggers on kittiwakes that weigh about 4 to 5% of body weight. Phillips et al. (2003) reported on studies deploying loggers on seabirds and concluded that adverse effects were especially likely to be evident where devices weighed more than 3% of the body weight of the bird. Chivers et al. (2016) found that loggers deployed for three days on breeding adult kittiwakes resulted in a 30% reduction in flight activity compared to controls equipped with much smaller devices. Heggøy et al. (2015) found that kittiwakes equipped with loggers had higher levels of corticosterone (stress hormone) at recapture and made longer foraging trips compared to controls. Kittiwakes with low body condition index attended nests less than controls, and this pattern was most pronounced among birds carrying loggers. They concluded that data obtained from kittiwakes carrying loggers were therefore not representative of the behaviour of unequipped birds and that the bias was especially strong among poor quality adults, such as those nesting at the edge of a colony (Coulson 2011).
364. There is evidence therefore, that the long trips recorded by these studies may be an artefact caused by the loggers themselves. Similarly, Kidawa et al. (2012) found that seabirds equipped with loggers weighing 0.9 to 3.4% of body mass

showed longer and more distant foraging trips than controls, and lower chick growth rates, although breeding success was similar (and high) in both tagged and control individuals. Passos et al. (2010) found that attaching loggers to the back of seabirds increased duration of foraging trips and reduced mass gain while on foraging trips. Birds with loads travelled greater distances while foraging, increased maximum foraging range, and spent longer resting on the sea surface than did controls.

365. It is therefore not possible to assume that data obtained from tracking breeding kittiwakes is unbiased; the evidence is that kittiwakes carrying loggers are likely to undertake much longer trips than are normal for the species, and to travel to areas that are not normally visited by breeding adults (i.e. when not fitted with loggers). This is especially a problem where loggers are above the 3% of body weight indicated as a maximum by Phillips et al. (2003) and where birds caught to fit loggers are from the edges of colonies so are likely to be low quality birds. Vandenabeele et al. (2012) found that devices weighing 3% of bird body mass increase energy cost of flight by between 4.7% and 5.7% depending on the anatomy of the species. This increase in flight cost can be predicted to reduce the flight speed of birds equipped with loggers, and to alter their foraging flight behaviour, providing an energetics explanation for impacts on behaviour of equipped birds.
366. Thus, while tracking data are undoubtedly very useful in understanding foraging ranges and locations, it is important to note that the data may not be representative of natural behaviour.
367. Since Flamborough and Filey Coast SPA is over 250km from the East Anglia TWO windfarm site and there is no evidence from tracking studies of individuals foraging at this site it is reasonable to assume that there is virtually no risk that breeding adults from the SPA will be at risk of collision mortality during the breeding season.
368. Kittiwakes from the Flamborough and Filey Coast SPA colony may be at risk of collision when they migrate, or during winter. During the autumn migration, large numbers of kittiwakes move from the vicinity of breeding colonies in coastal areas to wintering areas offshore. Birds from the Flamborough and Filey Coast SPA colony represent a small fraction of this large-scale migratory movement. In winter, kittiwake distribution is pelagic, with many birds far offshore in the mid-Atlantic (Bogdanova et al. 2017), where they will be at no risk of collision at offshore windfarms. In spring, birds return from offshore waters to coastal areas, with breeders returning to colonies and immatures tending to move towards breeding areas but not necessarily to the colonies themselves.

369. Whereas the winter distribution of birds is more pelagic, Natural England (2015a) cite Coulson (1966) as stating that kittiwakes of all ages vacate the mid-Atlantic pelagic zone by mid-May and concentrate over shallow continental shelves around islands and coasts. This change to a coastal distribution is associated with changes in the diet of birds with an increase in the consumption of fish. Coulson's study based on ring recovery data from the 1930s to 1960s, is consistent with more recent work deploying loggers on adult kittiwakes (Frederiksen et al. 2012).
370. Natural England (2015a) cite Coulson (1966) as providing evidence that young birds are found closer to their natal colony in the summer months compared to winter and that the distribution of immature birds varies with age such that birds tend to occupy waters closer to their natal colony in summer as they get older. Therefore, Natural England (2015a) suggest that it seems likely that some of the immature birds present in offshore windfarms during the breeding season months will be birds deriving from colonies closest to the offshore windfarm. It is worth pointing out that the mean distance of 2nd year and 3rd year birds from their natal colony during summer was 600km, while 4th year birds were an average of 400km from their natal colony (Coulson 1966).
371. These distances suggest that immatures in summer at the East Anglia TWO windfarm site are as likely to originate from Scotland as from the Flamborough and Filey Coast SPA colony. For example, a 2nd year or 3rd year bird at the average distance of 600km north of Flamborough and Filey Coast SPA would be near Fair Isle, Shetland. Therefore, the average 2nd or 3rd year kittiwake from Orkney is likely to be near the East Anglia TWO windfarm site (or alternatively near north Norway or Iceland or the west coast of Ireland). Furthermore, in later work, Coulson (2011) points out:
- 'for many years, there has been an assumption that colonies of seabirds are virtually self-reproducing units or closed populations which produce their own young to replace the adult mortality. This requires that all of the young return to the colony of their birth, a behaviour that is called philopatry. However, this concept of a colony is clearly incorrect'.*
372. In fact, kittiwakes show a low philopatry and high degree of emigration. Young fledged from Coulson's study colony in North-east England were subsequently found breeding in northern France, Sweden, Germany and Scotland. Ringed birds immigrating into his colony included birds ringed as chicks in Norway and Scotland, and 91% of recruiting females were birds immigrating from elsewhere (Coulson 2011).
373. Analysis of ring recovery data shows that kittiwakes recruited to breed in colonies up to 1,000km from their birthplace, with 18% moving more than 300km from their

natal colony. It is therefore inappropriate to define young birds reared at Flamborough and Filey Coast SPA colony as 'belonging' to that population and to assume that these birds will be present within the vicinity of the breeding colony. Most birds reared at Flamborough and Filey Coast SPA will breed in a different 'population' and not at Flamborough and Filey Coast SPA colony. Apportioning immature birds at risk of collision mortality at the East Anglia TWO windfarm site to the Flamborough and Filey Coast SPA colony is therefore difficult and probably inappropriate, other than to suggest that most immature birds present at the East Anglia TWO windfarm site may be associated (loosely) with kittiwake populations from within about 500 to 1,000km of the East Anglia TWO windfarm site.

374. Collision mortality of kittiwakes at the East Anglia TWO windfarm site based on Band Option 2 and an avoidance rate of 98.9% (as recommended by Natural England and other SNCBs) was estimated to be 50 birds per year. It is worth noting that recent analysis of kittiwake behaviour at an operational wind farm has indicated that a more realistic (and still precautionary) avoidance rate is 99.0% (Bowgen and Cook 2018), which would reduce the estimated collisions by 10% (although noting that most of the data collected was outside the breeding season so this conclusion may not apply all year round).

4.6.2.2.1 Assessment of collision risk to kittiwake

375. Collision mortality of kittiwakes at the East Anglia TWO windfarm site was estimated as 21 in spring, 20 in summer and 9 in autumn, giving an annual total of 50 birds (**ES Chapter 12 Offshore Ornithology**; note that there is no mid-winter BDMPS defined for kittiwake, with the spring migration period following immediately after autumn migration).
376. Estimates of the proportion of birds present on windfarms in the North Sea which originate from Flamborough and Filey Coast SPA during the breeding season and on migration in autumn and spring have previously been calculated (MacArthur Green 2015b), making use of the population estimates and movement data summarised in Furness (2015). This work has reported that, for windfarms at the equivalent distance from the colony as the East Anglia TWO windfarm site, a precautionary estimate of the proportion of birds present during the breeding season expected to originate from Flamborough and Filey Coast SPA would be 16.8%. Similarly, during migration in autumn and spring, 5.4% and 7.2% (respectively) of the birds observed are predicted to originate from Flamborough and Filey Coast SPA.
377. Applying these percentages to the collision estimates generates the following mortality estimates for the Flamborough and Filey Coast SPA population (**Table 4.15**).

Table 4.15 Kittiwake seasonal and annual total collisions at East Anglia TWO and apportioned to Flamborough and Filey coast SPA (HRA) using 0% in the breeding season, 7.2% in spring and 5.4% in autumn.

Month	Total collisions (mean and 95% c.i. using density)	FFC SPA using migration free breeding season (95% c.i.)	FFC SPA using full breeding season (95% c.i.)
January	8.35 (4.6-12.93)	0.6 (0.33-0.93)	0.6 (0.33-0.93)
February	0.37 (0-1.11)	0.03 (0-0.08)	0.03 (0-0.08)
March	2.8 (0-6.05)	0.2 (0-0.44)	0 (0-0)
April	9.36 (4.83-14.41)	0.67 (0.35-1.04)	0 (0-0)
May	7.4 (3.48-12.28)	0 (0-0)	0 (0-0)
June	4.46 (1.37-8.41)	0 (0-0)	0 (0-0)
July	7.91 (2.95-13.39)	0 (0-0)	0 (0-0)
August	2.89 (0-6.18)	0.16 (0-0.33)	0 (0-0)
September	0 (0-0)	0 (0-0)	0 (0-0)
October	0.01 (0-0.03)	0 (0-0)	0 (0-0)
November	1.87 (0.6-3.58)	0.1 (0.03-0.19)	0.1 (0.03-0.19)
December	4.52 (1.5-8.29)	0.24 (0.08-0.45)	0.24 (0.08-0.45)
Total	49.93 (19.33-86.65)	2 (0.79-3.46)	0.97 (0.44-1.65)

378. These sum to annual total maximum adult collision mortality of 2 individuals using the migration-free breeding season and 1 using the extended breeding season, from a population of approximately 89,040 (44,520 pairs multiplied by 2). It should also be noted that the population of kittiwake has increased since this estimate was obtained and now stands at around 51,000 pairs (RSPB unpublished report of 2017 census), which increases the total adult population for assessment to approximately 102,000.
379. At an average natural adult mortality rate of 0.146 (Horswill and Robinson 2015), the natural mortality of the population is 13,000 (based on the designated population size). The addition of a maximum of 2 individuals to this would increase the mortality rate by 0.01%. Using the upper 95% confidence estimate (3.5) the increase in mortality rate would be 0.03% and using the lower 95% confidence interval (0.8) this would be <0.01%.
380. Following SNCB recommendations, an increase in mortality of less than 1% is considered undetectable against the range of background variation. Therefore, this increase, which is below the threshold at which increases in mortality are detectable even using the upper 95% confidence estimate, demonstrates that no significant impact can be attributed to this level of impact arising from the proposed East Anglia TWO project alone.

381. It is, therefore, reasonable to conclude that there will be no adverse effect on the integrity of the Flamborough and Filey Coast SPA as a result of kittiwake collisions at the proposed East Anglia TWO project alone.

4.6.2.2.2 In-combination assessment

382. The cumulative total collision mortality estimates for kittiwake during the breeding season, autumn migration and spring migration and the numbers assigned to Flamborough and Filey Coast SPA are presented in **Table 4.16**.

Table 4.16 Kittiwake collision mortality for all windfarms with potential connectivity to the Flamborough and Filey Coast SPA. (see ES Appendix 12.3 for data sources).

Tier	Windfarm	Predicted collisions (@ 98.9% avoidance rate, Band Model option 1 or 2)					
		Breeding season		Autumn migration		Spring migration	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
1	Beatrice	37.66	0	4.3	0.2	15.9	1.1
1	Beatrice Demonstrator	1.15	0	2.1	0.1	1.7	0.1
1	Blyth (NaREC Demonstration)	1.69	0	2.3	0.1	1.4	0.1
1	Dudgeon	0	0	0	0	0	0
1	EOWDC (Aberdeen OWF)	11.8	0	5.8	0.3	1.1	0.1
1	Galloper	6.29	0	27.8	1.5	31.8	2.3
1	Greater Gabbard	1.1	0	15	0.8	11.4	0.8
1	Gunfleet Sands	0	0	0	0	0	0
1	Humber Gateway	2.55	2.55	3.19	0.2	1.9	0.1
1	Hywind	16.6	0	0.85	0	0.85	0.1
1	Kentish Flats	0.6	0	0.9	0	0.7	0.1
1	Lincs	0.92	0.92	1.16	0.1	0.69	0
1	London Array (Phase 1)	1.4	0	2.3	0.1	1.8	0.1
1	Lynn and Inner Dowsing	0	0	0	0	0	0
1	Race Bank	1.86	1.86	23.9	1.3	5.59	0.4
1	Rampion	54.4	0	37.4	2	29.7	2.1
1	Scroby Sands	0	0	0	0	0	0
1	Sheringham Shoal	0	0	0	0	0	0
1	Teesside	50.58	0	24	1.3	2.5	0.2
1	Thanet	0.2	0	0.5	0	0.4	0
1	Westermest Rough	0.18	0.18	0.22	0	0.13	0
2	East Anglia ONE	46.7	0	1.5	0.1	161	11.6
2	Hornsea Project 1	6.9	5.7	8.1	0.4	3	0.2
2	Kincardine	22	0	9	0.5	3	0.2
2	Moray Firth (EDA)	24.1	0	2	0.1	19.3	1.4

Tier	Windfarm	Predicted collisions (@ 98.9% avoidance rate, Band Model option 1 or 2)					
		Breeding season		Autumn migration		Spring migration	
		Total	FFC SPA	Total	FFC SPA	Total	FFC SPA
3	Dogger Bank Creyke Beck A & B	55.4	10.7	25.9	1.4	56.7	4.1
3	Dogger Bank Teesside A & B	88.7	17.1	67.1	3.6	202.2	14.6
3	East Anglia THREE	6.1	0	68.4	3.7	37.2	2.7
3	Firth of Forth Alpha and Bravo	153.2	0	313.5	16.9	247.8	17.8
3	Hornsea Project 2	16	13.3	9	0.5	3	0.2
3	Inch Cape	40	0	26	1.4	6	0.4
3	Moray Firth West	79	0	24	1.3	7	0.5
3	Neart na Goithe	9	0	17	0.9	2	0.1
3	Triton Knoll	24.6	24.6	139	7.5	45.4	3.3
4	Hornsea Project 3	165.3	153.7	61.3	3.3	11.4	0.8
4	Norfolk Boreas	29.9	12.2	116.6	6.3	56.3	4.1
4	Norfolk Vanguard	43.81	7.7	32.93	1.8	38.66	2.8
4	Thanet Extension	2.3	0	5.3	0.3	15.3	1.1
4	East Anglia TWO	19.8	0	9.3	0.5	20.9	1.5
4	East Anglia ONE North	18.6	0	12.1	0.7	27.3	2.0
	Total	1040.9	250.5	1099.7	58.8	1071.0	77.1

383. In autumn, the cumulative kittiwake collisions were estimated to be 1,100, in spring 1,071 and in the breeding season 1,041. Using the Flamborough and Filey Coast SPA proportions (as advised by Natural England) for all the windfarms with potential connectivity to the SPA, the proportions of the mortality attributed to the Flamborough and Filey Coast SPA population were 77 (spring), 251 (breeding) and 59 (autumn), an annual total of 387.
384. The increase in the background mortality for the estimated in combination collision mortality exceeded 1% therefore further assessment is provided below.
385. Outputs from a PVA model for this population were presented for the Hornsea Project Three windfarm (MacArthur Green 2018). This model was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Outputs for adult mortality levels of 350 and 400 (the nearest values to this impact prediction) are provided in **Table 4.17**.

Table 4.17 Kittiwake Flamborough and Filey Coast SPA population modelling results (see MacArthur Green 2018 for details).

Model	Adult mortality	Counterfactual metric (after 25 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	350	0.996	0.910	Table A2 5.1 & 5.3
	400	0.996	0.898	
Rate set 1, density dependent	350	0.999	0.968	Table A2 6.1 & 6.3
	400	0.999	0.964	
Rate set 2, density independent	350	0.996	0.910	Table A2 7.1 & 7.3
	400	0.995	0.898	
Rate set 2, density dependent	350	0.999	0.966	Table A2 8.1 & 8.3
	400	0.999	0.962	

386. The maximum reduction in the population growth rate, at a mortality of 400, using the more precautionary density independent model was 0.05% (0.995). Using the more realistic density dependent model the maximum reduction in growth rate was 0.01% (0.999). This growth rate reduction represents a very small risk to the population's conservation status.
387. The kittiwake breeding numbers at the Flamborough and Filey Coast SPA have remained relatively stable around an average of approximately 40,000 pairs over the last 20 years. The RSPB reported that since 2000 the population has grown by 7% which would equate to 0.4% annual growth rate (RSPB unpublished report). Therefore, the kittiwake population appears to be in favourable conservation status and the relevant conservation objective is to maintain this status, subject to natural change. On the basis of the precautionary in-combination collision estimate (including over-estimates for consented vs. built designs and over-estimated nocturnal activity) and the precautionary density independent model predictions for the total adult mortality of 387, there may be a small risk that further population growth will occur at a slower rate. However, the much more realistic density dependent model suggests that this level of mortality will have a much smaller effect on the population, with only a very slight reduction in the growth rate, and that the population's conservation status will not be affected.
388. Natural England contend that density dependence should only be included in population models when evidence for this is available for the population in question and that this is not the case for the Flamborough and Filey Coast SPA kittiwake population. However, as noted above, there is evidence for density dependence in the North Sea kittiwake population (EATL 2016) and exploratory analysis has been used to guide the most appropriate method for inclusion in

population models (MacArthur Green 2014). Therefore, while there may not be direct evidence for the SPA population, there is evidence of density dependence for the wider population of which it is an integral part and there is no reason that the SPA population would not be affected by the same regulatory drivers. Therefore, the arguments against the inclusion of density dependence are not considered to apply in this case.

389. It is, therefore, reasonable to assess that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA as a result of kittiwake collisions at the proposed East Anglia TWO project in-combination with other projects.

4.6.2.3 Conclusion

390. The decline in the kittiwake population observed since the population was designated for Flamborough Head and Bempton Cliffs SPA (assuming a decline has in fact occurred) is most likely due to a combination of climate change effects and effects of high fishing effort depleting sandeel stocks on Dogger Bank (Frederiksen et al. 2004, Cook et al. 2014, BirdLife International 2015, Carroll et al. 2017) and cannot be attributed to offshore windfarm development as the decline occurred before offshore windfarm construction. In the last few years, breeding numbers of kittiwakes at Flamborough and Filey Coast SPA have increased slightly (RSPB data), which is consistent with the relatively high breeding success of that colony (Coulson 2017). However, the large size of this colony, the increase in breeding numbers in recent years and the continued relatively high breeding success make this colony especially important for the conservation of kittiwakes throughout the UK, as most populations in the UK have shown large declines and poor productivity for the last few decades.
391. In view of the small effect of predicted collision mortality of kittiwakes at the East Anglia TWO windfarm site and the small proportion of individuals seen on the East Anglia TWO windfarm site which are estimated to originate from the Flamborough and Filey Coast SPA population it can be concluded that there will be no adverse effect on the integrity of Flamborough & Filey Coast SPA from effects on kittiwake due to the proposed East Anglia TWO project alone.
392. The number of predicted in-combination kittiwake collisions attributed to the Flamborough and Filey Coast SPA would not trigger a risk of population decline based on population viability analysis modelling and despite the precautionary nature of collision risk assessments. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA from impacts on kittiwake due to the proposed East Anglia TWO project in-combination with other projects.

4.6.3 Razorbill

4.6.3.1 Status and ecology

393. Breeding razorbill (10,570 pairs in 2008-2011) is a designated feature of the Flamborough and Filey Coast SPA. This is by far the largest colony of razorbills in the southern North Sea, holding over 95% of the breeding razorbills along that stretch of coastline (Mitchell et al. 2004).
394. Auks catch fish by flying underwater, and in order to do so have relatively small wings. This results in high wing loading that constrains their ability to fly and they tend to avoid flying because the energy cost is particularly high for birds with high wing loading. When they fly they tend to fly low over the sea surface, at high speed in a straight line. Therefore, their risk of colliding with offshore wind turbines is low. However, they show displacement from offshore wind farms and are sensitive to disturbance and displacement by ship traffic. When breeding, they have to fly out from the colony to forage, and foraging distances from large colonies can be tens of kilometres. However, razorbill chicks fledge when only partly grown, and travel out to sea by swimming, led to foraging areas away from the colony by their male parent. Adults moult rapidly after the breeding season, becoming flightless for a period. It is likely that they select areas with reliable food fish availability for moulting but details of the moult locations used are not yet clear. After the moult, birds move to wintering areas. In general, many razorbills spend the winter not far from their breeding area but dispersed over the sea. There is evidence from maps of razorbill densities at sea that they tend to aggregate to an extent over some shallow sandbanks. In the southern North Sea the Dogger Bank area is one of these sites with higher density of birds during winter.

4.6.3.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

395. The East Anglia TWO windfarm site is located over 250km from Flamborough and Filey Coast SPA (the nearest breeding colony), which is beyond the razorbill mean maximum foraging range of 48.5km (Thaxter et al. 2012). Therefore, it is appropriate to assume there is no breeding season connectivity with the East Anglia TWO windfarm site. Outside the breeding season, razorbills migrate from their breeding sites. Large numbers are found throughout the North Sea in the nonbreeding seasons (covering the period from August to March).
396. **Table 4.18** presents the abundance of razorbills in all windfarms included in the in-combination assessment, including the proposed East Anglia TWO project. The annual total of razorbills at risk of displacement on the East Anglia TWO windfarm site (combined across the breeding season and all the nonbreeding seasons) was a mean maximum of 691 individuals (**Table 4.18**).
397. The totals at risk on other North Sea windfarms and apportioned to the Flamborough and Filey Coast SPA have been calculated using the following rates

(advised by Natural England for the Norfolk Vanguard project). In the breeding season: 100% for projects within mean maximum foraging range (Westermest Rough), 48.2% for Hornsea One and Two; 30% for Dogger Bank Creyke Beck and Dogger Bank Teesside. For all windfarms, in the autumn: 3.4%, midwinter 2.7% and spring 3.4%.

Table 4.18 Razorbill cumulative and in-combination numbers on wind farms in the North Sea.
(see *ES Appendix 12.3* for data sources).

Windfarm	Total				Apportioned to the FFC SPA			
	Breeding	Autumn	Winter	Spring	Breeding	Autumn	Winter	Spring
EOWDC (Aberdeen OWF)	161	64	7	26	0	2.2	0.2	0.9
Beatrice Demonstrator	No data	No data	No data	No data	0	No data	No data	No data
Blyth (NaREC Demonstration)	121	90.9	60.6	90.9	0	3.1	1.6	3.1
Dudgeon	256	346.1	745.4	346.1	0	11.8	20.1	11.8
Galloper	44	43	105.5	394	0	1.5	2.8	13.4
Greater Gabbard	0	0	387.3	83.8	0	0	10.5	2.8
Gunfleet Sands	No data	No data	No data	No data	0	No data	No data	No data
Humber Gateway	27	20	13.4	20	0	0.7	0.4	0.7
Hywind	30	719	10	0	0	24.4	0.3	0
Kentish Flats	No data	No data	No data	No data	0	No data	No data	No data
Lincs & Lynn and Inner Dowsing	45	33.5	22.3	33.5	0	1.1	0.6	1.1
London Array (Phase 1)	14	20.4	13.6	20.4	0	0.7	0.4	0.7
Race Bank	28	42	28	42	0	1.4	0.8	1.4
Scroby Sands	No data	No data	No data	No data	0	No data	No data	No data
Sheringham Shoal	106	1343	211.3	30.2	0	45.7	5.7	1
Teesside	16	61.5	1.9	20	0	2.1	0.1	0.7
Thanet	3	0	13.6	20.9	0	0	0.4	0.7

Windfarm	Total				Apportioned to the FFC SPA			
	Breeding	Autumn	Winter	Spring	Breeding	Autumn	Winter	Spring
Westermost Rough	91	121.3	151.6	90.9	91	4.1	4.1	3.1
Beatrice	873	833	555.3	833	0	28.3	15	28.3
East Anglia ONE	16	26	154.5	336	0	0.9	4.2	11.4
Hornsea Project 1	1109	4812.3	1518	1802.8	534.5	163.6	41	61.3
Kincardine	22	0	0	0	0	0	0	0
Dogger Bank Creyke Beck A & B	2788	3673	3871	9267.7	836.4	124.9	104.5	315.1
Dogger Bank Teesside A & B	1987	902.6	2384.5	4872.3	596.1	30.7	64.4	165.7
East Anglia THREE	1807	1122	1499	1524	0	38.1	40.5	51.8
Firth of Forth Alpha and Bravo	9574	853.1	568.8	853.1	0	29	15.4	29
Hornsea Project 2	2511	4220.5	719.5	1668	1210.3	143.5	19.4	56.7
Inch Cape	4671	1839.4	1226.3	1839.4	0	62.5	33.1	62.5
Moray Firth (EDA)	2423	1102.6	30.2	168.3	0	37.5	0.8	5.7
Neart na Goithe	1248	1162.9	775.3	1162.9	0	39.5	20.9	39.5
Triton Knoll	40	253.7	854.5	116.7	0	8.6	23.1	4
Hornsea Project 3	630	2020	3649	1236	0	68.7	98.5	42
Moray Firth West	2808	3544	184	3585	0	120.5	5	121.9
Norfolk Boreas	345	630	263	1065	0	21.4	7.1	36.2
Norfolk Vanguard	879	866	839	924	0	29.4	22.7	31.4
Thanet Extension	0	6	56	124	0	0.2	1.5	4.2
East Anglia TWO	281	44	136	230	0	1.5	3.7	7.8
East Anglia ONE North	403	85	54	207	0	2.9	1.5	7
Total	35,357	30,901	21,109	33,034	3268.3	1050.5	570.3	1122.9

398. Natural England advises presentation of a range of displacement rates of between 30% and 70% displacement and 1% and 10% mortality. However,

evidence was presented in support of the use of a precautionary displacement rate of 50% within the windfarm, 30% within the 1km buffer and 0% thereafter, combined with a consequent 1% mortality rate for displaced guillemot and razorbill (Vattenfall 2019; although note that the variable buffer has not been applied in this assessment, with the 50% rate applied across both the windfarm and 2km buffer). Predictions using these alternative rates are presented in **Table 4.19**.

Table 4.19 Razorbill seasonal and annual displacement at North Sea windfarms and apportioned to Flamborough and Filey coast SPA (HRA) using the full breeding season.

Site	Season	Total population at risk of displacement	Total impact, displacement and mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement and mortality rates:		
			30%-1%	50%-1%	70%-10%		30%-1%	50%-1%	70%-10%
East Anglia TWO	Spring	230	0.7	1.2	16.1	7.8	0	0	0.5
	Breeding	281	0.8	1.4	19.7	0	0	0	0
	Autumn	44	0.1	0.2	3.1	1.5	0	0	0.1
	Midwinter	136	0.4	0.7	9.5	3.7	0	0	0.3
	Annual	691	2.1	3.5	48.4	13	0	0.1	0.9
UK North Sea and Channel Wind Farms	Spring	33034	99.1	165.2	2312.4	1122.9	3.4	5.6	78.6
	Breeding	35357	106.1	176.8	2475	3268.3	9.8	16.3	228.8
	Autumn	30901	92.7	154.5	2163.1	1050.5	3.2	5.3	73.5
	Midwinter	21109	63.3	105.5	1477.6	570.3	1.7	2.9	39.9
	Annual	120401	361.2	602	8428.1	6012.0	18	30.1	420.8

4.6.3.2.1 Assessment of displacement risk to razorbill

399. Natural England considered that a likely significant effect on the razorbill population of the Flamborough and Filey Coast SPA due to displacement from the East Anglia TWO windfarm site could not be ruled out. Apportioning the East Anglia TWO windfarm site displacement mortality to the SPA on the basis of no connectivity in the breeding season (as the windfarm site is located more than five times the mean maximum foraging range for this species from the SPA) and an even distribution in the nonbreeding season (on the assumption that the SPA population is evenly distributed within the nonbreeding BDMPS population) the worst case mortality due to the proposed East Anglia TWO project was 0.9 individuals. This would increase the baseline mortality (of 2,220, calculated using adult mortality of 10.5%, Horswill and Robinson 2015) by 0.04%, which would be undetectable. Therefore, displacement of razorbill from the East Anglia TWO windfarm site would not have an Adverse Effect on the Integrity of the SPA.

4.6.3.2.2 In-combination assessment of displacement risk to razorbill

400. It is clear from the project alone assessment that the proposed East Anglia TWO project will make an extremely small contribution to an in-combination impact. Nonetheless, on the basis of the totals in **Table 4.19** the combined displacement mortality across the whole year was estimated to be in the range 18 to 421 individuals. These would increase the baseline mortality rate of the population (all ages) by 0.8% to 19%, while assessed using the evidence-based displacement and mortality rates, the increase would be 1.3%.
401. On the basis of the most precautionary rates preferred by Natural England, there is potential for an adverse effect on the razorbill population due to in-combination displacement effects. However, the contribution to this from the proposed East Anglia TWO project is very small, estimated to comprise 0.2% (0.9 individuals from a total of 420.8).
402. Outputs from a PVA model for this population were presented for the Hornsea Project Three windfarm (MacArthur Green 2018). This modelling was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from these models for mortality levels of 400 and 450 (the nearest values to the in-combination prediction) are provided in **Table 4.20**.

Table 4.20. Razorbill FFC SPA population modelling results from MacArthur Green (2018).

Model	Adult mortality	Counterfactual metric (after 25 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	400	0.981	0.632	Table A2 13.1 & 13.3
	450	0.979	0.597	
Rate set 1, density dependent	400	0.996	0.833	Table A2 14.1 & 14.3
	450	0.995	0.813	
Rate set 2, density independent	400	0.981	0.631	Table A2 15.1 & 15.3
	450	0.979	0.596	
Rate set 2, density dependent	400	0.985	0.680	Table A2 16.1 & 16.3
	450	0.984	0.651	

403. The maximum reduction in the population growth rate, at a mortality of 400 (which is the nearest modelled value to the in-combination adult total of 421), using the

more precautionary density independent model was 1.9% (0.981). On the basis of the observed rate at which this population has grown, between 2000 and 2008 (7.2%) and between 2008 and 2017 (7.2%) (RSPB unpubl. report 2017), a reduction of 1.9% to this rate, due to the worst case displacement predictions, would still permit population growth at over 5% per year.

- 404. The razorbill breeding numbers at the Flamborough and Filey Coast SPA have shown strong growth over the last 20 years and are continuing to increase so the population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the razorbill population, subject to natural change.
- 405. On the basis of the population model outputs the number of predicted in-combination razorbill displacement mortalities attributed to the Flamborough and Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a small reduction in the growth rate currently seen at this colony, and so would not have an adverse effect on integrity of the SPA.
- 406. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA from impacts on razorbill due to the proposed East Anglia TWO project in-combination with other plans and projects.

4.6.4 Guillemot

4.6.4.1 Status and ecology

- 407. Breeding guillemot (41,607 pairs in 2008-2011) is a designated feature of the Flamborough and Filey Coast SPA. This is by far the largest colony of guillemots in the southern North Sea, holding over 100% of the breeding guillemots from County Durham to Kent (Mitchell et al. 2004).
- 408. Auks catch fish by flying underwater, and in order to do so have relatively small wings. This results in high wing loading that constrains their ability to fly and they tend to avoid flying because the energy cost is particularly high for birds with high wing loading. When they fly they tend to fly low over the sea surface, at high speed in a straight line. Therefore, their risk of colliding with offshore wind turbines is low. However, they show displacement from offshore windfarms and are sensitive to disturbance and displacement by ship traffic. When breeding, they have to fly out from the colony to forage, and foraging distances from large colonies can be tens of kilometres. However, guillemot chicks fledge when only partly grown, and travel out to sea by swimming, led to foraging areas away from the colony by their male parent. Adults moult rapidly after the breeding season, becoming flightless for a period. It is likely that they select areas with reliable food fish availability for moulting but details of the moult locations used are not yet clear. After the moult, birds move to wintering areas. In general, many guillemots spend the winter not far from their breeding area but dispersed over the sea.

There is evidence from maps of guillemot densities at sea that they tend to aggregate to an extent over some shallow sandbanks. In the southern North Sea the Dogger Bank area is one of these sites with higher density of birds during winter.

4.6.4.2 Potential effects of the proposed East Anglia TWO project on the SPA feature

409. East Anglia TWO is located over 250km from Flamborough and Filey Coast SPA (the nearest breeding colony), which is beyond the guillemot mean maximum foraging range of 84.2km (Thaxter et al. 2012). Therefore, it is appropriate to assume there is no breeding season connectivity with the East Anglia TWO windfarm site. Outside the breeding season, guillemots migrate from their breeding sites. Large numbers are found throughout the North Sea in the nonbreeding seasons (covering the period from August to February).

410. **Table 4.21** presents the abundance of guillemots in all wind farms included in the in-combination assessment, including the proposed East Anglia TWO project. The annual total of guillemots at risk of displacement on the East Anglia TWO windfarm site (combined across the breeding season and all the nonbreeding seasons) was a mean maximum of 691 individuals (**Table 4.21**).

411. The totals at risk on other North Sea windfarms and apportioned to the Flamborough and Filey Coast SPA are also presented in **Table 4.21**. These have been calculated using the rates advised by Natural England (for the Norfolk Vanguard project). In the breeding season: 100% for projects within mean maximum foraging range (Teesside, Humber Gateway, Triton Knoll, Westernmost Rough), 46.3% for Hornsea One and Two; 35% for Dogger Bank Creyke Beck and Dogger Bank Teesside. For all windfarms in the nonbreeding season: 4.4%.

Table 4.21 Guillemot cumulative and in-combination numbers on windfarms in the North Sea.
(see **ES Appendix 12.3** for data sources).

Windfarm	Total		Apportioned to the FFC SPA	
	Breeding	Nonbreeding	Breeding	Nonbreeding
EOWDC (Aberdeen OWF)	547	225	0	9.9
Beatrice Demonstrator	No data	No data	No data	No data
Blyth (NaREC Demonstration)	1220	1321	0	58.1
Dudgeon	334	542	0	23.8
Galloper	305	593	0	26.1
Greater Gabbard	345	548	0	24.1
Gunfleet Sands	No data	No data	No data	No data
Humber Gateway	99	138	138	6.1

Windfarm	Total		Apportioned to the FFC SPA	
	Breeding	Nonbreeding	Breeding	Nonbreeding
Hywind	249	2136	0	94
Kentish Flats	No data	No data	No data	No data
Lincs & Lynn and Inner Dowsing	582	814	0	35.8
London Array (Phase 1)	192	377	0	16.6
Race Bank	361	708	0	31.2
Scroby Sands	No data	No data	No data	No data
Sheringham Shoal	390	715	0	31.5
Teesside	267	901	901	39.6
Thanet	18	124	0	5.5
Westermest Rough	347	486	486	21.4
Beatrice	13610	2755	0	121.2
East Anglia ONE	274	640	0	28.2
Hornsea Project 1	9836	8097	4554.1	356.3
Kincardine	632	0	0	0
Dogger Bank Creyke Beck A & B	14886	16763	5210.1	737.6
Dogger Bank Teesside A & B	8494	5969	2972.9	262.6
East Anglia THREE	1744	2859	0	125.8
Firth of Forth Alpha and Bravo	24724	8800	0	387.2
Hornsea Project 2	7735	13164	3581.3	579.2
Inch Cape	8184	3912	0	172.1
Moray Firth (EDA)	9820	547	0	24.1
Neart na Goithe	4894	7618	0	335.2
Triton Knoll	425	746	746	32.8
Hornsea Project 3	13374	17772	0	782
Moray Firth West	24426	38174	0	1679.7
Norfolk Boreas	7767	13777	0	606.2
Norfolk Vanguard	4320	4776	0	210.1

Windfarm	Total		Apportioned to the FFC SPA	
	Breeding	Nonbreeding	Breeding	Nonbreeding
Thanet Extension	12	1105	0	48.6
East Anglia ONE North	4183	1888	0	83.1
East Anglia TWO	2077	1675	0	73.7
Total	166,673	160,665	18589.4	7069.4

412. Natural England advises presentation of a range of displacement rates of between 30% and 70% displacement and 1% and 10% mortality. However, evidence was presented in support of the use of a precautionary displacement rate of 50% within the windfarm, 30% within the 1 km buffer and 0% thereafter, combined with a 1% mortality rate for guillemot and razorbill (Vattenfall 2019; although note that the variable buffer has not been applied in this assessment, with the 50% rate applied across both the windfarm and 2km buffer). Predictions using these alternative rates are presented in **Table 4.22**.

Table 4.22 Guillemot seasonal and annual displacement at North Sea windfarms and apportioned to Flamborough and Filey Coast SPA (HRA) using the full breeding season.

Site	Season	Total population at risk of displacement	Total impact, displacement and mortality rates:			Population apportioned to FFC SPA	FFC SPA impact, displacement and mortality rates:		
			30% -1%	50%- 1%	70%- 10%		30% -1%	50% -1%	70%- 10%
East Anglia TWO	Breeding	2077	6.2	10.4	145.4	0	0	0	0
	Nonbreeding	1675	5	8.4	117.3	73.7	0.2	0.4	5.2
	Annual	3752	11.3	18.8	262.6	73.7	0.2	0.4	5.2
UK North Sea and Channel Wind Farms	Breeding	166,673	500	833.4	11667.1	18589.4	55.8	92.9	1301.3
	Nonbreeding	160,665	482	803.3	11246.6	7069.4	21.2	35.3	494.9
	Annual	327,338	982	1636.7	22913.7	25658.8	77	128.3	1796.1

4.6.4.2.1 Assessment of displacement risk to guillemot

413. Natural England considered that a likely significant effect on the guillemot population of the Flamborough and Filey Coast SPA due to displacement from the East Anglia TWO windfarm site could not be ruled out. Apportioning the East

Anglia TWO windfarm site displacement mortality to the SPA on the basis of no connectivity in the breeding season (as the windfarm is located more than three times the mean maximum foraging range for this species from the SPA) and an even distribution in the nonbreeding season (on the assumption that the SPA population is evenly distributed within the nonbreeding BDMPS population) the worst case mortality due to the proposed East Anglia TWO project was 5.2 individuals. This would increase the baseline mortality (of 5,051 calculated using the adult mortality rate of 6.07%, Horswill and Robinson 2015) by 0.1%, which would be undetectable. Therefore, displacement of guillemot from East Anglia TWO windfarm site would not have an adverse effect on the integrity of the SPA.

4.6.4.2.2 In-combination assessment of displacement risk to guillemot

414. Given the extremely small mortality due to East Anglia TWO it is clear that the project will make an extremely small contribution to an in-combination impact. Nonetheless, on the basis of the totals in **Table 4.22** the combined displacement mortality across the whole year was estimated to be in the range 77 to 1,796 individuals. These would increase the baseline mortality rate of the population (all ages) by 1.5% to 35%, while assessed using the evidence-based displacement and mortality rates, the increase would be 2.5%.
415. On the basis of the most precautionary rates preferred by Natural England, there is potential for an adverse effect on the guillemot population due to in-combination displacement effects. However, the contribution to this from East Anglia TWO is very small, estimated to comprise 0.2%.
416. Outputs from a PVA model for this population were presented for the Hornsea Project Three (MacArthur Green 2018). This modelling was an update of similar models produced for Hornsea Project Two, with the addition of a matched-run approach for calculating counterfactual outputs and an extended simulation period (up to 35 years). Simulations were conducted with and without density dependence and were summarised as the counterfactual of population size and population growth rate. The outputs from these models for mortality levels of 100,150 and 1,600 (the nearest values to the in-combination predictions) are provided in **Table 4.20**.

Table 4.23. Guillemot Flamborough and Filey Coast SPA population modelling results from MacArthur Green (2018).

Model	Adult mortality	Counterfactual metric (after 25 years)		Source table (MacArthur Green 2018)
		Growth rate	Population size	
Rate set 1, density independent	100	0.999	0.972	Table A2 9.1 & 9.3
	150	0.998	0.958	
	1600	0.981	0.627	
Rate set 1, density dependent	100	1.000	0.985	Table A2 10.1 & 10.3
	150	0.999	0.977	
	1600	0.992	0.773	
Rate set 2, density independent	100	0.999	0.972	Table A2 11.1 & 11.3
	150	0.998	0.958	
	1600	0.981	0.628	
Rate set 2, density dependent	100	1.000	0.984	Table A2 12.1 & 12.3
	150	0.999	0.976	
	1600	0.991	0.754	

417. The maximum reduction in the population growth rate, at a mortality of 1600 (which is the nearest modelled value to the in-combination adult total of 1,769), using the more precautionary density independent model was 1.9% (0.981). On the basis of the observed rate at which this population has grown, between 2000 and 2008 (3.0%) and between 2008 and 2017 (4.0%) (RSPB unpubl. report 2017), a reduction of 1.9% to this rate, due to the worst case displacement predictions, would still permit population growth.
418. The guillemot breeding numbers at the Flamborough and Filey Coast SPA have shown strong growth over the last 20 years and are continuing to increase so the population is therefore clearly in favourable conservation status. The relevant conservation objective is to maintain favourable conservation status of the razorbill population, subject to natural change.
419. On the basis of the population model outputs the number of predicted in-combination guillemot displacement mortalities attributed to the Flamborough and Filey Coast SPA is not at a level which would trigger a risk of population decline, but would only result in a small reduction in the growth rate currently

seen at this colony, and so would not have an adverse effect on integrity of the SPA.

420. Therefore, it can be concluded that there will be no adverse effect on the integrity of Flamborough and Filey Coast SPA from impacts on guillemot due to the proposed East Anglia TWO project in-combination with other plans and projects.

4.7 Breydon Water SPA and Ramsar Site

421. Migrant collision risk modelling was undertaken for all the species with potential for connectivity to East Anglia TWO on passage using the methods developed for the Strategic Ornithological Support Services (SOSS) programme (Wright et al. 2012). This assessment found that predicted collisions apportioned to this SPA and Ramsar were very small, with none exceeding 1 individual per year (**East Anglia TWO ES Appendix 12.2 Annex 8**). These levels of additional mortality would not increase the background mortality rate by more than 1% and would therefore be undetectable against natural variations. It can therefore be concluded that there would be no adverse effect on the integrity of Breydon Water SPA and Ramsar as a result of collisions at East Anglia TWO alone.
422. In-combination collision mortality with the nearby Norfolk Vanguard, Norfolk Boreas, East Anglia THREE and East Anglia ONE North projects were similarly very small (increases in background mortality rates remained less than 1% (**East Anglia TWO ES Appendix 12.2 Annex 8**) leading to the same conclusion of no adverse effect on the integrity of Breydon Water SPA and Ramsar as a result of collisions at East Anglia TWO in-combination with other plans and (**East Anglia TWO ES Appendix 12.2 Annex 8**).

4.8 Broadland SPA and Ramsar Site

423. Migrant collision risk modelling was undertaken for all the species with potential for connectivity to East Anglia TWO on passage using the methods developed for the SOSS programme (Wright et al. 2012). This assessment found that predicted collisions apportioned to this SPA and Ramsar were very small, with none exceeding 1 individual per year (**East Anglia TWO ES Appendix 12.2 Annex 8**). These levels of additional mortality would not increase the background mortality rate by more than 1% and would therefore be undetectable against natural variations. It can therefore be concluded that there would be no adverse effect on the integrity of Broadland Water SPA and Ramsar as a result of collisions at East Anglia TWO alone.
424. In-combination collision mortality with the nearby Norfolk Vanguard, Norfolk Boreas, East Anglia THREE and East Anglia ONE North projects were similarly very small (increases in background mortality rates remained less than 1% (**East Anglia TWO ES Appendix 12.2 Annex 8**) leading to the same conclusion of no adverse effect on the integrity of Broadland Water SPA and Ramsar as a result

of collisions at East Anglia TWO in-combination with other plans and projects (***East Anglia TWO ES Appendix 12.2 Annex 8***).

4.9 North Norfolk Coast SPA and Ramsar Site

425. Migrant collision risk modelling was undertaken for all the species with potential for connectivity to East Anglia TWO on passage using the methods developed for the SOSS programme (Wright et al. 2012). This assessment found that predicted collisions apportioned to this SPA and Ramsar were very small, with none exceeding 1 individual per year (***East Anglia TWO ES Appendix 12.2 Annex 8***). These levels of additional mortality would not increase the background mortality rate by more than 1% and would therefore be undetectable against natural variations. It can therefore be concluded that there would be no adverse effect on the integrity of North Norfolk Coast SPA and Ramsar as a result of collisions at East Anglia TWO alone.
426. In-combination collision mortality with the nearby Norfolk Vanguard, Norfolk Boreas, East Anglia THREE and East Anglia ONE North projects were similarly very small (increases in background mortality rates remained less than 1% (***East Anglia TWO ES Appendix 12.2 Annex 8***) leading to the same conclusion of no adverse effect on the integrity of North Norfolk Coast SPA and Ramsar as a result of collisions at East Anglia TWO in-combination with other plans and projects (***East Anglia TWO ES Appendix 12.2 Annex 8***).

5 Marine Mammals Assessment of Effects

5.1 Approach to Assessment

427. This section provides information to determine whether there is an adverse effect on the integrity of the conservation objectives of the Southern North Sea SAC, The Wash and North Norfolk SAC, Humber Estuary SAC, Vlaamse Banken SAC, SBZ 1 / ZPS 1 SPA, SBZ 2 / ZPS 2 SPA, SBZ 3 / ZPS 3 SPA, Vlakte van de Raan SCI, Bancs des Flandres SAC, Vlakte van de Raan SAC and the Voordelta SAC and SPA due to the potential effects of the proposed East Anglia TWO project. **Section 2.1 of Appendix 1** provides a description of the HRA methodology. This section takes the following structure:

- A summary of proposed East Anglia TWO project offshore infrastructure details, outlining the worst-case scenario and embedded mitigation for the marine mammal assessment.
- Then for each SAC
 - o A description of each SAC, its conservation objectives, and baseline marine mammal information gathered to aid the assessment.
 - o A description of potential effects associated with the proposed East Anglia TWO project on the qualifying feature;
 - o An assessment of the effects during construction and operation of the proposed East Anglia TWO project; and
 - o An assessment of in-combination effects when considering the proposed East Anglia TWO project alongside other developments.
 - o A summary for each SAC of the conclusions with regard to effects.

428. The classes of designations considered within this HRA for marine mammals are:

- Special Areas of Conservation (SACs);
- Possible SACs (pSACs);
 - o A site which has been identified and approved to go out to formal consultation.
- Candidate SACs (cSACs);
 - o Following consultation on the pSAC, the site is submitted to the European Commission (EC) for designation and at this stage it is called a cSAC.
- Sites of Community Importance (SCI);
 - o Once the EC approves the site it becomes a SCI, before the national government then designates it as a SAC.

429. For marine mammals, consultation has taken place through a non-statutory Evidence Plan Process (EPP) and includes an Expert Topic Group (ETG) for marine mammals, which is comprised of representatives from Natural England, the Marine Management Organisation (MMO), The Wildlife Trust (TWT) and Whale and Dolphin Conservation (WDC). The ETG was consulted to agree the approach taken forward in many aspects of the HRA. See **Appendix 4** of this document for a summary of the consultation undertaken for marine mammals.

5.2 Project Details

5.2.1 Worst-Case Scenario

430. The worst-case scenario for each category of potential effect on marine mammals has been determined (**Table 5.1**). The worst-case scenarios identified here also apply to the in-combination assessment.

Table 5.1 Worst Case Parameters for Marine Mammal Receptors

Potential Effect	Parameter	Maximum worst-case	Notes
Construction			
Underwater noise during unexploded ordnance (UXO) clearance	Number of UXO	Up to 80	Indicative only. Based on best available information from East Anglia ONE.
	Type and size of UXO	Up to 700kg (net explosive quantities (NEQ))	Indicative only. Based on East Anglia ONE UXO survey. A detailed UXO survey will be completed prior to construction.
Underwater noise during geophysical surveys	Area	Windfarm site and cable corridor	Duration and timing / season currently unknown. However, as outlined in Section 5.3 , the potential disturbance of during offshore wind farm construction has been assessed based on the disturbance during piling and for other construction activities, therefore the potential for any disturbance during any geophysical surveys at these sites has already been taken into account (i.e. the areas of potential disturbance has already been included / covered as part of these assessments).
Underwater noise during piling (represents worst case scenario for underwater noise, alternative foundation types are also considered)	Number of wind turbines	Up to 75	Maximum number of wind turbines.
	Number of offshore platforms	4 x Offshore electrical platforms 1 x Met mast 1 x Construction, operation and maintenance platform	

Potential Effect	Parameter	Maximum worst-case	Notes
		= 6	
	Wind turbine foundation options	Monopile 4-legged jacket = pin-piles	Hammer piled foundations represent the worst-case scenario for underwater noise.
	Platform foundation options	Electrical platforms = jacket with pin-piles Met mast = monopile or jacket with pin-piles Construction, operation and maintenance = jacket with pin-piles	
	Proportion of foundations that are piled	100%	The maximum proportion of hammer piled foundations represents the worst-case scenario for underwater noise.
	Number of piles per infrastructure type	Wind turbines = 1 monopile or 4 pin-piles Electrical platforms = 8 pin-piles per platform Met mast = 1 monopile or 4 pin-piles Construction, operation and maintenance platform = 8 pin-piles per platform	
	Number of piles for wind turbines	250m devices = 75 monopiles or 300 pin-piles 300m devices = 60 monopiles or 240 pin-piles	Maximum number of pin-piles for all wind turbine foundations is 300.
	Number of piles for offshore platforms	Electrical platforms = 4 x 8 pin-piles = 32 pin-piles Met mast = 1 monopile or 4 pin-piles	Maximum number of pin-piles for all platform foundations is 44.

Potential Effect	Parameter	Maximum worst-case	Notes
		Construction, operation and maintenance platform = 8 pin-piles	
	Total number of piled foundations	Maximum number of pin-piles = 300 (250m wind turbine) + 44 (platforms) = 344; Or Maximum number of monopiles = 75 (250m wind turbine) + 1 (met mast) = 76; plus 40 pin-piles for platforms.	
	Hammer energy - monopiles	Maximum hammer energy applied = 4,000kJ for 300m wind turbine with 15m diameter monopile. Starting hammer energy of 400kJ will be used for 10 minutes. Ramp up will then be undertaken for at least 20 minutes to 80% of maximum hammer energy applied.	This is the worst-case scenario with potential underwater noise impacts greater than those for 250m wind turbine monopile with a maximum applied hammer energy of 3,000kJ. Note that a hammer with a larger energy (up to 6,000kJ) may be used, but the maximum hammer energy that will be applied in this project will be 4,000kJ for monopiles.
	Hammer energy – pin-piles	Maximum hammer energy applied = 2,400kJ for 4.6m diameter pin-piles (300m wind turbines or platforms). Starting hammer energy of 240kJ will be used for 10 minutes. Ramp up will then be undertaken for at least 20 minutes to 80% of maximum hammer energy applied.	This is the worst-case scenario with potential underwater noise impacts greater than for 250m wind turbine pin-piles with maximum applied hammer energy of 1,800kJ. Note that a hammer with a larger energy (up to 6,000kJ) may be used, but the maximum hammer energy that will be applied will be 2,400kJ for pin-piles.

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Potential Effect	Parameter	Maximum worst-case	Notes
	Pile diameter - monopiles	Maximum monopile diameter of 15m for 300m wind turbines.	15m diameter is the worst-case scenario for monopiles, with potential underwater noise impacts greater than 13m diameter monopile for 250m wind turbines and 8m diameter monopile for met mast.
	Pile diameter – pin-piles	Maximum pin-pile diameter of 4.6m for 300m wind turbines and platforms (offshore electrical and construction, operation and maintenance platforms).	This is the worst case, with the greatest potential underwater noise impact ranges for installation of pin-piles.
	Total piling time – per wind turbine foundation for monopiles (including soft-start and ramp-up and providing allowance for issues such as low blow rate, refusal, etc.)	325 minutes (5.42hrs) x 60 (300m wind turbines) monopiles = 2325 hours (13.5 days)	The maximum hammer piling duration of 325 hours (up to 13.5 days) represents the temporal worst-case scenario for the installation of monopiles for the 300m wind turbines (this includes 10 minute soft-start and 20 minute ramp-up). This is greater than the maximum hammer piling duration of 137.5 hours for the installation of monopiles for the 250m wind turbines (110 minutes, including soft-start and ramp-up x 75).
	Total piling time – per wind turbine foundation for pin-piles (including soft-start and ramp-up and providing allowance for issues such as low blow rate, refusal, etc.)	199 minutes (3.32 hours) x 4 pin-piles x 60 (300m devices) = 797 hours (33.2 days)	The maximum hammer piling duration of 797 hours (up to 33.2 days) represents the temporal worst-case scenario for the installation of pin-piles for the 300m wind turbines (this includes 10 minute soft-start and 20 minute ramp-up). This is greater than the maximum hammer piling duration of 585 hours for the installation of pin-piles for the 250m wind turbines (117

Potential Effect	Parameter	Maximum worst-case	Notes
			minutes, including soft-start and ramp-up x 75 x 4).
	Total piling time – per platform foundation (including soft-start and ramp-up and providing allowance for issues such as low blow rate, refusal, etc.)	199 minutes x 8 pin-piles x 4 electrical platforms = 106hours 199 minutes x 8 pin-piles x 1 construction, operation and maintenance platform = 26.5hours 127 minutes x 4 pin-piles x 1 Met mast = 8.5hours Total = 141 hours (up to 6 days)	The maximum hammer piling duration of 141hrs (6 days) represents the temporal worst-case scenario for the installation of the platforms (including soft-start and ramp-up).
	Maximum total active piling time for wind turbines and platforms	938hrs (39.2 days)	Based on the worst-case scenario of pin-piles for wind turbines (up to 33.2 days) and platforms (up to 6 days).
	Activation of Acoustic Deterrent Devices (ADDs)	For example, 10 minutes activation per pile. Up to 57.3 hours (up to 2.4 days) for 344 pin-piles.	Indicative only. If required, the ADDs will be activated prior to the soft-start to reduce the risk of auditory injury from the first single strike of the soft-start. This is greater than up to 19.3 hours (up to 0.8 days) for 76 monopiles and 40 offshore platform pin-piles.
	Concurrent piling events	None	Concurrent piling will not be conducted at the East Anglia TWO windfarm site.
Underwater noise from activities such as seabed	Cable installation methods	Trenching (potential noisiest cable installation method)	

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Potential Effect	Parameter	Maximum worst-case	Notes
preparations, cable installation and rock dumping	Total export cable length	160km (2 cables, 80km each)	
	Inter-array cable length	200km	
	Platform cable link length	75km	
	Maximum number of inter-array cable laying vessels on site	3	
	Maximum number of export cable laying and support vessels on site	5	
Barrier effects caused by underwater noise	Maximum impact ranges associated with underwater noise	The maximum spatial area of potential impact and the maximum duration for any potential barrier effects are considered in relation to barrier effect.	
Vessels: Interactions and collision risk; and Underwater noise and disturbance from vessels	Approximate number of vessels on site at any one time during construction	74	Indicative number of movements based on 27-month maximum construction period.
	Indicative number of movements	Approximate total trips: 3,672 Average trips per year: 1,632 Average trips per month: 136	
	Vessel types	Vessels could include: Dredging vessels	

Potential Effect	Parameter	Maximum worst-case	Notes
		Tugs and storage barges Jack-up vessels Dynamic Position (DP) Heavy Lift Vessels (HLV) Support Vessels Platform installation vessels Accommodation vessels Windfarm service vessels Supply vessels Inter-array cable laying vessel Export cable laying vessels Export cable support vessels Pre-trenching / backfilling vessel Cable jetting and survey vessels Workboats	
	Port locations	To be determined post consent.	. Vessel traffic to and from port would likely become integrated in existing shipping routes.
Changes to prey resources	Impacts upon prey species	Physical disturbance and temporary loss of sea bed habitat = up to 11.35km ² . Increased suspended sediments and sediment re-deposition = approximately 0.004km ³ .	See ES Chapter 10 Fish and Shellfish Ecology . Physical disturbance and temporary loss of sea bed habitat based on maximum potential areas for preparation area for wind turbines and

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Potential Effect	Parameter	Maximum worst-case	Notes
		Underwater noise during piling = parameters as outlined above. Underwater noise from activities, including UXO clearance = parameters as outlined above.	platform foundation installation, cable installation, footprint of jack up barges and boulder clearance. The worst case suspended sediment and deposition is modelled in ES Chapter 7 Marine Geology, Oceanography and Physical Processes , based on maximum are of seabed preparation, sand wave levelling, trenching / dredging requirements and drill arisings.
Operation			
Underwater noise from maintenance activities such as cable repairs and rock dumping	Parameters for any cable lengths or areas requiring any additional rock dumping or cable burial are unknown. The following estimates are assumed: Repair and reburial of one array cable of up to 4km length every 5 years. Repair and reburial of up to 300m of export cable less than once every five years.		n/a
	Annual number of maintenance activities at individual wind turbines requiring the use of a jack-up vessel	0.5 per annum for 75 turbines = 37.5 visits by a jack-up vessel per annum	n/a
	Annual number of maintenance activities requiring the use of a cable laying vessel (inter-array,	5	n/a

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Potential Effect	Parameter	Maximum worst-case	Notes
	platform link and export cable)		
	Annual number of geophysical surveys required for non-intrusive inspection (for example, of cable burial/scour).	4	n/a
Underwater noise from operational wind turbines	Number of wind turbines	Up to 75	n/a
Vessels: Interactions and collision risk; and Underwater noise and disturbance from vessels	Number of trips made by support vessels to the windfarm per year	687	Maximum potential for risk from disturbance or collisions.
Changes to prey resources	Impacts upon prey species	Permanent habitat loss = 2.02km ² . Increased suspended sediments and sediment re-deposition = 0.000375km ³ Underwater noise = parameters as outlined above Electromagnetic fields (EMF) = 435km maximum cable length (as outlined above), buried to a depth of 0.5m to 5m.	See <i>ES Chapter 10 Fish and Shellfish Ecology</i> The overall total footprint which could be subject to permanent habitat loss from gravity based foundations, platform foundations, scour protection and cable protection. The maximum amount of suspended sediment that would be released into the water column due to changes in tidal regime around infrastructure.

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Potential Effect	Parameter	Maximum worst-case	Notes
Decommissioning			
Underwater noise from foundation removal (e.g. cutting)	Assumed to be no worse than for construction (with no pile driving) Explosives will not be used, assumed piles cut off 1m below seabed level and all wind turbine components above seabed level removed. All buried array and offshore export cables would be left <i>in situ</i> while unburied sections would be cut at the ends and removed. Scour and cable protection would also be left <i>in situ</i> .		
Barrier effects caused by underwater noise	Maximum impact ranges associated with underwater noise.		
Vessels: Interactions and collision risk; and Underwater noise and disturbance from vessels	Vessel types, movements and numbers assumed to be similar or less than construction phase.		
Changes to prey resources	Assumed to be no worse than for construction phase.		

5.2.2 Mitigation

5.2.2.1 East Anglia TWO commitments

431. In addition to the embedded mitigation secured through the MMMP (such as establishing a mitigation zone based on the maximum potential range for PTS, soft-start and ramp-up, and activation of ADDs prior to soft-start, also see below), the Applicant has also committed to the following:
- Only one UXO would be detonated at a time during UXO clearance operations in the East Anglia TWO offshore development area. There would be no simultaneous UXO detonations, but potentially more than one UXO detonation could occur in a 24 hour period.
 - There would be no concurrent piling at East Anglia TWO, with only one pile being installed at a time, with no overlap in the piling duration of any two piles. Piles will be installed sequentially, and more than one pile could be installed in a single 24 hour period.
 - There would be no UXO detonation in the East Anglia TWO offshore development area at the same time as piling in the East Anglia TWO offshore development area during the winter period, in that 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 concurrent piling or UXO detonation between the proposed East Anglia TWO and East Anglia ONE North projects if both projects are constructed at the same time. This is stated within the draft Marine Mammal Mitigation Protocol (MMMP) (document reference 8.14) which is submitted with the DCO application. The final MMMP for piling will be produced pre-construction and is secured through the DCO.
432. The commitments apply irrespective of any additional measures agreed through the development of the SIP.

5.2.2.2 Mitigation and Best Practice

433. The Applicant has committed to a number of techniques and engineering designs / modifications inherent as part of the project where practical, during the pre-application phase, in order to avoid a number of impacts or reduce impacts as far as reasonably possible. Embedding mitigation into the project design is a type of primary mitigation and is an inherent aspect of the EIA process.
434. A range of different information sources have been considered as part of embedding mitigation into the design of the project (for further details see **Chapter 6 Project Description** and **Chapter 4 Site Selection and Assessment of Alternatives**) including engineering requirements, ongoing discussions with

stakeholders and regulators, commercial considerations and environmental best practice.

435. Where possible, the embedded mitigation has been taken into account in each relevant impact assessment when assessing the potential magnitude of the impact.
436. In addition to embedded mitigation, if further mitigation is required and possible, (i.e. those measures to prevent or reduce any remaining significant adverse effects) these are discussed in the relevant impact sections and the post-mitigation residual impact significance is provided.

5.2.2.2.1 Soft-Start and Ramp-Up

437. The Applicant has committed to the following to reduce potential effects of underwater noise on marine mammals, secured through the draft MMMP (document reference 8.14) submitted with the DCO application:
438. The proposed soft-start and ramp-up protocol:
- Each piling event would commence with a soft-start for a minimum of 10 minutes at 10% of the maximum hammer energy applied followed by a gradual ramp-up for at least 20 minutes to 80% of the maximum hammer energy applied (maximum hammer energy to be applied is only likely to be required at a few of the piling installation locations).
 - This minimum 30 minute soft-start and ramp-up duration is more precautionary than the current Joint Nature and Conservation Committee (JNCC) (2010a) guidance, which recommends that the soft-start and ramp-up period duration should be a period of not less than 20 minutes.
 - During the 30 minutes for the soft-start and ramp-up it is estimated that animals would move over 2.7km away from the piling location (0.9km during the soft-start and 1.8km during the ramp-up), based upon an average marine mammal swimming speed of 1.5m/s (Otani et al. 2000). However, Kastelein et al. (2018) recorded harbour porpoise swimming speeds of 1.97m/s during playbacks of pile driving sounds.

5.2.2.2.2 Water quality

439. Throughout the proposed East Anglia TWO project, best practice techniques and due diligence regarding the potential for pollution throughout all construction, operation and maintenance, and decommissioning activities will be followed. The Environmental Management Plan (EMP) will include the mitigation measures embedded into the design (see ES **Chapter 8 Water and Sediment Quality**), including, but not limited to:

- Oils and lubricants used in the wind turbines would be biodegradable where possible and all chemicals would be certified to the relevant standard.
 - All wind turbines would incorporate appropriate provisions to retain spilled fluids within the nacelle and tower. In addition, converter and collector stations would be designed with a self-contained bund to contain any spills and prevent discharges to the environment.
 - Best practice procedures would be put in place when transferring oil or fuel between converter or collector stations and service vessels.
 - Appropriate spill plan procedures would also be implemented in order to appropriately manage any unexpected discharge into the marine environment, these would be included in a Marine Pollution Contingency Plan (MPCP) to be agreed post-consent. To avoid discharge or spillage of oils it is anticipated that the transformers would be filled for their operational life and would not need interim oil changes.
 - Inclusion of control measures such as the requirement to carry spill kits and the requirement for vessel personnel to undergo training to ensure requirements of the Project Environmental Management Plan (PEMP) are understood and communicated.
 - All work practices and vessels would adhere to the requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78; specifically Annex 1 Regulations for the prevention of pollution by oil concerning machine waters, bilge waters and deck drainage and Annex IV Regulations for the prevention of pollution by sewage from ships concerning black and grey waters.
440. Any risk of accidental release of contaminants (e.g. through spillage) will be mitigated, as outlined above, and any changes to water quality as a result of any accidental release of contaminants (e.g. through spillage or vessel collision) is negligible.

5.2.2.3 Additional Mitigation

5.2.2.3.1 Marine Mammal Mitigation Protocol (MMMP) for Piling

441. The MMMP for piling will be developed in the pre-construction period and will be based upon best available information, methodologies and industry best practice. The protocol will be developed in consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs), detailing the proposed mitigation measures to reduce the risk of physical or permanent auditory injury (Permanent Threshold Shift (PTS)) to marine mammals during all piling operations. This will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the mitigation zone and any additional mitigation measures required to minimise

potential impacts of any physical or permanent auditory injury (PTS), for example, the activation of acoustic deterrent devices (ADDs) prior to the soft-start (the potential disturbance during ADD activation has been assessed in **section 11.6.1.4** of **Chapter 11 Marine Mammals** in the ES).

442. A mitigation zone, based on maximum potential instantaneous PTS impact ranges, will be established. Mitigation measures would aim to remove marine mammals from the mitigation zone prior to the start of piling to reduce the risk of any physical or auditory injury.
443. For example, the activation of ADDs for 10 minutes prior to the soft-start would allow harbour porpoise, grey and harbour seal to move at least 0.9km from the piling location (based on a precautionary average swimming speed of 1.5m/s), which is beyond the maximum PTS predicted impact range for the starting hammer energy (400kJ) of up to 0.58km.
444. The example of mitigation for up to 10 minutes ADD activation, 10 minute soft-start and 20 minute ramp-up would enable marine mammals to move at least 3.6km from the piling location (2.7km during the 30 minute soft-start and ramp-up plus 0.9km during ADD activation for 10 minutes, based on a precautionary average marine mammal swimming speed of 1.5m/s). This would therefore be greater than the maximum predicted distance of 1.2km for PTS from a single strike at the maximum hammer energy applied for monopiles of 4,000kJ, based on the unweighted Sound Pressure Level (SPL)_{peak} National Oceanic and Atmospheric Administration (NOAA) (National Marine Fisheries Service (NMFS) 2018) and Southall et al. (2019) threshold criteria (**Table 11.32.** of **Chapter 11 Marine Mammals** in the ES).
445. The PTS SPL_{peak} criteria and maximum impact range is the most appropriate to use for the MMMP. As outlined in **Appendix 11.4** of the ES, peak SPLs are often used to characterise sound transients from impulsive sources and represents the maximum change in positive pressure (differential pressure from positive to zero) as the transient pressure wave propagates. However, SPL_{peak} noise levels over larger distances are difficult to predict accurately (von Benda-Beckmann et al. 2015), therefore at longer ranges, greater confidence is expected with the calculations using Sound Exposure Levels (SELs).
446. For the PTS SEL_{cum} ranges, it is important to note that an impulsive wave tends to be smoothed (i.e. the pulse becomes longer) over distance (Cudahy and Parvin 2001) and the injurious potential of a wave at greater range can be even lower than just a reduction in the absolute noise level. The smoothing of the pulse at range means that technically it develops into a 'non-pulse' of the order of 2km to 5km. This range is still to be formally determined and agreed for use in noise modelling and will be different depending on the noise source and

conditions. The SEL_{cum} ranges, also do not take into account the position of the animal in the water column. Therefore, not all animals within the maximum SEL_{cum} range would be at risk of PTS.

447. Mitigation for East Anglia ONE windfarm consisted of a mitigation zone of 500m around each individual piling location, each piling event commenced with a soft-start of at least 20 minutes and an ADD was activated for 15-30 minutes immediately prior to the soft-start to actively deter marine mammals from the mitigation zone (SPR 2017a). During daylight hours MMOs conducted a dedicated pre-piling watch of the mitigation zone for a minimum of 30 minutes prior to the commencement of soft-start piling. At night and during periods of poor visibility pre-piling monitoring was undertaken by a PAM Operator using a PAM system. The three dedicated dual role MMOs / PAM Operators undertook visual observations and acoustic monitoring for marine mammals during the installation of 102 three legged jacket foundations between the 25th April 2018 and the 30th January 2019. There were 675 hours and 38 minutes of visual observations and 880 hours and 46 minutes of acoustic monitoring conducted throughout the survey. During this time there were only three marine animal sightings, two of which were while the vessel was in transit and the other was on site and resulted in a delay to soft-start operations. No acoustic detections were made. This indicates that the mitigation implemented during piling at the East Anglia ONE windfarm was effective and there was no risk of physical or auditory injury to marine mammals.
448. The methods for achieving the mitigation zone would be agreed with the MMO in consultation with the relevant SNCBs and secured as commitments within the MMMP for piling. A combined draft MMMP has been submitted with the DCO Application (document reference 8.14) for both UXO clearance and piling, however, two separate MMMPs, one for piling and one for UXO clearance will be prepared in-consultation with the relevant SNCBs during the pre-construction period.

5.2.2.3.2 MMMP for Unexploded Ordnance (UXO) Clearance

449. 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, in consultation with the MMO and relevant SNCBs.
450. The MMMP for UXO clearance will involve the establishment of a suitable mitigation zone around the UXO location before any detonation. The Applicant

will implement mitigation measures considered adequate to exclude marine mammals from within the mitigation zone prior to any UXO detonation, to reduce the risk of any physical or permanent auditory injury (PTS).

451. The MMMP for UXO clearance will include details of all the required mitigation measures to minimise the potential risk of physical and auditory injury (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:

- All detonations taking place in daylight.
- The controlled explosions of the UXO, undertaken by specialist contractors, using the minimum amount of explosives required in order to achieve safe disposal of the device.
- Consideration of any commercially available alternative (e.g. Low Order deflagration).
- Monitoring of the mitigation zone by marine mammal observers (MMOs) during daylight hours and when conditions allow suitable visibility, pre- and post-detonation.
- Deployment of passive acoustic monitoring (PAM) devices, if required and if the equipment can be safely deployed and retrieved.
- The activation of acoustic deterrent devices (ADDs).
- If required and where possible and safe to do so, a soft-start procedure using scare charges.
- The sequencing of detonations, if there are multiple UXO in close proximity to be disposed of near simultaneously, where practicable, will start with the smallest detonation and end with the larger detonations.

452. The final MMMP for UXO clearance will detail what is required for all agreed mitigation measures to ensure that they are successfully undertaken, including if marine mammals are observed in the mitigation zone. As noted above, a combined draft MMMP has been submitted with the DCO Application (document reference 8.14) for both piling and UXO clearance, however, two separate MMMPs, one for UXO clearance and one for piling will be prepared in consultation with the relevant SNCBs during the pre-construction period.

5.2.2.3.3 Site Integrity Plan

453. The designation of the Southern North Sea (SNS) candidate Special Area of Conservation (cSAC) was approved by the European Commission to be designated as a Site of Community Importance (SCI) in 2017 and has further

been formally designated by the UK government as a Special Area of Conservation (SAC) and is therefore referred throughout as the SNS SAC.

454. The draft HRA undertaken by the Secretary of State for Business Energy and Industrial Strategy (BEIS) for the Review of Consents (RoC) process for the SNS SAC (BEIS 2018) proposes that each project develops a Site Integrity Plan (SIP). The SIP would set out the approach to deliver any project mitigation or management measures in relation to the SNS SAC for harbour porpoise.
455. Any SIP would be in addition to the MMMPs for piling and UXO clearance. A combined In principle SNS SIP has been submitted with the DCO Application (document reference 8.17) for both UXO clearance and piling, however, two separate SIPs, one for piling and one for UXO clearance will be prepared in consultation with the relevant SNCBs during the pre-construction period.

5.3 Southern North Sea SAC

456. The majority of the SNS SAC is less than 40m in depth, reaching up to 75m in the northern most areas. The seabed is mainly sublittoral sand and sublittoral coarse sediment (JNCC 2017a). The site overlaps with a number of existing Natura 2000 sites, including the Dogger Bank SAC, Margate and Long Sands SAC, Haisborough, Hammond and Winterton SAC and North Norfolk Sandbanks and Saturn Reef SAC, all of which have important sandbank and gravel beds.
457. The SNS SAC has been recognised as an area with persistent high densities of harbour porpoise (JNCC 2017b). The SNS SAC has a surface area of 36,715km² and covers both winter and summer habitats of importance to harbour porpoise, with approximately 27,018km² of the site being important in the summer and 12,697km² of the site being important in the winter period (**Figure 11**; JNCC 2017b).
458. The SNS SAC Site Selection Report (JNCC 2017b) 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 2017b). However, JNCC (2017b) 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 2017b).
459. The Statutory Nature Conservation Bodies (SNCBs) current advice on the assessment of impacts on the SNS harbour porpoise SAC is that:
- A distance of 26km (an Effective Deterrent Radius (EDR)) from an individual percussive piling location should be used to assess the area of SNS SAC

habitat which harbour porpoise may be disturbed from during piling operations (noting previous references made during industry workshops to the potential for a reduction in this measure, where project specifics allow).

- Displacement of harbour porpoise should not exceed 20% of the seasonal component of the SNS SAC at any one time and or on average exceed 10% of the seasonal component of the SNS SAC over the duration of that season.
- The effect of the project should be considered in the context of the seasonal components of the SNS SAC, rather than the SNS SAC as a whole.
- A buffer of 10km around seismic operations by the oil and gas industry and 26km around UXO detonations should be used to assess the area of SAC habitat from which harbour porpoise may be disturbed.

460. The SNCBs also advise the planned approach to in-combination assessment to consider the following:

- Inclusion of seismic surveys by the oil and gas industry within 10km of the SNS SAC;
- Inclusion of projects undertaking percussive piling within 26km from the SNS SAC boundary (or relevant seasonal component); and
- Inclusion of UXO detonation within 26km of the SNS SAC.

461. This latest SNCB advice has been used in the assessments for the HRA. Guidance on managing noise disturbance within the SNS SAC is currently under review and subject to change.

462. It should be noted that this assessment is based on the potential impacts for seismic surveys required by the oil and gas industry. Geophysical surveys conducted for offshore wind farms generally use multi-beam surveys in shallow waters. Therefore, the higher frequencies typically used fall outside the hearing frequencies of cetaceans and the sounds produced are likely to attenuate more quickly than the lower frequencies used in deeper waters (JNCC 2017e). JNCC (2017e) do not, therefore, advise that mitigation is required for multi-beam surveys in shallow waters as there is no risk to EPS in relation to deliberate injury or disturbance offences.

463. The draft HRA for the SNS SAC RoC (BEIS 2018) undertook underwater noise modelling to determine the potential impact ranges of geophysical surveys for harbour porpoise. The assessment used the maximum source levels that could be expected from geophysical equipment: sub-bottom profilers, with a maximum source noise level of 267 dB re 1 μ Pa-m. The noise modelling indicates that the onset of PTS in harbour porpoise could occur within a maximum range of 23m (an area of 0.0017km²) from the source location (BEIS, 2018) for the PTS

cumulative threshold of 155dB SEL weighted (NMFS 2018). For possible behavioural disturbance of harbour porpoise, based on a threshold of 140 dB re 1 μ Pa SPL unweighted the maximum range was 3.77km (44.65km²) (BEIS 2018).

464. The potential disturbance of harbour porpoise during offshore windfarm construction has been assessed based on the disturbance during piling and for other construction activities, therefore the potential for any disturbance during any geophysical surveys at these sites has already been taken into account (i.e. the areas of potential disturbance has already been included and covered as part of these assessments).

5.3.1 Conservation Objectives

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

466. The Conservation Objectives for the site are (JNCC and Natural England 2019):

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 the 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.*

Conservation Objective 1: Harbour porpoise is a viable component of the site

467. The intent of this Conservation Objective is to minimise the risk of injury and killing or other factors that could restrict the survivability and reproductive potential of harbour porpoise within the site. Specifically, this objective is concerned with operations within the site that would result in unacceptable levels of impact upon individuals using the site. Unacceptable levels are defined as those that would have an impact upon the FCS of the population. The Conservation Objectives 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 (IAMMWG 2015)'*.

468. Harbour porpoise are considered to a *viable component of the site* if they are able to live successfully within it. As this SAC has been selected primarily for its long

term preferential use by harbour porpoise in contrast with other areas of the North Sea, with the implication being that it provides relatively good habitat for foraging, and may also be used for breeding and calving (JNCC and Natural England 2019).

469. 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. Within the UK, The Habitats Directive is enacted through The Habitats Regulations 2017. Under these Regulations, it is deemed 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.

470. The term *deliberate* is defined as any action that is shown to be any action ‘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’.

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

471. Disturbance of harbour porpoise typically originated from operations that cause underwater noise including seismic surveys by the oil and gas industry, pile driving and sonar. Responses to noise can be physiological and/or behavioural, however, disturbance is primarily a behavioural response to noise and may lead to harbour porpoise being displaced from the affected area. Therefore, operations within or affecting the site should be managed to ensure that any individuals’ potential usage of the site is maintained.

472. 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. Draft SNCB guidance for assessing the significance of noise disturbance to a site suggests:

“Noise disturbance within an SAC from a plan/project individually or in combination is significant if it excludes harbour porpoise from more than:

1. 20% of the relevant area of the site in any given day, and

2. an average of 10% of the relevant area of the site over a season”.

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

473. Within this Conservation Objective, supporting habitats relates to the characteristics of the seabed and water column, and supporting processes encompass the movements and physical properties of the habitat. The maintenance of supporting habitats and processes contributes to ensuring that prey is maintained and available to individuals within the site. Harbour porpoise are strongly reliant on the availability of prey species due to their high energy demands, and are highly dependent on being able to access prey species year-round. The densities of harbour porpoise within a site are therefore highly dependant on the availability of key prey species.
474. 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.

5.3.2 Management Measures

475. Specific management measures are yet to be developed for the SNS SAC, however JNCC and Natural England (2016) 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'*.
476. JNCC and Natural England (2016) also state that *'management measures are the responsibility of the relevant regulatory bodies, which consider the SNCBs' advice and hold appropriate discussions with the sector concerned, but the scale and type of mitigation is decided by the Regulators'*.

5.3.3 Advice on Activities

477. JNCC and Natural England (2019) have provided advice on activities that specifically occur within or near to the SNS SAC site that could be expected to impact on the site's integrity. The key impacts and activities that JNCC and Natural England (2019) consider to have the greatest impact on the population of UK harbour porpoise and therefore the SNS SAC are:
- Commercial fisheries with by-catch of harbour porpoise;
 - Increased contaminants from discharge / run-off from land fill, terrestrial and offshore industries;
 - Increased anthropogenic underwater noise from shipping, drilling, dredging and disposal, aggregate extraction, pile driving, acoustic surveys, underwater

- explosion, military activity, acoustic deterrent devices and recreational boating;
- Death or injury by collision with, shipping, recreational boating and tidal energy installations; and
 - Reduction in prey resources by commercial fisheries.
478. The aim is that the advice should help identify the extent to which existing activities are, or can be made, consistent with the Conservation Objectives, and thereby focus the attention of Relevant and Competent Authorities and surveillance programmes to areas that may need management measures (JNCC and Natural England 2019).
479. For the purposes of this assessment, the potential effects are considered in relation to the SNS SAC Conservation Objectives; as outlined in **Table 5.2**.

Table 5.2 Potential effects of East Anglia TWO in relation to the Conservation Objectives for the Southern North Sea SAC

Conservation Objective	Potential Effect
Harbour porpoise is a viable component of the site	Lethal effects and permanent auditory injury from piling and the clearance of UXO will be mitigated and therefore there is no potential for LSE.
	Disturbance and displacement as a result of increased underwater noise levels (e.g. from UXO clearance, piling, other construction activities, vessels, operational and maintenance (OandM) noise, and noise associated with decommissioning works) have the potential to have an effect on the site and will be considered further.
	Increased collision risk with vessels during installation, operation and decommissioning has the potential to have an effect on the site and will be considered further.
There is no significant disturbance of the species	Significant disturbance and displacement as a result of increased underwater noise levels (e.g. from UXO clearance, piling, other construction activities, vessels, OandM noise, and noise associated with decommissioning phase works) have the potential to have an effect on the site and will be considered further.
The condition of supporting habitats and processes, and the availability of prey is maintained.	Changes in prey availability have potential to affect the site and will be considered further.

5.3.4 Harbour Porpoise Status and Ecology

480. The following sections provide a summary of information on the existing environment and designated site for harbour porpoise, relevant to the HRA. Further information is provided in the HRA screening (**Appendix 1**),

Environmental Statement (ES) **Chapter 11 Marine Mammals** and ES **Appendix 11.2**.

5.3.4.1 Density Estimates

5.3.4.1.1 SCANS-III

481. The offshore development area is in SCANS-III survey block L:

- The estimated abundance of harbour porpoise in SCANS-III survey block L is 19,064 harbour porpoise (CV = 0.38; 95% CI = 6,933-35,703), with an estimated density of 0.607 harbour porpoise/km² (CV = 0.38; Hammond et al. 2017).

5.3.4.1.2 East Anglia TWO Site Specific Surveys

482. A high resolution aerial digital still imagery was collected for marine mammals over the East Anglia TWO windfarm site with a 4km buffer (referred to as the marine mammal survey area). **Appendix 11.2** of the ES shows the location of the marine mammal survey area and further information on the analysis and interpretation of the survey results, including seasonal correction factors, is also provided in **Appendix 11.2** of the ES.

483. The information included in this assessment is based on 24 months of survey for the proposed East Anglia TWO project (November 2015 to April 2016, September 2016 to October 2017, and May to August 2018).

484. The annual mean density estimate when using the seasonal correction factors is 0.73/km² for the East Anglia TWO windfarm site. The density estimate during summer (April to September) is 0.45/km² and during the winter (October to March) the estimated density is 1.01/km² using the corrected densities.

485. The East Anglia TWO windfarm site density estimate of 0.73/km², based on the mean annual density and using the seasonal correction factors, has been used in the HRA (**Table 5.4**). Using the mean annual density allows for seasonal variation in the number of harbour porpoise that could be present.

486. The number of harbour porpoise is put into the context of the North Sea MU, therefore it is appropriate to base the assessments on the annual mean density estimates rather than the seasonal density estimates.

5.3.4.2 Reference Population

487. The reference population used in the assessment for harbour porpoise is the most up to date SCANS-III estimate of harbour porpoise abundance in the North Sea MU of 345,373 (CV = 0.18; 95% CI = 246,526-495,752; Hammond et al. 2017). The reference population for harbour porpoise (**Table 5.3**), was agreed with Natural England as part of the marine mammal ETG at the meeting on 6th March 2018.

Table 5.3 Harbour Porpoise Reference Population

Species	Reference Population Extent	Year of Estimate	Size	Data Source
Harbour porpoise	North Sea MU	2016	345,373 (CV = 0.18; 95% CI = 246,526-495,752)	SCANS-III (Hammond et al. 2017)

Table 5.4 Harbour Porpoise Density Estimates

Species	Density Estimate (number of individuals per km ²)	Data Source
Harbour porpoise	0.73/km ² for the East Anglia TWO windfarm site*	Site specific surveys (see ES Appendix 11.2)
	0.607/km ²	SCANS-III survey block L (Hammond et al. 2017)

5.3.4.3 Conservation Status

488. Member states report back to the EU every six years on the Favourable Conservation Status (FCS) of marine European Protected Species (EPS). The current conservation status of harbour porpoise is 'favourable' based on the 2007-2012 reporting (JNCC 2013).

5.3.5 Assessment of Potential Effects on Southern North Sea SAC

489. The potential effects during the construction, operation and decommissioning of the proposed East Anglia TWO project to be assessed as part of the HRA process for the SNS SAC have been agreed in consultation with the marine mammal ETG as part of the EPP.

490. The assessment has been based on the current SNCB advice outlined in **section 5.2.2**.

5.3.5.1 Potential Effects during Construction of East Anglia TWO (alone)

491. The potential effects during construction of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the site in relation to the Conservation Objectives are:

- Underwater noise associated with the clearance of UXO;
- Underwater noise during piling;
- Underwater noise during non-piling construction activities, for example, seabed preparation, rock dumping and cable installation;
- Underwater noise and disturbance from vessels;
- Barrier effects as a result of underwater noise associated with activities above;

- Vessel interaction (collision risk);
- Changes to prey resource; and
- Changes to water quality.

492. The worst-case scenario on which the assessment is based for harbour porpoise is outlined in **Table 5.1**.

5.3.5.1.1 Potential effects resulting from underwater noise associated with clearance of UXO at East Anglia TWO (alone)

493. There is the likely requirement for UXO clearance prior to construction. Whilst any underwater UXO that are identified would preferentially be avoided, it is necessary to consider the potential requirement for underwater UXO detonation where it is deemed unsafe to retrieve the UXO from the seafloor and avoidance is not possible.
494. A detailed UXO survey would be completed prior to construction. The exact number of possible detonations and duration of UXO clearance operations is therefore not known at this stage. It has been estimated, based on the UXO survey for East Anglia ONE (East Anglia ONE Limited 2017), that there could be up to 80 UXO within the offshore development area. As a worst-case scenario, it has been assumed that the maximum duration of UXO clearance would be 80 days, based on one UXO detonation per day.
495. Only one UXO at a time would be detonated during UXO clearance operation in the offshore development area; i.e. there would be no concurrent UXO detonations. Potentially more than one UXO detonation could occur in a 24 hour period. This would be secured through the MMMP and the SIP (see **section 5.2.2**).
496. A number of UXOs with a range of charge weights could be located within the offshore development area. As it is not currently known the size or type of the UXO that could be present, a selection of maximum explosive sizes has been considered in the estimation of the underwater noise levels produced by detonation of UXO, with the maximum charge weight of up to 700kg, based on the UXO survey for East Anglia ONE (East Anglia ONE Limited 2017) and assessment for Norfolk Vanguard (Norfolk Vanguard Limited 2018). As a worst-case scenario it has been assumed disturbance for one day per one UXO event, however, the actual duration of the noise will be only seconds or minutes.
497. The noise produced by the detonation of explosives is affected by a number of different elements (e.g. its design, composition, age, position, orientation, whether it is covered by sediment) which are unknown and cannot be directly considered in an assessment. This leads to a high degree of uncertainty in the

estimation of the source noise level (i.e. the noise level at the position of the UXO). A worst-case estimation has therefore been used for calculations, assuming that the UXO to be detonated is not buried, degraded or subject to any other significant attenuation. The consequence of this is that the noise levels produced, particularly by the larger explosives under consideration, are likely to be over-estimated as they are likely to be covered by sediment and degraded.

498. The assessment also does not take into account the variation in the noise level at different depths. Where animals are swimming near the surface, the acoustics at the surface cause the noise level, and hence the exposure, to be lower at this position (Marine Technical Directorate (MTD) 1996). The risk to animals near the surface may therefore be lower than indicated by the range estimate and therefore this can be considered conservative in respect of impact at different depths.
499. The impact criteria use thresholds and weightings based on the National Oceanic and Atmospheric Administration (NOAA) (National Marine Fisheries Services (NMFS) 2018) criteria (**Table 5.5**). The thresholds indicate the onset of Permanent Threshold Shift (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). These indicators do not take into account the spreading of underwater sound over long distances, and thus there is a greater likelihood of accuracy where the ranges are small.

5.3.5.1.1.1 Risk of permanent auditory injury during UXO clearance

500. Underwater noise modelling (**Appendix 11.4** of the ES) has been undertaken to estimate the potential impact ranges for marine mammals likely to arise during UXO clearance, based on the maximum UXO charge sizes that could be located at East Anglia TWO (**Table 5.5**). The maximum number of harbour porpoise that could potentially be at increased risk of permanent auditory injury (PTS) has been estimated, based on the maximum potential impact ranges for UXO clearance of the maximum potential charge size (**Table 5.5**).
501. Peak noise levels are difficult to predict accurately in a shallow water environment (von Benda Beckmann et al. 2015) and would tend to be significantly over-estimated by the modelling over increased distances from the source. With increased distance from the source, impulsive noise, such as UXO detonation, noise becomes more of a non-impulsive noise, unfortunately it is currently difficult to determine the distance at which an impulsive noise becomes more like a non-impulsive noise. Therefore, modelling was conducted using both the impulsive and non-impulsive criteria for PTS weighted Sound Exposure Levels (SEL) to give an indication of the difference between maximum potential impact ranges.

502. Impulsive noise sources are described as having a rapid rise time, short duration and high peak pressure. A study into the distance at which underwater noise sources (from offshore windfarm piling and seismic surveys) 'transformed' from an impulsive to a non-impulsive noise revealed that, at a distance of between 2 and 3km the noise sources no longer contained the characteristics (in particular a high enough peak pressure) to be classed as an impulsive noise (Hastie et al. 2019). However, this study was completed in a shallow water environment, with a relatively flat seabed, and the actual range at which a sound source transforms into a non-impulsive noise is likely to be dependent on a number of environmental variables and other sound source characteristics (Hastie et al. 2019).
503. As outlined in **Appendix 11.4** of the ES, it is suggested that, for any injury ranges calculated using the impulsive criteria in excess of 5km, the non-pulse criteria should be considered more appropriate.

Table 5.5 Potential Effects of Permanent Auditory Injury (PTS) on Harbour Porpoise during UXO Clearance without Mitigation

Potential effect	Criteria threshold	Possible maximum charge weight			
		200kg	300kg	500kg	700kg
		Maximum predicted impact range (km) and area* (km ²)			
Permanent auditory injury (PTS) – without mitigation	SPL _{peak} unweighted (NMFS 2018) 202 dB re 1 µPa Impulsive criteria	7.8km (191km ²)	8.8km (243km ²)	10.2km (327km ²)	11.1km (387km ²)
	SEL weighted (NMFS 2018) 155 dB re 1 µPa ² s Impulsive criteria	2.1km (14km ²)	2.5km (20km ²)	3.1km (30km ²)	3.6km (41km ²)
	SEL weighted (NMFS 2018) 173 dB re 1 µPa ² s Non-impulsive criteria	0.093km (0.03km ²)	0.11km (0.04km ²)	0.14km (0.06km ²)	0.17km (0.09km ²)
Maximum number of harbour porpoise and % of reference population based on maximum impact area* (387km ²) for PTS unweighted SPL _{peak}		235 harbour porpoise (0.07% of NS MU) based on SCANS-III survey density (0.607/km ²). 283 harbour porpoise (0.08% of NS MU) based on site specific survey density (0.73/km ²) at EA2.			
Number of harbour porpoise and % of reference population based on maximum impact area* (0.09-		0.05-25 harbour porpoise (0.00002-0.007% of NS MU) based on SCANS-III survey density (0.607/km ²).			

Potential effect	Criteria threshold	Possible maximum charge weight			
		200kg	300kg	500kg	700kg
		Maximum predicted impact range (km) and area* (km ²)			
41km ²) for PTS weighted SEL impulsive and non-impulsive criteria		0.07-30 harbour porpoise (0.00002-0.009% of NS MU) based on site specific survey density (0.73/km ²) at EA2.			

*Maximum area based on area of circle with maximum impact range for radius as worst-case scenario.

Mitigation

504. 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 (PTS) 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, in consultation with the MMO and relevant SNCBs.
505. The MMMP for UXO clearance will involve the establishment of a suitable mitigation zone around the UXO location before any detonation. The Applicant will implement mitigation measures considered adequate to exclude marine mammals from within the mitigation zone prior to any UXO detonation, to reduce the risk of any physical or permanent auditory injury (PTS) to negligible levels.
506. Details of the MMMP for UXO clearance are given in **section 5.2.2.3.2**.
507. The final MMMP for UXO clearance will detail what is required for all agreed mitigation measures to ensure that they are successfully undertaken, including if marine mammals are observed in the mitigation zone. A combined draft MMMP has been submitted with the DCO Application (Document 15) for both piling and UXO clearance. However, two separate MMMPs, one for UXO clearance and one for piling will be prepared in-consultation with the relevant SNCBs during the pre-construction period.
508. The effective implementation of the UXO MMMP will reduce the risk of permanent auditory injury (PTS) to harbour porpoise to negligible levels during any underwater detonations at East Anglia TWO (alone), therefore, there would be **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.1.1.2 Potential disturbance during UXO clearance

509. Although implementation of mitigation measure in the MMMP for UXO clearance will increase the distance of harbour porpoise from any UXO detonations, it cannot mitigate the potential disturbance to harbour porpoise.

Spatial assessment

510. The current SNCBs recommendation is that an EDR of 26km (approximate area of 2,124km²) around UXO detonations is used to assess the area that harbour porpoise could be disturbed in the SNS SAC. This approach has been used in this assessment, taking into account the potential maximum and average area of possible disturbance of harbour porpoise from the SNS SAC seasonal areas, based on the worst-case scenario for UXO clearance at East Anglia TWO (**Table 5.6**).

511. Only one UXO at a time would be detonated during UXO clearance operation in the offshore development area; i.e. there would be no simultaneous UXO detonations. Potentially more than one UXO detonation could occur in a 24 hour period. This would be secured through the MMMP and the SIP (see **section 5.2.2**).

512. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time during UXO clearance at East Anglia TWO (alone), based on the worst-case scenario (**Table 5.6**). Therefore, under these circumstances, **there is no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Table 5.6 Estimated Area of SNS SAC Winter and Summer Areas that Harbour Porpoise Could Potentially be Disturbed from During UXO Clearance at East Anglia TWO

UXO clearance	Maximum potential overlap with SNS SAC	Minimum potential overlap with SNS SAC	Average potential overlap with SNS SAC	Potential adverse effect on site integrity
UXO detonation in East Anglia TWO offshore development area	2,124km ² (approximately 16%) in the winter area 45km ² (approximately 0.2%) in the summer area	2,042km ² (approximately 15%) in the winter area 0km ² (approximately 0%) in the summer area	2,083km ² (approximately 16%) in the winter area 23km ² (approximately 0.09%) in the summer area	No Temporary effect. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time during any UXO clearance at East Anglia TWO

UXO clearance	Maximum potential overlap with SNS SAC	Minimum potential overlap with SNS SAC	Average potential overlap with SNS SAC	Potential adverse effect on site integrity
				(alone), based on the worst-case scenario.

Seasonal averages

513. Disturbance from any UXO detonations would be temporary and for a short-duration (i.e. the detonation). For the estimated worst-case it is predicted that there could be up to 80 clearance operations in the offshore development area. As a precautionary worst-case scenario, the maximum number of days of UXO clearance could be up to 80 days, based on one detonation per day within the overall UXO clearance operation, which could be conducted over several months.
514. The seasonal averages have been calculated by multiplying the average of the minimum and maximum effect on any one day by the proportion of days within the season on which UXO clearance could occur (i.e. taking into account the average area of overlap with SAC seasonal areas and number of UXO clearance days per season). The seasonal averages have been based on the worst-case scenario that all detonations could occur in the same season. The summer season is assumed to be 183 days (April-September) and the winter season is assumed to be 182 days (October-March).
515. The assessment indicates, less than 10% (approximately 7%) of the seasonal component of the SNS SAC over the duration of that season could be affected during any UXO clearance at East Anglia TWO offshore development area (alone), based on the worst-case scenario of one detonation per day for 80 days in one season and maximum overlap (2,124km²) (**Table 5.7**). Therefore, under these circumstances, there would be **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.
516. Based on a more realistic, but precautionary scenario that there could be up to two detonations per day (e.g. in a 12 hour period based on average daylight hours), the maximum number of days of UXO clearance would be 40 days. The assessment indicates, less than 10% (approximately 3.5%) of the seasonal component of the SNS SAC over the duration of that season could be affected during UXO clearance in the offshore development area (alone), based on two detonations per day for 40 days in one season and maximum overlap (2,124km²) (**Table 5.7**). Therefore, under these circumstances, there would be **no significant disturbance and no potential adverse effect on the integrity of**

the SNS SAC in relation to the conservation objectives for harbour porpoise.

Table 5.7 Estimated Seasonal Area Averages for the SNS SAC Winter and Summer Areas during UXO Clearance at East Anglia TWO

UXO clearance	Number of UXO clearance days per season	Average area within SNS SAC seasonal areas	Estimated seasonal area average	Potential adverse effect on site integrity
UXO detonations in the offshore development area	One detonation per day			No
	80 days	Winter area = 16% Summer area = 0.2%	Winter area = 7% Summer area = 0.09%	Temporary effect. Disturbance of harbour porpoise would not exceed 10% of the seasonal component of the SNS SAC over the duration of that season during any UXO clearance at East Anglia TWO (alone)
	Two detonations per day			
	40 days	Winter area = 16% Summer area = 0.2%	Winter area = 3.5% Summer area = 0.04%	

Assessment in relation to the North Sea Management Unit

517. The estimated number of harbour porpoise that could be disturbed during underwater UXO clearance in the offshore development area, based on the SNCBs current recommendation of a disturbance range of 26km, is presented in **Table 5.8**.
518. As outlined above, only one UXO would be detonated at a time during UXO clearance operations in the offshore development area (i.e. there would be no concurrent UXO detonations, but potentially more than one UXO detonation could occur in a 24 hour period, with UXO detonations occurring sequentially).
519. The assessment indicates that without mitigation, 0.5% or less of the North Sea MU reference population could be temporarily disturbed during any UXO clearance at East Anglia TWO offshore development area (alone), based on the worst-case scenario (**Table 5.8**). Therefore, under these circumstances, **there is no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Table 5.8 Estimated Number of Harbour Porpoise Potentially Disturbed during UXO Clearance at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2,124km ²) during underwater UXO clearance - based on 26km	1,289 harbour porpoise based on SCANS-III density (0.607/km ²). 1,551 harbour porpoise based on site specific survey density (0.73/km ²).	0.4% of NS MU (345,373 harbour porpoise) based on SCANS-III density. 0.5% of NS MU based on the site specific survey density.	No Temporary effect. 0.5% or less of the reference population could be temporarily disturbed during any UXO clearance at East Anglia TWO (alone), based on the worst-case scenario.

5.3.5.1.2 Potential effects resulting from underwater noise during piling at East Anglia TWO (alone)

520. A range of foundation options are being considered for the proposed East Anglia TWO project, including monopile, jacket (pin-piles), jacket (on suction caissons), gravity base and suction caisson. 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 would be hammer piled, using the maximum hammer energy to be applied and pile diameter for the maximum potential duration to install (**Table 5.1**).

5.3.5.1.2.1 Risk of permanent auditory injury during piling

521. Underwater noise modelling has been undertaken to estimate the maximum potential impact ranges for underwater noise that could arise during construction of East Anglia TWO (**Appendix 11.4** of the ES) and determine the potential effects on harbour porpoise. The modelling has been based on the worst-case scenarios for:

- Monopile up to 15m diameter with maximum hammer energy applied of 4,000kJ and starting hammer energy of 10% maximum hammer energy (400kJ); and
- Pin-piles up to 4.6m diameter with maximum hammer energy applied of 2,400kJ and starting hammer energy of 10% maximum hammer energy (240kJ).

522. The underwater noise modelling results for the maximum predicted ranges (and areas) for permanent auditory injury (PTS) in harbour porpoise, based on the NOAA (NMFS 2018) criteria for unweighted peak sound pressure levels (SPL_{peak}) and PTS from weighted sound exposure levels (SEL), which take into account

the species hearing sensitivity, for single strike (SEL_{ss}) and cumulative exposure (SEL_{cum}) are presented in **Table 5.9**.

523. Without any mitigation, the estimated maximum number of harbour porpoise that could potentially be at risk of PTS (SPL_{peak}) as a result of a single strike of the maximum monopile hammer energy applied of 4,000kJ is 3.4 individuals (0.00097% of the North Sea MU reference population), based on the site specific density for East Anglia TWO (0.73 harbour porpoise per km²).
524. The indicative maximum number of harbour porpoise that could potentially be at risk of PTS from cumulative SEL as a result of installation using the maximum monopile hammer energy applied of 4,000kJ, including the soft-start and ramp-up is up to 70.1 individuals (0.02% of the North Sea MU reference population), based on the site specific density for East Anglia TWO. As a result of the maximum pin-pile hammer energy applied of 2,400kJ, the estimated maximum number of harbour porpoise that could potentially be at risk of PTS from cumulative SEL is up to 708 harbour porpoise (up to 0.21% of the North Sea MU reference population), based on the site specific density for East Anglia TWO (**Table 5.9**).
525. It is important to note that the predicted impact range for the SEL_{cum} for pin-piles is based on the worst case scenario. The modelling and assessments will be updated for the MMMP prior to construction taking into account the pin-pile installation requirements, such as soft-start and ramp-up duration, overall installation for single pin-pile and four pin-piles.
526. It should be noted that assessment for PTS from cumulative exposure is highly precautionary for the following reasons:
- The maximum impact ranges, based on the worst case exposure levels an animal may receive at different depths in the water column, have been used in the assessment, this is highly conservative as it is unlikely a marine mammal would remain at this depth level;
 - The location used within the modelling is for the worst case water depth, with the worst case surrounding bathymetry, which is unrealistic to the majority of the site (for example, the maximum predicted impact range for PTS SEL_{cum} for monopile with maximum hammer energy of 4,000kJ is 6.4km, with a minimum range of 4.6km and mean range of 5.5km for the worst case location. At the average depth location, the maximum predicted impact range is 5.4km, with a minimum range of 3.5km and mean range of 4.6km);
 - The maximum hammer energy expected to be applied has been used within the modelling, which will not be required at all locations across the site;

- o For example, the East Anglia ONE Offshore Windfarm piling logs for the first four jacket foundations indicate that the maximum hammer energy used was 935kJ, 52% of the potential maximum hammer energy of 1,800kJ. The average hammer energy used over these first four jacket foundations was 787kJ, only 44% of the potential maximum hammer energy of 1,800kJ (East Anglia ONE Ltd, 2019). This pattern is also shown for the remainder of the piling logs, with 74% of all the piled foundations using less than 50% of the 1,800kJ maximum hammer energy (less than 900kJ) and the remaining 26% of the piled foundations using between 50 and 63% of the 1,800kJ maximum hammer energy (up to 1,132kJ), with the actual maximum hammer of 1,132kJ only used for one pile location (unpublished, taken from the Actual Pile Driving Energies Technical Note for East Anglia ONE Offshore Windfarm).
- The assessment does not take account of periods where exposure will be reduced when they are at the surface or heads are out of the water; and
- The cumulative noise dose received by the marine mammal will be largely dependent on the swimming speed, and whether the animal moves away from the noise source rapidly as a flee response. For the SEL_{cum} noise modelling the swim speed of 1.5m/s used is highly conservative and therefore this is likely to overestimate the received noise levels.

Table 5.9 Maximum Predicted Impact Ranges (and Areas) for Permanent Auditory Injury (PTS) for Harbour Porpoise from a Single Strike and from Cumulative Exposure during Piling at East Anglia TWO based on NOAA (NMFS 2018) Criteria

Potential effect	Criteria threshold	Maximum predicted impact range (km) and area* (km ²)			
		Monopile with starting hammer energy of 400kJ	Monopile with maximum hammer energy of 4,000kJ	Pin-pile with starting hammer energy of 240kJ	Pin-pile with maximum hammer energy of 2,400kJ
PTS without mitigation – single strike	NMFS (2018) unweighted SPL _{peak} 202 dB re 1 µPa	0.58km (1km ²)	1.2km (4.6km ²)	0.38km (0.45km ²)	1.2km (4.1km ²)
Number of harbour porpoise and % of reference population based on maximum impact area (4.6km ²) for PTS unweighted SPL _{peak}		2.8 harbour porpoise (0.0008% of NS MU) based on SCANS-III survey density (0.607/km ²). 3.4 harbour porpoise (0.00097% of NS MU) based on site specific survey density (0.73/km ²).			

Potential effect	Criteria threshold	Maximum predicted impact range (km) and area* (km ²)			
		Monopile with starting hammer energy of 400kJ	Monopile with maximum hammer energy of 4,000kJ	Pin-pile with starting hammer energy of 240kJ	Pin-pile with maximum hammer energy of 2,400kJ
PTS without mitigation – single strike	NMFS (2018) SEL _{ss} weighted 155 dB re 1 µPa ² s	<0.05km (<0.01km ²)	0.07km (0.02km ²)	0.13km (0.05km ²)	0.4km (0.5km ²)
Number of harbour porpoise and % of reference population based on maximum impact area (0.5km ²) for PTS weighted SEL _{ss}		0.3 harbour porpoise (0.00009% of NS MU) based on SCANS-III survey density (0.607/km ²). 0.4 harbour porpoise (0.0001% of NS MU) based on site specific survey density (0.73/km ²).			
PTS from cumulative SEL (including soft-start and ramp-up)	NMFS (2018) SEL _{cum} weighted 155 dB re 1 µPa ² s	N/A	6.4km (96km ²)	N/A	21km (970km ²)
Number of harbour porpoise and % of reference population based on maximum impact area (970km ²) for PTS weighted SEL _{cum}		589 harbour porpoise (0.17% of NS MU) based on SCANS-III survey density (0.607/km ²). 708 harbour porpoise (0.21% of NS MU) based on site specific survey density (0.73/km ²).			

*areas for maximum hammer energies for monopile and pin-pile based on modelled contour area; area for starting hammer energy based on precautionary area of circle with maximum impact range as radius

Mitigation

527. The MMMP for piling will be developed pre-construction in consultation with the MMO and relevant SNCBs and will be based on the best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will detail the proposed mitigation measures to reduce the risk of permanent auditory injury (PTS) to harbour porpoise during piling.
528. The MMMP for piling will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the mitigation zone and any additional mitigation measures required to minimise potential impacts of any physical or

- permanent auditory injury (PTS), for example, the activation of acoustic deterrent devices (ADDs) prior to the soft-start.
529. The MMMP for piling will involve the establishment of a suitable mitigation zone around the piling location before piling commences. The Applicant will implement mitigation measures considered adequate to exclude marine mammals from within the mitigation zone prior to piling, to reduce the risk of any permanent auditory injury (PTS).
530. The methods for achieving the mitigation zone would be agreed with the MMO in consultation with the relevant SNCBs and secured as commitments within the MMMP for piling. A combined draft MMMP has been submitted with the DCO Application (document reference 8.14) for both UXO clearance and piling, however, two separate MMMPs, one for piling and one for UXO clearance will be prepared in-consultation with the relevant SNCBs during the pre-construction period.
531. An example of possible mitigation measures is the activation of ADDs for up to 10 minutes prior to the 30 minute soft-start and ramp-up. The activation of ADDs for example, for up to 10 minutes prior to the soft-start would allow harbour porpoise to move at least 0.9km from the piling location (based on a precautionary average swimming speed of 1.5m/s; Otani et al. 2000), which is beyond the maximum PTS predicted impact range of 0.58km for the starting hammer energy of 400kJ (**Table 5.9**).
532. The example of mitigation for up to 10 minutes ADD activation, 10 minute soft-start and 20 minute ramp-up would enable harbour porpoise to move at least 3.6km from the piling location (2.7km during the 30 minute soft-start and ramp-up plus 0.9km during the example ADD activation for 10 minutes, based on a precautionary average marine mammal swimming speed of 1.5m/s). This would therefore be greater than the maximum predicted distance of 1.2km for PTS from a single strike at the maximum hammer energy applied for monopiles of 4,000kJ, based on the unweighted SPL_{peak} NOAA (NMFS 2018) criteria (**Table 5.9**).
533. For the PTS SEL_{cum} ranges, it is important to note, as previously outlined, that an impulsive wave tends to be smoothed (i.e. the pulse becomes longer) over distance (see **Appendix 11.4** of the ES) and the injurious potential of a wave at greater range can be even lower than just a reduction in the absolute noise level. The smoothing of the pulse at range means that technically it develops into a 'non-pulse' of the order of 2km to 5km. A study into the distance at which underwater noise sources (from offshore windfarm piling and seismic surveys) 'transformed' from an impulsive to a non-impulsive noise revealed that, at a distance of between 2 and 3km the noise sources no longer contained the characteristics (in particular a high enough peak pressure) to be classed as an

impulsive noise (Hastie et al. 2019). This range is still to be formally determined and agreed for use in noise modelling and will be different depending on the noise source and conditions. The SEL_{cum} ranges, also do not take into account the position of the animal in the water column. Where possible, this will be considered when determining the required mitigation zone.

534. In addition, Brandt et al. (2018) found that at seven German offshore wind farms in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. This disturbance of harbour porpoise from the area around the construction site prior to piling would also reduce the risk of PTS.
535. The MMMP for piling will reduce the risk of permanent auditory injury to harbour porpoise as a result of underwater noise during piling at East Anglia TWO (alone) to negligible levels, therefore, there would be **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.
536. Although the proposed mitigation will increase the distance of harbour porpoise from the piling location, it cannot mitigate the potential disturbance to harbour porpoise.

5.3.5.1.2.2 Potential disturbance during proposed mitigation

537. During the implementation of the proposed mitigation, for example the activation of ADDs for up to 10 minutes it is estimated that animals would move 0.9km (based on a precautionary average marine mammal swimming speed of 1.5m/s), a potential disturbance area of 2.54km². This is approximately 0.02% of the winter SNS SAC area (12,697km²), where the East Anglia TWO windfarm site is located (**Figure 11**). Therefore, disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SAC at any one time. Based on an unrealistic worst-case scenario of ADD activation every day throughout the season, the estimated seasonal average disturbance would be 0.02%. This would not exceed the average 10% of the seasonal component of the SNS SAC over the duration of that season as a result of the example ADD activation before piling at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.
538. The number of harbour porpoise that could potentially be disturbed as a result of the proposed mitigation, for example the activation of ADDs for up to 10 minutes, would be up to 1.9 individuals (0.0005% of the NS MU reference population), based on the site specific density for East Anglia TWO (0.73 harbour porpoise

per km²). The assessment indicates that up to 0.0005% of the NS MU reference population could be temporarily affected as a result of the example ADD activation before piling at East Anglia TWO (alone). Therefore, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

539. The potential ADD activation, based on up to 10 minutes per pile, would be up to 57.3 hours (approximately 2.4 days) for up to 344 pin-piles for wind turbines and platforms (**Table 5.1**).
540. It should be noted that the disturbance of harbour porpoise as a result of the example ADD activation prior to piling would be part of the 26km disturbance range for piling and is therefore not an additive effect to the overall area of potential disturbance. However, the duration of the example ADD activation prior to piling has been taken into account, in the assessment of the duration of potential disturbance for piling.

5.3.5.1.2.3 Potential disturbance during piling

Spatial assessment

541. The current SNCBs recommendation is that an EDR of 26km (approximate area of 2,124km²) around pile locations is used to assess the area that harbour porpoise could be disturbed in the SNS SAC. This approach has been used in this assessment, taking into account the potential maximum and average area of possible disturbance of harbour porpoise from the SNS SAC seasonal areas, based on the worst-case scenario for underwater noise during piling at East Anglia TWO (**Table 5.10**).
542. There will be no concurrent piling at the East Anglia TWO windfarm site (i.e. only one pile will be installed at a time, with no overlap in the piling duration of any two piles). Piles will be installed sequentially, and more than one pile could be installed in a single 24 hour period). Therefore, the potential effects have been assessed for single pile installation only.
543. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time during piling at East Anglia TWO (alone), based on the worst-case scenario (**Table 5.10**). Therefore, under these circumstances, **there is no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Table 5.10 Estimated Area of SNS SAC Winter and Summer Areas that Harbour Porpoise Could Potentially be Disturbed from During Piling at East Anglia TWO

Piling	Maximum potential overlap with SNS SAC	Minimum potential overlap with SNS SAC	Average potential overlap with SNS SAC	Potential adverse effect on site integrity
Single pile installation in the East Anglia TWO windfarm site	2,124km ² (approximately 16%) in the winter area 45km ² (approximately 0.2%) in the summer area	2,042km ² (approximately 15%) in the winter area 0km ² (approximately 0%) in the summer area	2,083km ² (approximately 16%) in the winter area 23km ² (approximately 0.09%) in the summer area	No Temporary effect. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time during piling at East Anglia TWO (alone), based on the worst-case scenario.

Seasonal averages

544. The maximum piling duration for the proposed East Anglia TWO project would be up to 938 hours (equivalent of up to 39.2 days) based on the worst-case scenario (**Table 5.1**). The example for ADD activation, based on up to 10 minutes per pile, would be up to 57.3 hours (up to 2.4 days) for 344 pin-piles.
545. Therefore, the duration of potential disturbance, based on the worst-case scenario for the installation of wind turbines with pin-piles, five platforms with pin-piles and 10 minute ADD activation per pile, could be up to 41.6 days.
546. The seasonal averages have been calculated by multiplying the average potential area of effect on any one day by the proportion of days within the season piling could occur (i.e. taking into account the average area of overlap with SAC and number of piling days per season). The summer season is assumed to be 183 days (April-September) and the winter season is assumed to be 182 days (October-March).
547. The seasonal averages have been based on the unrealistic worst-case scenario that all 41.6 days of disturbance could occur in a single season.
548. The assessment indicates, based on the maximum potential duration of disturbance (piling, soft-start, ramp-up and ADD activation), less than 10% (up to 3.66%) of the seasonal component of the SNS North Sea SAC over the duration of that season could be affected during piling and ADD activation at East Anglia TWO (alone), based on the worst-case scenario of up to 41.6 days in one season and average area of overlap (**Table 5.11**). Therefore, under these circumstances, there would be **no significant disturbance and no potential**

adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.

Table 5.11 Estimated Seasonal Averages for Piling at East Anglia TWO Using Pin-piles for Wind Turbines and Offshore Platforms (Including ADD Activation, Soft-Start and Ramp-Up)

Piling	Duration based on worst-case scenario	Seasonal area averages	Potential adverse effect on site integrity
Pin-piles for 300m wind turbines and offshore platforms (including ADD activation, soft-start and ramp-up)	41.6 days	Winter area (based on 16% average overlap) = 3.66% Summer area (based on 0.09% average overlap) = 0.02%	No Temporary effect. Disturbance of harbour porpoise would not on average exceed 10% of the seasonal component of the SAC area over the duration of that season.

549. Based on maximum potential overlap with the SNS SAC winter area (16%) it is estimated that piling could occur on 112 days of the 182 days (approximately 62%) in the winter period and on all 183 days in the summer period, without exceeding the 10% seasonal average threshold.
550. Piling would not be constant during the foundation piling period. 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 down-time for weather or other technical issues.
551. The duration of piling is based on a worst-case scenario and a very precautionary approach and, as has been shown at other offshore windfarms, the duration used in the assessment can be overestimated. For example, during the installation of monopile foundations at the Dudgeon Offshore Wind Farm (DOW) the assessment was based on estimated piling period of 93 days, time to install each monopile was estimated to be up to 4.5 hours and the estimated duration of active piling was 301.5 hours (approximately 13 days). However, the actual total duration of active piling to install the 67 monopiles was 65 hours (approximately 3 days) with the average time for installation per monopile of 71 minutes (DOWL 2016). Therefore, the actual piling duration was approximately 21% of the predicated maximum piling duration.
552. Similar results were observed for the more recently constructed Beatrice Offshore Wind Farm, where within the ES it was estimated that each pin-pile would require five hours of active piling time and that the maximum hammer energy would be 2,300kJ (Beatrice Offshore Wind Farm Ltd 2018). During construction, the total

duration of piling ranged from 19 minutes to 2 hours and 45 minutes, with an average duration of 1 hour and 15 minutes per pile (Beatrice Offshore Wind Farm Ltd 2018).

Assessment in relation to the North Sea Management Unit

553. The estimated number of harbour porpoise that could be disturbed during piling at the East Anglia TWO windfarm site, based on the SNCBs current recommendation of a disturbance range of 26km, is presented in **Table 5.12**. As outlined above, there would be no concurrent piling at East Anglia TWO.
554. The assessment indicates that without mitigation, 0.4% or less of the North Sea MU reference population could be temporarily disturbed during piling at East Anglia TWO (alone), based on the worst-case scenario (**Table 5.12**). Therefore, under these circumstances, **there is no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**
555. In addition, the number of harbour porpoise that could be disturbed during underwater piling at East Anglia TWO has been estimated based on:
- The maximum potential for temporary auditory injury (TTS) / fleeing response. Although not all individuals within the maximum TTS range will have temporary hearing impairment, it is assumed as a worst-case scenario that all animals could be displaced; and
 - Up to 75% or 50% of harbour porpoise could be disturbed in the estimated maximum area which could result in a possible behavioural response based on the unweighted Lucke et al. (2009) criteria.
556. The assessment indicates that, without mitigation, 0.85% or less of the North Sea MU reference population could be temporarily displaced (maximum TTS / fleeing response range) during piling at East Anglia TWO (alone) (**Table 5.12**). Therefore, under these circumstances, **there is no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**
557. The assessment indicates that, without mitigation, 0.73% or less of the North Sea MU reference population could have a behavioural response and be temporarily displaced (based on 75% or 50% of harbour porpoise in maximum area for possible behavioural response) during piling at East Anglia TWO (alone) (**Table 5.12**). Therefore, under these circumstances, **there is no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Table 5.12 Estimated Number of Harbour Porpoise Potentially Disturbed during Piling at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2,124km ²) - based on 26km EDR	1,289 harbour porpoise based on SCANS-III density (0.607/km ²). 1,551 harbour porpoise based on site specific survey density (0.73/km ²).	0.4% of NS MU based on SCANS-III density. 0.4% of NS MU based on the site specific survey density.	No Temporary effect. 0.4% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
Maximum area of potential TTS onset / fleeing response for single strike – based on weighted SEL _{ss} (140 dB re 1 µPa ² s impulsive criteria; NMFS 2018)	Up to 3.9km ² for monopiles (4,000kJ) 2.4 harbour porpoise based on SCANS-III density (0.607/km ²). 2.8 harbour porpoise based on site specific survey density (0.73/km ²).	0.0007% of NS MU based on SCANS-III density. 0.0008% of NS MU based on the site specific survey density.	No Temporary effect. 0.0008% or less of the reference population could be temporarily displaced during single pile installation at East Anglia TWO (alone).
	Up to 70km ² for pin-piles (2,400kJ) 42 harbour porpoise based on SCANS-III density (0.607/km ²). 51 harbour porpoise based on site specific survey density (0.73/km ²).	0.012% of NS MU based on SCANS-III density. 0.015% of NS MU based on the site specific survey density.	No Temporary effect. 0.015% or less of the reference population could be temporarily displaced during single pile installation at East Anglia TWO (alone).
Maximum area of potential TTS onset / fleeing response for cumulative exposure over 24 hrs – based on weighted SEL _{cum} (140 dB re 1 µPa ² s impulsive criteria; NMFS 2018).	Up to 1,500km ² for monopiles (4,000kJ) 911 harbour porpoise based on SCANS-III density (0.607/km ²). 1,095 harbour porpoise based on site specific survey density (0.73/km ²).	0.26% of NS MU based on SCANS-III density. 0.32% of NS MU based on the site specific survey density.	No Temporary effect. 0.32% or less of the reference population could be temporarily displaced during single pile installation at East Anglia TWO (alone).
	Up to 4,000km ² for pin-piles (2,400kJ) 2,428 harbour porpoise based on SCANS-III density (0.607/km ²).	0.70% of NS MU based on SCANS-III density. 0.85% of NS MU based on the site specific survey density.	No Temporary effect. 0.85% or less of the reference population could be temporarily displaced during single

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
	2,920 harbour porpoise based on site specific survey density (0.73/km ²).		pile installation at East Anglia TWO (alone).
75% disturbed in maximum range for a possible behavioural response – based on Lucke et al. (2009) SEL unweighted 145 dB re 1 µPa ² s criteria	Up to 4,600km ² for monopiles (4,000kJ)	0.61% of NS MU based on SCANS-III density.	No Temporary effect. 0.73% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
	2,094 harbour porpoise based on SCANS-III density (0.607/km ²).	0.73% of NS MU based on the site specific survey density.	
	2,519 harbour porpoise based on site specific survey density (0.73/km ²).		No Temporary effect. 0.71% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
	Up to 4,500km ² for pin-piles (2,400kJ)	0.59% of NS MU based on SCANS-III density.	
50% disturbed in maximum range for a possible behavioural response – based on Lucke et al. (2009) SEL unweighted 145 dB re 1 µPa ² s criteria	2,049 harbour porpoise based on SCANS-III density (0.607/km ²).	0.71% of NS MU based on the site specific survey density.	No Temporary effect. 0.49% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
	2,464 harbour porpoise based on site specific survey density (0.73/km ²).		
	Up to 4,600km ² for monopiles (4,000kJ)	0.40% of NS MU based on SCANS-III density.	
	1,396 harbour porpoise based on SCANS-III density (0.607/km ²).	0.49% of NS MU based on the site specific survey density.	
	1,679 harbour porpoise based on site specific survey density (0.73/km ²).		No Temporary effect. 0.48% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
	Up to 4,500km ² for pin-piles (2,400kJ)	0.40% of NS MU based on SCANS-III density.	
	1,366 harbour porpoise based on SCANS-III density (0.607/km ²).	0.48% of NS MU based on the site specific survey density.	
	1,643 harbour porpoise based on site specific survey density (0.73/km ²).		

5.3.5.1.3 Potential disturbance from underwater noise during non-piling construction activities at East Anglia TWO (alone)

558. Possible sources of underwater noise during non-piling construction activities, include seabed preparation, geophysical surveys, rock placement and cable

installation. The results of the underwater noise modelling (**Table 5.13**) indicate that harbour porpoise would have to remain in close proximity to be exposed to levels of sound that are sufficient to induce PTS based on the NMFS (2018) threshold criteria.

559. The potential risk of any auditory injury in marine mammals as a result of dredging or cable laying activity is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction activities, other than piling.
560. Geophysical surveys conducted for offshore wind farms generally use multi-beam surveys in shallow waters. Therefore, the higher frequencies typically used fall outside the hearing frequencies of cetaceans and the sounds produced are likely to attenuate more quickly than the lower frequencies used in deeper waters (JNCC 2017e).
561. The draft RoC HRA for the Southern North Sea SAC (BEIS 2018) undertook underwater noise modelling to determine the potential impact ranges of geophysical surveys for harbour porpoise. The assessment used the maximum source levels that could be expected from geophysical equipment: sub-bottom profilers, with a maximum source noise level of 267 dB re 1 μ Pa-m. The noise modelling indicates that the onset of PTS in harbour porpoise could occur within a maximum range of 23m (an area of 0.0017km²) from the source location (BEIS, 2018) for the PTS cumulative threshold of 155dB SEL weighted (NMFS 2018). For possible behavioural disturbance of harbour porpoise, based on a threshold of 140 dB re 1 μ Pa SPL unweighted the maximum range was 3.77km (44.65km²) (BEIS 2018).
562. The potential disturbance of harbour porpoise during offshore wind farm construction has been assessed based on the East Anglia TWO offshore development area, therefore the potential for any disturbance during any geophysical surveys has already been taken into account (i.e. the areas of potential disturbance has already been included and covered as part of these assessments).

Table 5.13 Maximum Predicted Impact Ranges and Areas for Permanent Auditory Injury (PTS), Temporary Auditory Injury (TTS) / Fleeing Response and for Possible Behavioural Response from Non-Piling Construction Activities

Potential Impact	Criteria and threshold	The modelled impact ranges (km) and area* (km ²) for each offshore non-piling construction activity				
		Dredging	Drilling	Cable Laying	Rock Placement	Trenching
Permanent auditory injury (PTS) from 24 hr cumulative exposure	NMFS (2018) 173 dB re 1 μ Pa ² s non-impulsive criteria	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)
Temporary auditory injury (TTS) / fleeing response from 24 hr cumulative exposure	NMFS (2018) 153 dB re 1 μ Pa ² s non-impulsive criteria HF SEL _{cum}	0.23km (0.17km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	0.99km (3.08km ²)	<0.1km (0.031km ²)
Possible behavioural response	Lucke et al. (2009) Unweighted SEL 145 dB re 1 μ Pa	0.15km (0.071km ²)	0.13km (0.053km ²)	0.11km (0.038km ²)	0.18km (0.1km ²)	0.12km (0.045km ²)

*Maximum area based on area of circle with maximum impact range for radius as worst-case scenario.

Spatial assessment

563. As a very precautionary worst-case scenario, the assessment for the disturbance as a result of underwater noise during non-piling construction activities, has been assessed based on the entire offshore development area. This is very precautionary, as it is highly unlikely that non-piling construction activities could result in disturbance from the entire windfarm site and the offshore cable corridor, even if different activities are underway at the same time at different locations within the offshore development area. Any disturbance is likely to be limited to the area in and around where the activity is actually taking place as indicated by the noise modelling (**Table 5.13**).
564. The offshore development area (356km²) is approximately 3% of the SNS SAC winter area (12,697km²).

565. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC at any one time during non-piling construction activities at East Anglia TWO (alone), based on the worst-case scenario of 100% disturbance from the offshore windfarm and offshore cable corridor areas. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Seasonal averages

566. The potential effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature and not consistent throughout the offshore construction period or offshore construction area. For the worst-case scenario, it is assumed that non-piling construction activities could occur throughout each season (e.g. all 182 days in winter period) and that the disturbance as a result of underwater noise during non-piling construction activities could be from the entire windfarm area and the offshore cable corridor area (i.e. 100% disturbance from the offshore development area) (**Table 5.14**). The offshore development area is located entirely within the SNS SAC winter area (**Figure 11**), therefore the potential effects of non-piling construction activities would only affect the winter area during the winter period.
567. Disturbance of harbour porpoise would not on average exceed 10% (approximately 3%) of the seasonal component of the SNS SAC over the duration of that season during any non-piling construction activities at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Table 5.14 Estimated Worst-Case Scenario for Seasonal Area Averages for Non-Piling Construction Activities Than Piling at East Anglia TWO

Potential effect area	Duration based on worst-case scenario	Maximum seasonal area average	Potential adverse effect on site integrity
Total East Anglia TWO offshore development area (3% of winter area)	All 182 days of winter period	3% of winter area	No Temporary effect. Disturbance of harbour porpoise would not on average exceed 10% of the seasonal component of the SAC area over the duration of that season.

Assessment in relation to the North Sea Management Unit

568. The estimated maximum number of harbour porpoise that could be disturbed during non-piling construction activities at East Anglia TWO (alone) is presented in **Table 5.15**. The assessment indicates that up to 0.08% of the North Sea MU reference population could be temporarily disturbed from the total offshore development area during non-piling construction activities at East Anglia TWO (alone), based on the worst-case scenario. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.
569. However, based on the noise modelling the number of porpoise that could potentially be disturbed is significantly less, for example, up to 2.2 harbour porpoise around rock placement activities (0.0007% of the North Sea MU in a 3.08km² area; based on TTS / fleeing response from 24 hour cumulative exposure; **Table 5.13**).

Table 5.15 Estimated Number of Harbour Porpoise that could be present in the East Anglia TWO Offshore Development Area

Potential effect area	Estimate number in area	% of reference population	Potential adverse effect on site integrity
Total offshore development area (356km ²)	216 harbour porpoise based on SCANS-III survey density (0.607/km ²). 260 harbour porpoise based on site specific survey densities (0.73/km ²).	0.06% of NS MU based on SCANS-III density. 0.08% of NS MU based on site specific survey density	No Temporary effect. Maximum of 0.08% of the reference population could be temporarily displaced from the total offshore development area.

5.3.5.1.4 Possible disturbance from construction vessels at East Anglia TWO (alone)

570. During construction, there will be an increase in the number of vessels associated with installation of the turbine foundations, associated sub-structures and installation of the array and export cables. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the windfarm site and offshore cable corridor.
571. The results of the underwater noise modelling (**Table 5.16**) indicate that harbour porpoise would have to remain in close proximity to vessels (less than 1m), to be exposed to levels of sound that are sufficient to induce PTS or TTS from cumulative exposure based on the NMFS (2018) threshold criteria.

572. The potential risk of any auditory injury in marine mammals as a result of vessels is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction vessels.
573. The modelling indicates that based on the Lucke et al. (2009) unweighted criteria for possible behavioural response, the area around each large vessel could be up to (0.07km²). Therefore for 74 large vessels the potential area of possible behavioural response for harbour porpoise is up to 5.2km² (1.5% of the 356km² total offshore development area).

Table 5.16 Maximum Predicted Impact Ranges and Areas for Auditory Injury (PTS and TTS) and for Possible Behavioural Response from Vessels

Potential Impact	Criteria and threshold	The modelled impact ranges (km) and area* (km ²) for offshore construction vessels	
		Large vessels	Medium sized vessels
Permanent auditory injury (PTS) from 24 hour cumulative exposure	NMFS (2018) 173 dB re 1 µPa ² s non-impulsive criteria	<0.1km (<0.031km ²)	<0.1km (<0.031km ²)
Temporary auditory injury (TTS) from 24 hour cumulative exposure	NMFS (2018) 153 dB re 1 µPa ² s non-impulsive criteria	<0.1km (<0.031km ²)	<0.1km (<0.031km ²)
Possible behavioural response	Lucke et al. (2009) Unweighted SEL 145 dB re 1 µPa	0.15km (0.071km ²)	<0.05km (0.0079km ²)

*Maximum area based on area of circle with maximum impact range for radius as worst-case scenario.

574. 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. Responses to number of ships per year indicate 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 5km² area).
575. During construction, the approximate number of vessels on site at any one time during construction is estimated to be 74 vessels (**Table 5.1**). Based on the total offshore development area (356km²) there would be approximately 1 vessel per 5km², therefore this would not exceed the Heinänen and Skov (2015) threshold.
576. The marine traffic baseline survey (see ES **Chapter 14 Shipping and Navigation**), indicates that during the summer survey of 2018, an average of 63 vessels per day passed within the shipping and navigation study area, recorded

on AIS and Radar, and in summer 2017 this number was 74. During winter, an average of 71 vessels per day passed within the shipping and navigation study area.

577. There will be an average of 4.5 vessel movements per day during the construction period. Therefore, the vessels during construction could represent an increase of approximately 6% in the number of vessels during the summer period (with a total of approximately 78.5 vessels per day in the area) and approximately 6.3% increase in the number of vessels during the winter periods (with a total of approximately 75.5 vessels per day in the area), compared to current baseline vessel numbers. Based on the precautionary worst-case scenario, including existing vessel movements in around the offshore development area, but taking into account that other vessels would be restricted from entering the immediate construction site (with a 500m safety zone around construction vessels and partially installed foundations), the number of vessels would be unlikely to exceed the Heinänen and Skov (2015) threshold level of 80 vessels per day in a 5km² area.
578. Therefore, the assessment for vessels assumes a very precautionary worst-case scenario, that harbour porpoise in the windfarm site and the offshore cable corridor could be disturbed. However, any disturbance is likely to be limited to the immediate vicinity around the vessel, as indicated by the noise modelling (**Table 5.16**).

Spatial assessment

579. As outlined above, the East Anglia TWO total offshore development area (356km²) is approximately 3% of the SNS SAC winter area.
580. Disturbance of harbour porpoise would not exceed 20% (approximately 3%) of the seasonal component of the SNS SAC at any one time, based on the worst-case scenario of 100% disturbance from the offshore windfarm site and offshore cable corridor area. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

581. For the worst-case scenario, it is assumed that construction activities and therefore construction vessels could occur throughout each season (e.g. all 182 days in winter period) and that the disturbance as a result of underwater noise during construction from vessels could be from the entire windfarm site and the offshore cable corridor area (i.e. 100% disturbance from the offshore development area) (**Table 5.14**).

582. Disturbance of harbour porpoise would not on average exceed 10% (approximately 3%) of the seasonal component of the SNS SAC over the duration of that season as a result of construction vessels at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

583. The estimated number of harbour porpoise that could be disturbed as a result of construction vessels at East Anglia TWO is presented in **Table 5.15**. The assessment indicates that approximately 0.08% of the North Sea MU reference population could be temporarily disturbed from the total offshore development area, based on the worst-case scenario for East Anglia TWO (alone). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.1.5 Potential barrier effects from underwater noise during construction at East Anglia TWO (alone)

584. Underwater noise during construction could have the potential to create a barrier effect, preventing movement or migration of harbour porpoise between important feeding and / or breeding areas, or potentially increasing swimming distances to avoid the site rather than going through it.
585. 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. longest duration) scenarios.
586. The spatial worst-case is the maximum area over which potential disturbance could occur at any one time based on single foundation installation (2,124km²) and UXO clearance (2,124km²).
587. As outlined in **section 5.3.5.1.9**, the estimated maximum number of harbour porpoise that may be temporarily disturbed as a result of underwater noise from single piling and UXO clearance is up to 0.9% of the reference population.
588. As outlined in **section 5.3.5.1.9**, the duration of potential disturbance, based on the worst-case scenario could be up to 80 days.
589. It is important to note that piling and any UXO detonation, and therefore any potential barrier effects would not be constant during the construction period and there is expected to be significant periods when piling and / or UXO clearance would not be underway. When piling and / or UXO clearance is not taking place, there are periods where harbour porpoise could return to the area, rather than

assuming that they will be disturbed / move away for the entire construction period.

590. To reduce the potential for any adverse effect on the integrity of the winter area of SNS SAC during UXO clearance and piling at East Anglia TWO in the winter season, the Applicant, if required, will ensure UXO detonation and piling will not occur concurrently or overlap with the offshore development area during the winter period.
591. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.1.6 Possible vessel interaction (collision risk) during construction at East Anglia TWO (alone)

592. During the construction of East Anglia TWO there will be an increase in vessel traffic, with an estimated average of 136 trips per month (**Table 5.1**). Vessels will follow established shipping routes, where possible, between East Anglia TWO and the relevant ports in order to minimise vessel traffic in the wider area.
593. The baseline conditions indicate an already relatively high level of shipping activity in and around East Anglia TWO. Therefore, based on an average of 4.5 vessel movements per day, the increase in vessels movements during construction would be relatively small compared to existing vessel traffic. Although there could be approximately 74 vessels on site at any one time, most vessels once on site would remain within the site area.
594. Harbour porpoises 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 avoid vessel collisions. Heinänen and Skov (2015) indicated a negative relationship between the number of ships and the distribution of harbour porpoises in the North Sea suggesting potential avoidance behaviour. However, harbour porpoises have been observed with signs of physical trauma (blunt trauma or propeller cuts) indicating vessel strike (Wilson et al. 2007).
595. Of the 273 reported harbour porpoise strandings in 2015 (latest UK Cetacean Strandings Investigation Programme Report currently available), 53 were investigated at post mortem (27 were conducted in England, 13 in Scotland and 13 in Wales). A cause of death was established in 51 examined individuals (approximately 96% of examined cases). Of these, four (8%) had died from physical trauma of unknown cause, which could have been vessel strikes (CSIP 2015). 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).

596. As a precautionary worst-case scenario approach the number of harbour porpoise that could be at increased collision risk with vessels during construction has been assessed based on 5-10% (taking the strandings data of 4-8% into account) of the number of animals that could be present in the East Anglia TWO offshore development area (**Table 5.17**).
597. This is very precautionary, as it is highly unlikely that all harbour porpoise present in the offshore development area would be at increased collision risk with vessels during construction, especially taking into account the relatively small increase in number of vessel movements compared to existing vessel movements in the area.
598. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where harbour porpoise 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 harbour porpoise.
599. In addition, based on the assumption that harbour porpoise would be disturbed from the offshore development area as a result of underwater noise from construction activities and vessels, as assessed above, there should be no potential for increased collision risk with vessels during the construction period.
600. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.17 Estimated Number of Harbour Porpoise that Could be Present in the East Anglia TWO Offshore Development Area at Potential Increased Vessel Collision Risk

Potential effect area	Estimated number at potential collision risk based on 5-10% increased risk	% of reference population ¹	Potential adverse effect on site integrity
Total offshore project area (356km ²)	11-22 harbour porpoise based on SCANS-III survey density. 13-26 harbour porpoise based on site specific survey density at EA2.	0.003-0.006% of NS MU based on SCANS-III density. 0.004-0.008% of NS MU based on site specific survey density.	No Maximum of 0.009% of the reference population at potential increased risk.

5.3.5.1.7 Potential changes to prey resource during construction at East Anglia TWO (alone)

601. Potential effects on fish species during construction can result from physical disturbance and temporary loss of seabed habitat; increased suspended

- sediment concentrations and sediment re-deposition; and underwater noise, (that could lead to mortality, physical injury, auditory injury or behavioural responses).
602. Potential sources of underwater noise during construction include piling, increased vessel traffic, seabed preparation, rock dumping, 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 effects on fish. Underwater noise modelling (**Appendix 11.4** of the ES) indicates that fish species in which the swim bladder is involved in hearing are the most sensitive to piling noise with ranges of up to 0.5km for mortality and potential mortal injury (based on SPL_{peak} for monopile with maximum hammer energy applied of 4,000kJ) and up to 6.0km for recoverable injury (based on maximum potential ranges for SEL cumulative exposure for pin-piles with maximum hammer energy applied) assuming a fleeing receptor, travelling at a speed of 1.5m/s (Hirata 1999).
603. Under a stationary receptor scenario, an impact range of up to 15km has been modelled for recoverable injury for the species that have a swim bladder, based on the maximum potential ranges for cumulative exposure (SEL_{cum} for monopile with full hammer energy applied). It should be noted that using a stationary receptor is considered to be over precautionary as most fish species are likely to move away from a sound that is loud enough to cause harm (Dahl et al. 2015; Popper et al. 2014), some may seek protection in the sediment and others may dive deeper in the water column. In addition, the flee speed used of 1.5m/s is relatively slow in relation to the data shown in Hirata (1999) and is therefore considered to be conservative. There is further evidence that those fish species that do not flee are likely to be benthic fish species or to not have a swim bladder, which are the least sensitive species. More information is included within **Appendix 11.4** of the ES. The maximum potential range where TTS and behavioural impacts could occur up to 38km (for a stationary receptor).
604. The maximum potential area of temporary physical disturbance and/or temporary loss of habitat to fish during construction could be approximately 11.35km² in total, approximately 2.75% of the total offshore development area (see ES **Chapter 10 Fish and Shellfish Ecology**).
605. The potential impact on prey from any increased suspended sediment concentrations and sediment re-deposition would be low. Modelling predicted that close to the release locations, suspended sediment concentrations would be very high (orders of magnitude greater than natural background levels), but of very short duration (seconds to minutes) as the dynamic plume falls to the sea bed. Within the passive plume, suspended sediment concentration above background levels were low (less than 10mg/l) and within the range of natural variability (see ES **Chapter 7 Marine Geology, Oceanography and Physical**

Processes). The total maximum excavation requirement for all infrastructure within the offshore development area would be up to 0.004km³ (see ES **Chapter 9 Benthic Ecology**).

606. As a precautionary worst-case scenario, the number of harbour porpoise that could be affected as a result of changes to prey resources during construction has been assessed based on the number of animals that could be present in the windfarm site and the offshore cable corridor (**Table 5.15**). This is very precautionary, as it is highly unlikely that any changes in prey resources could occur over the entire windfarm site and the offshore cable corridor during construction. It is more likely that effects would be restricted to an area around the working sites.
607. In addition, there would be no additional displacement of harbour porpoise as a result of any changes in prey resources during construction, as they would already be potentially disturbed from the offshore development area as a result of underwater noise during piling, non-piling construction activities or vessels, as the potential area of effect would be the same or less as those assessed for directly for harbour porpoise.

Spatial assessment

608. As outlined above, the East Anglia TWO total offshore development area (356km²) is approximately 3% of the SNS SAC winter area.
609. Any changes to prey availability at East Anglia TWO (alone) resulting in the displacement of all harbour porpoise from the entire offshore development area would not exceed 20% of the seasonal component of the SNS SAC at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

610. For the assessment, it is assumed, as the worst-case scenario that changes to prey availability could occur throughout each season (e.g. all 182 days in winter period) and that the changes in prey availability could, as a worst-case scenario, be across the entire offshore development area (**Table 5.14**).
611. Displacement of harbour porpoise as a result of any changes in prey availability would not on average exceed 10% (approximately 3%) of the seasonal component of the SNS SAC over the duration of that season during construction at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

612. The estimated maximum number of harbour porpoise that could potentially be affected by any potential changes to prey availability during construction at East Anglia TWO (alone) is less than 0.08% of the NS MU reference population, based on the worst-case scenario (**Table 5.15**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.1.8 Potential changes to water quality during construction at East Anglia TWO (alone)

613. Throughout the construction phase, best practice techniques and due diligence regarding the potential for pollution throughout all construction activities will be followed. The EMP will include the mitigation measures embedded into the design (see **section 5.2.2.2**).
614. Any risk of accidental release of contaminants (e.g. through spillage) will be mitigated in line with the EMP and any changes to water quality as a result of any accidental release of contaminants (e.g. through spillage or vessel collision) is negligible. Therefore, the potential for pollutants to be released into the environment is not considered further in this assessment.
615. Disturbance of seabed sediments during construction 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. However, data from the site specific survey undertaken in 2018 indicates that levels of contaminants within the offshore windfarm site and offshore cable corridor are very low (see ES **Chapter 8 Water and Sediment Quality**). There were eight exceedances of Cefas Action Level 1 for arsenic within the offshore cable corridor (out of 11 samples) and none within the windfarm site (contaminant levels below Action Level 1 are not considered to be of concern). Exceedances were marginal for arsenic and likely due to high concentrations of naturally occurring arsenic. One sample site also recorded levels of cadmium, copper, nickel and zinc above Cefas Action Level 1. However, none of the increases bring the concentrations close to Cefas Action Level 2 (persistent contaminant levels above Cefas Action Level 2 are generally considered to pose an unacceptable risk to the marine environment), therefore the potential for any effect was considered to be negligible.
616. There is the potential for increased suspended sediments as a result of construction activities, such as installation of foundations (for wind turbines, accommodation and electrical substation platforms), drill arisings, cable installation and during any levelling or dredging activities. However, the assessment in ES **Chapter 7 Marine Geology, Oceanography and Physical Processes** indicates that:

- Measurable increases in Suspended Sediment Concentrations (SSC) will be found in the water column over a short period of time (a matter of days);
 - Disturbed material will remain close to the sea bed and rapidly settle out (within tens of minutes). For example, sand-sized sediment would settle out of suspension within less than 1km from the point of release within a few tens of minutes;
 - The majority of sediment released at the water surface would rapidly (within tens of minutes) settle on to the seabed as a highly turbid dynamic plume upon discharge;
 - Finer sediment fractions will remain in the water column as a measurable but low concentration plume for up to half a tidal cycle settling within a kilometre of the disturbance or becoming indistinguishable from background levels; and
 - No likely cumulative effect from plumes interacting due to plumes not persisting in the water column for a sufficiently long time.
617. As outlined above and in ES **Chapter 8 Water and Sediment Quality**, any changes in SSCs due to sea bed preparation, drill arisings and cable installation are predicted to be localised, short term and rapidly return to normal conditions following cessation of activity.
618. However, as a precautionary worst-case scenario, the number of harbour porpoise that could be affected as a result of any changes to water quality during construction has been assessed based on the number of animals that could be present in the windfarm area and the offshore cable corridor. This is very precautionary, as it is highly unlikely that any changes in water quality could occur over the entire windfarm area and the offshore cable corridor during construction. It is more likely that effects would be restricted to an area around the working sites.

Spatial assessment

619. As outlined above, the East Anglia TWO total offshore development area (356km²) is approximately 3% of the SNS SAC winter area.
620. Any changes to water quality at East Anglia TWO (alone) that could result in the displacement of all harbour porpoise from the entire windfarm site and cable corridor area would not exceed 20% (approximately 3%) of the seasonal component of the SNS SAC at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Seasonal averages

621. For the assessment, it is assumed, as the worst-case scenario that changes to water quality could occur throughout each season (e.g. all 182 days in winter period) and that the changes in water quality could, as a worst-case scenario, be across the entire windfarm area and the offshore cable corridor area (**Table 5.14**).
622. Any changes to water quality at East Anglia TWO (alone) that could result in the displacement of all harbour porpoise from the entire windfarm site and cable corridor area would not on average exceed 10% (approximately 3%) of the seasonal component of the SNS SAC over the duration of that season during construction at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

623. The estimated maximum number of harbour porpoise that could potentially be affected by any potential changes to water quality during construction at East Anglia TWO (alone) is less than 0.08% of the NS MU reference population, based on the worst-case scenario (**Table 5.15**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.1.9 Potential overall effects during construction of East Anglia TWO (alone)

5.3.5.1.9.1 Potential overall effects during UXO clearance at East Anglia TWO (alone)

624. It is not anticipated that piling would be undertaken at the same time as UXO clearance, however, as a worst-case scenario it has been assumed that UXO clearance could be undertaken, for example in the cable corridor while piling could be undertaken in the windfarm site.
625. Only one UXO would be detonated at a time during UXO clearance operations in the East Anglia TWO offshore development area, as previously outlined, there would be no simultaneous UXO detonations, but potentially more than one UXO detonation could occur in a 24 hour period. There would also be no concurrent piling at East Anglia TWO, as previously outlined, only one pile will be installed at a time, with no overlap in the piling duration of any two piles. Piles will be installed sequentially, and more than one pile could be installed in a single 24 hour period.
626. There would also be no UXO detonation in the East Anglia TWO offshore development area at the same time as piling East Anglia TWO offshore development area during the winter period, in that although they may occur in the same day or 24 hour period, they would not at exactly the same time.

Spatial assessment

627. **Table 5.18** outlines the potential maximum, minimum and average overlap with the seasonal areas of the SNS SAC, taking into the overlap in the impact areas for UXO detonation in the cable corridor and piling in the windfarm site. The assessment indicates that the maximum and average overlap with the winter area would exceed 20% of the seasonal area, if conducted in winter. Therefore, under these worst-case scenario circumstances, there is the potential for an adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.
628. As previously outlined, the SIP would set out the approach to deliver any project mitigation or management measures in relation to the SNS SAC for harbour porpoise, to ensure no adverse effect on the integrity of the SNS SAC for harbour porpoise. For example, to reduce the potential for any adverse effect on the integrity of the winter area of SNS SAC during UXO clearance and piling at East Anglia TWO in the winter season, the Applicant, if required, would ensure UXO detonation and piling would not occur at the same time, although may occur on the same day or 24 hour period, at the East Anglia TWO site during the winter period. Therefore, under these circumstances, there would be **no potential for an adverse effect on the integrity of the SNS SAC winter area in relation to the conservation objectives for harbour porpoise.**
629. The assessment also indicates that the maximum and average overlap with the summer area would not exceed 20% of the seasonal area. Therefore, if any UXO clearance in the offshore cable corridor was undertaken in summer during piling at the East Anglia TWO windfarm site, there would be **no potential for an adverse effect on the integrity of the SNS SAC summer area in relation to the conservation objectives for harbour porpoise.**

Table 5.18 Estimated Area of SNS SAC Winter and Summer Areas that Harbour Porpoise Could Potentially be Disturbed from During UXO Clearance and Piling at East Anglia TWO

Potential effect	Maximum potential overlap with SNS SAC	Minimum potential overlap with SNS SAC	Average potential overlap with SNS SAC	Potential adverse effect on site integrity
UXO detonation in cable corridor and piling at windfarm site - winter area	3,742km ² (approximately 29.5%) in the winter area	2,132km ² (approximately 16.8%) in the winter area	2,937km ² (approximately 23%) in the winter area	No SIP would set out the approach to deliver any project mitigation or management measures in relation to the SNS SAC for harbour porpoise, to ensure no adverse effect on the

Potential effect	Maximum potential overlap with SNS SAC	Minimum potential overlap with SNS SAC	Average potential overlap with SNS SAC	Potential adverse effect on site integrity
				integrity of the SNS SAC for harbour porpoise.
UXO detonation in cable corridor and piling at windfarm site - summer area	174km ² (approximately 0.6%) in the summer area	0km ² (approximately 0%) in the summer area	87km ² (approximately 0.3%) in the summer area	No Temporary effect. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time during any UXO clearance and piling at East Anglia TWO (alone), based on the worst-case scenario.

Seasonal averages

630. This assessment is based on a precautionary approach of the maximum number of days of potential disturbance during UXO clearance, based on one UXO detonated per day, for up to 80 days. It is assumed, as a worst-case scenario, that harbour porpoise could be disturbed for maximum duration of these 80 days in one season.
631. However, it should be noted that this is highly unlikely, as outlined in the BEIS (2018) 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, 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 2010b).
632. This assessment is also based on the precautionary approach that the total duration for active piling and ADD activation could occur in one season.
633. The assessment indicates that, for UXO detonation in the cable corridor and piling in the offshore windfarm site, more than 10% (10.1%) of the seasonal

component of the SNS SAC over the duration of that season could be affected during any UXO clearance and piling at East Anglia TWO (alone), if conducted in winter, based on the worst-case scenario of 41.6 days piling and ADD activation (see **section 5.3.5.1.2.3**) or 80 days of UXO clearance per season (see **section 5.3.5.1.1.2**) and average area overlap (**Table 5.19**). Therefore, under these worst-case scenario circumstances, there is the potential for an adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.

634. However, as previously outlined the SIP would set out the approach to deliver any project mitigation or management measures in relation to the SNS SAC for harbour porpoise, to ensure no adverse effect on the integrity of the SNS SAC for harbour porpoise. For example, to reduce the potential for any adverse effect on the integrity of the winter area of SNS SAC during any UXO clearance and piling at East Anglia TWO in the winter season, the Applicant, if required, would ensure UXO detonation and piling would not occur at the same time, although they may occur on the same day or 24 hour period, at the East Anglia TWO site during the winter period. Therefore, under these circumstances, there would be **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC winter area in relation to the conservation objectives for harbour porpoise.**
635. The assessment indicates that piling in the East Anglia TWO windfarm site and UXO clearance within the cable corridor, would not on average exceed the seasonal component of the site, if these activities were undertaken in the summer period. Therefore, if any UXO clearance in the offshore cable corridor was undertaken in summer during piling at the East Anglia TWO windfarm site, there would be **no potential for an adverse effect on the integrity of the SNS SAC summer area in relation to the conservation objectives for harbour porpoise.**

Table 5.19 Estimated Seasonal Averages for UXO Clearance and Piling at East Anglia TWO

Potential effect	Duration based on worst-case scenario	Seasonal area averages	Potential adverse effect on site integrity
UXO detonation in cable corridor and piling at windfarm site	41.6 days of piling per season (see section 5.3.5.1.2.3)	Winter area (based on average 23% overlap) = 5.26% Summer area (based on average 0.3% overlap) = 0.07%	No SIP would set out the approach to deliver any project mitigation or management measures in relation to the SNS SAC for harbour porpoise, to ensure no adverse effect on the integrity of the SNS SAC for harbour porpoise.
	80 days of UXO clearance per season (see	Winter area (based on average 23% overlap) = 10.1%	

Potential effect	Duration based on worst-case scenario	Seasonal area averages	Potential adverse effect on site integrity
	section 5.3.5.1.1.2)	Summer area (based on average 0.3% overlap) = 0.13%	

Assessment in relation to the North Sea Management Unit

636. The maximum potential area of disturbance is 4,248km², based on 26km disturbance range around each piling location and UXO location, and assuming no overlap in the potential impact areas.
637. The estimated maximum number of harbour porpoise that could potentially be disturbed during any UXO clearance in the cable corridor at the same time as piling in the windfarm site at East Anglia TWO is less than 0.9% of the NS MU reference population, based on the worst-case scenario (**Table 5.20**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.20 Estimated Number of Harbour Porpoise Potentially Disturbed during UXO Clearance and Piling at East Anglia TWO

Potential effect	Estimated number in area	% of reference population ¹	Potential adverse effect on site integrity
Area of disturbance (4,248km ²) during underwater UXO clearance and piling - based on 26km EDR for each	2,578 harbour porpoise based on SCANS-III density (0.607/km ²). 3,101 harbour porpoise based on site specific survey density (0.73/km ²).	0.75% of NS MU (345,373 harbour porpoise) based on SCANS-III density. 0.90% of NS MU based on the site specific survey density at EA2.	No Temporary effect. Less than 0.90% of the reference population could be temporarily disturbed during any UXO clearance and piling at East Anglia TWO (alone), based on the worst-case scenario.

5.3.5.1.9.2 Potential overall effects during piling at East Anglia TWO (alone)

638. As a worst-case scenario, it is assumed piling would take place in the East Anglia TWO windfarm site at the same time as other non-piling construction activities, including any geophysical surveys and any vessels in the offshore cable corridor.

Spatial assessment

639. Disturbance of harbour porpoise during piling and other construction activities, including vessels would not exceed 20% (up to 17.9%) of the seasonal component of the SNS SAC during any construction at East Anglia TWO (alone), based on the worst-case scenario (**Table 5.21**). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.21 Estimated Area of SNS SAC Winter and Summer Areas that Harbour Porpoise Could Potentially be Disturbed from During Piling and Other Construction Activities including Vessels at East Anglia TWO

Potential effect	Maximum potential overlap with SNS SAC	Minimum potential overlap with SNS SAC	Average potential overlap with SNS SAC	Potential adverse effect on site integrity
Piling at windfarm site and other construction activities and vessels in cable corridor	2,271km ² (approximately 17.9%) in the winter area (with up to 2,124km ² from piling and 147km ² of cable corridor) 45km ² (approximately 0.2%) in the summer area (with up to 45km ² from piling and 0km ² of cable corridor)	2,167km ² (approximately 17.1%) in the winter area (with up to 2,124km ² from piling and 43km ² of cable corridor) 0km ² (approximately 0%) in the summer area (with up to 0km ² from piling and 0km ² of cable corridor)	2,219km ² (approximately 17.5%) in the winter area (with up to 2,124km ² from piling and 95km ² of cable corridor) 23km ² (approximately 0.09%) in the summer area (with up to 23km ² from piling and 0km ² of cable corridor)	No Temporary effect. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area during pile installation in-combination with other construction activities and vessels at East Anglia TWO (alone), based on the worst-case scenario.

Seasonal averages

640. The seasonal average for the disturbance of harbour porpoise during piling (including soft-start, ramp-up and ADD activation) and other construction activities, including vessels has been assessed based on the average potential area of disturbance (**Table 5.21**) and worst-case scenarios of 41.6 days of piling and ADD activation (see **section 5.3.5.1.2.3**) and all 182 days in winter period for other construction activities and vessels.

641. Disturbance of all harbour porpoise during piling and other construction activities, including vessels at East Anglia TWO (alone) would not on average exceed 10% (approximately 7.5%) of the seasonal component of the SNS SAC area over the

duration of that season (**Table 5.22**). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.22 Estimated Maximum Seasonal Averages for Piling and Other Construction Activities, Including Vessels at East Anglia TWO

Potential effect	Duration based on worst-case scenario	Seasonal area averages	Potential adverse effect on site integrity
Piling at windfarm site and other construction activities, including geophysical surveys and vessels in offshore cable corridor	41.6 days of piling per season (see section 5.3.5.1.2.3)	Winter area (based on average 17.5% overlap) = 4.0% Summer area (based on average 0.09% overlap) = 0.02%	No Temporary effect. Disturbance of harbour porpoise would not on average exceed 10% of the seasonal component of the SAC area over the duration of that season.

Assessment in relation to the North Sea Management Unit

642. The estimated number of harbour porpoise that could potentially be disturbed during pile installation and other construction activities, including vessels, based on 100% of all harbour porpoise being disturbed from 26km EDR around the pile location and in the area of the East Anglia TWO windfarm site and offshore cable corridor not covered by piling disturbance area (**Table 5.23**).
643. The assessment indicates that 0.5% or less of the North Sea MU reference population could be temporarily displaced during pile installation at the same time as other construction activities, including vessels in the cable corridor at East Anglia TWO (alone), based on the worst-case scenario (**Table 5.23**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.23 Estimated Maximum Number of Harbour Porpoise Potentially Disturbed during Piling and Other Construction Activities including Vessels at East Anglia TWO

Potential effect	Estimate number in area	% of reference population	Potential adverse effect on site integrity
Up to 2,271km ² area of disturbance during pile installation (2,124km ²) at windfarm site and disturbance from other construction activities, including geophysical surveys and vessels in the cable corridor (147km ²)	1,378 harbour porpoise based on SCANS-III density (0.607/km ²). 1,658 harbour porpoise based on site specific survey density (0.73/km ²).	0.4% of NS MU based on SCANS-III density. 0.5% of NS MU based on the site specific survey density at EA2.	No Temporary effect Up to 0.5% of the reference population could be temporarily disturbed during pile installation in-combination with construction and vessels at East Anglia TWO (alone), based on the worst-case scenario.

5.3.5.1.9.3 Potential overall effects during construction at East Anglia TWO (alone)

644. There would be no further overall effects during construction other than those assessed above, as the potential disturbance from underwater noise during construction has been based on the entire East Anglia TWO windfarm site and cable corridor area, as has any potential disturbance from vessels, any changes in prey availability and water quality.

5.3.5.2 Potential Effects during Operation and Maintenance at East Anglia TWO (alone)

645. The potential effects during operation and maintenance of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the SNS SAC in relation to the Conservation Objectives are:

- Disturbance resulting from the underwater noise associated with operational turbines;
- Disturbance resulting from the underwater noise associated with maintenance activities, such as any additional rock dumping and cable re-burial;
- Disturbance resulting from underwater noise and disturbance from vessels;
- Vessel interaction (collision risk);
- Changes to prey resource;
- Changes to water quality.

646. The worst-case scenario on which the assessment is based for harbour porpoise is outlined in **Table 5.1**

5.3.5.2.1 Potential disturbance from the underwater noise associated with operational turbines at East Anglia TWO (alone)

647. Currently available data suggests that there is no lasting disturbance or exclusion of harbour porpoise around windfarm sites during operation (e.g. Tougaard et al. 2005, 2006, 2009a, 2009b; Diederichs et al. 2008; Scheidat et al. 2011).
648. The MMO (2014) review found that data on the operational turbine noise, from the UK and abroad, generally showed that noise levels radiated from operational wind turbines are low and the spatial extent of the potential effect of the operational wind turbine noise on marine receptors is generally estimated to be small, with behavioural response only likely at ranges close to the turbine. It is however noted that the early measured data were mainly for smaller capacity wind turbines.
649. Harbour porpoise have been shown to forage within operational windfarm sites (e.g. Lindeboom et al. 2011), indicating no restriction to movements in operational offshore windfarm sites. Lindeboom et al. (2011) found that relatively more porpoises were found in the windfarm area compared to the two reference areas (Scheidat et al. 2011). It was established that this effect is genuinely linked to the presence of the windfarm. The most likely explanations are increased food availability due to the attached fauna on and in the hard substrates (reef effect) as well as the exclusion of fisheries and reduced vessel traffic in the wind farm (shelter effect) (Lindeboom et al. 2011).
650. Underwater noise modelling was undertaken to assess the potential impact ranges of operational turbines on marine mammals. The underwater noise propagation modelling used measured sound source data scaled to relevant parameters for the East Anglia TWO windfarm site (see **Appendix 11.4** of the ES for further information).
651. The results of the underwater noise modelling indicate that at the source levels predicted for operational underwater noise, any harbour porpoise would have to remain in very close proximity of the turbine over a 24 hour period to be exposed to levels of sound could be sufficient to result in PTS or TTS from cumulative exposure (**Table 5.24**).
652. The modelling indicates that based on the Lucke et al. (2009) unweighted criteria for possible behavioural response, the area around each turbine could be up to (0.02km²). Therefore for 75 wind turbines the potential area of possible behavioural response for harbour porpoise is up to 1.5km² (0.7% of the 218.4km² East Anglia TWO windfarm site).

Table 5.24 Maximum Predicted Impact Ranges for Auditory Injury (PTS or TTS) and for Possible Behavioural Response from Operational Turbines at East Anglia TWO

Potential Impact	Criteria and threshold	Operational wind turbines (300m) modelled impact ranges (km) (and areas* (km ²))
Permanent auditory injury (PTS) from cumulative exposure	NMFS (2018) 173 dB re 1 μ Pa ² s non-impulsive criteria HF SEL _{cum}	<0.1km (0.031km ²)
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 153 dB re 1 μ Pa ² s non-impulsive criteria HF SEL _{cum}	<0.1km (0.031km ²)
Possible behavioural response	Lucke et al. (2009) Unweighted SEL 145 dB re 1 μ Pa	0.08km (0.02km ²)

*Maximum area based on area of circle with maximum impact range for radius as worst-case scenario

Spatial Assessment

653. The East Anglia TWO windfarm site (218.4km²) is approximately 1.7% of the winter SNS SAC.
654. The maximum area of potential PTS or TTS from cumulative exposure for 75 wind turbines is 2.33km², based on the underwater noise modelling (**Table 5.24**), is approximately 0.018% of the winter SNS SAC (12,697km²).
655. The maximum area of possible behavioural response (1.5km²), based on the underwater noise modelling (**Table 5.24**), is approximately 0.012% of the winter SNS SAC.
656. Any disturbance of harbour porpoise as a result of underwater noise from operational turbines at East Anglia TWO (alone) would not exceed 20% (up to 2%) of the seasonal component of the SNS SAC at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

657. The potential disturbance of harbour porpoise as a result of underwater noise from operational turbines at East Anglia TWO (alone) has been assessed, based on the worst-case scenario, that disturbance could occur throughout the season (i.e. all 182 days in winter period) and that, as a worst-case scenario, all harbour porpoise could be disturbed from the entire East Anglia TWO windfarm site (**Table 5.25**).

Table 5.25 Estimated Worst-Case Scenarios for Maximum Seasonal Averages of Potential Disturbance from Operational Turbines

Potential effect	Duration based on worst-case scenario	Maximum seasonal averages	Potential adverse effect on site integrity
East Anglia TWO windfarm site (2% of the winter SNS SAC)	Throughout the winter period (182 days).	2% of the SNS SAC winter area.	No Displacement of harbour porpoise would not on average exceed 10% of the seasonal component of the SNS SAC area over the duration of that season.
Maximum potential area for PTS or TTS from cumulative exposure (0.018% of the winter area)	Throughout the winter period (182 days).	0.018% of the SNS SAC winter area.	
Maximum area of possible behavioural response (0.012% of the winter SNS SAC)	Throughout the winter period (182 days).	0.012% of the SNS SAC winter area	

658. Disturbance of harbour porpoise as a result of underwater noise from operational turbines at East Anglia TWO (alone) would not on average exceed 10% (up to 2%) of the seasonal component of the SNS SAC, based on the worst-case scenario (**Table 5.25**). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

659. The estimated maximum number of harbour porpoise that could potentially be disturbed as a result of underwater noise from operational turbines at East Anglia TWO (alone) is 1.1 (0.0003% of the NS MU reference population), or up to 159.5 harbour porpoise (up to 0.05% of the NS MU reference population) based on the worst-case scenario of disturbance from the entire windfarm site (**Table 5.26**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.26 Estimated Maximum Number of Harbour Porpoise that Could be Disturbed by Operational Turbines at East Anglia TWO

Potential effect	Estimate number in area	% of reference population ¹	Potential adverse effect on site integrity
East Anglia TWO windfarm site (218.4km ²)	133 harbour porpoise based on SCANS-III density (0.607/km ²). 159.5 harbour porpoise based on site specific survey density (0.73/km ²).	0.04% of NS MU based on SCANS-III density. 0.05% of NS MU based on site specific survey density.	No Long-term (not permanent) effect. Maximum of 0.05% of the reference population could be disturbed.
Maximum potential area for PTS or TTS from cumulative exposure (2.33km ²)	1.4 harbour porpoise based on SCANS-III density (0.607/km ²). 1.7 harbour porpoise based on site specific survey density (0.73/km ²).	0.0004% of NS MU based on SCANS-III density. 0.0005% of NS MU based on site specific survey density.	No Long-term (not permanent) effect. Maximum of 0.0005% of the reference population could be disturbed.
Maximum area of possible behavioural response (1.5km ²)	0.9 harbour porpoise based on SCANS-III density (0.607/km ²). 1.1 harbour porpoise based on site specific survey density (0.73/km ²).	0.0003% of NS MU based on SCANS-III density. 0.0003% of NS MU based on site specific survey density.	No Long-term (not permanent) effect. Maximum of 0.0003% of the reference population could have a possible behavioural response.

5.3.5.2.2 Potential disturbance from the underwater noise associated with maintenance activities at East Anglia TWO (alone)

660. The requirements for any potential maintenance work, such as additional rock dumping or cable re-burial, are currently unknown, however the work required and associated effects would be less than those during construction.
661. The effects 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 and any disturbance is likely to be limited to the area in and around where the actual activity is taking place (see **Table 5.13**).
662. Following the approach for the assessment of underwater noise during construction from activities other than piling and vessels, a very precautionary worst-case scenario approach assumes disturbance as a result of underwater noise during maintenance activities could cover the East Anglia TWO windfarm

site and the offshore cable corridor area. However, any disturbance is likely to be limited to the area in and around where the activity is taking place.

Spatial assessment

663. The East Anglia TWO offshore development area (356km²) is approximately 3% of the SNS SAC winter area (12,697km²).
664. Disturbance of harbour porpoise would not exceed 20% (up to 3%) of the seasonal component of the SNS SAC at any one time during any maintenance activities at East Anglia TWO (alone), based on the worst-case scenario of 100% disturbance from the offshore windfarm and offshore cable corridor areas. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

665. For the assessment, it is assumed, as the worst-case scenario, that disturbance of harbour porpoise as a result of underwater noise during maintenance activities at East Anglia TWO (alone) could occur throughout the season (e.g. all 182 days in winter period) and that all harbour porpoise could be, as a worst-case scenario, disturbed from the entire offshore development area (**Table 5.14**).
666. Disturbance of harbour porpoise as a result of underwater noise during maintenance activities at East Anglia TWO (alone) would not on average exceed 10% (up to 3%) of the seasonal component of the SNS SAC over the duration of that season as a result of any maintenance activities at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

667. The estimated maximum number of harbour porpoise that could potentially be disturbed during maintenance activities at East Anglia TWO (alone) is less than 0.08% of the NS MU reference population, based on the worst-case scenario of 100% disturbance from the entire offshore development area (**Table 5.15**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.2.3 Potential disturbance from vessels during operation and maintenance at East Anglia TWO (alone)

668. The requirements for any potential maintenance work are currently unknown, however the work required and effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than

those during construction. However, it is estimated that there could be up to 687 vessel round trips per year (1-2 vessels per day) during operation and maintenance (**Table 5.1**).

669. As outlined in **section 5.3.5.1.4**, the results of the underwater noise modelling (**Table 5.16**) indicate that harbour porpoise would have to remain in close proximity to vessels over a 24 hour period, to be exposed to levels of sound that are sufficient to induce PTS or TTS from cumulative exposure based on the NMFS (2018) threshold criteria.
670. The potential risk of any auditory injury in marine mammals as a result of vessels is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction vessels.
671. The modelling indicates that based on the Lucke et al. (2009) unweighted criteria for possible behavioural response, the area around each large vessel could be up to (0.071km²). Therefore, for two large vessels per day the potential maximum area of possible behavioural response for harbour porpoise is 0.142km² (0.04% of the 356km² total offshore development area).
672. The potential effects as a result of underwater noise and disturbance from additional vessels during operation and maintenance would be short-term and temporary in nature. Disturbance responses are likely to be limited to the area in the immediate vicinity of the vessel. Marine mammals would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.
673. Taking into account the existing vessel movements in and around the East Anglia TWO offshore development area and the potential 1-2 vessel movements per day during operation and maintenance, the number of vessels would not exceed the Heinänen and Skov (2015) threshold level of approximately 80 vessels per day within an area of 5km² (approximately 16 vessels per km²). Therefore, there is no potential for the significant disturbance to harbour porpoise as a result of the increased number of vessels during operation and maintenance.

Spatial assessment

674. The East Anglia TWO offshore development area (356km²) is approximately 3% of the winter SNS SAC.
675. The maximum area of possible behavioural response to vessels during operation and maintenance (0.142km²), based on the underwater noise modelling (**Table 5.16**), is approximately 0.001% of the winter SNS SAC.
676. Disturbance of harbour porpoise from operation and maintenance vessels at East Anglia TWO (alone), based on the worst-case scenario, would not exceed 20%

(up to 3%) of the seasonal component of the SNS SAC at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Seasonal average

677. For the worst-case scenario, it is assumed that disturbance of harbour porpoise as a result of operation and maintenance vessels at East Anglia TWO (alone) could occur throughout the season (e.g. all 182 days in winter period) and that all harbour porpoise could be, as a worst-case scenario, disturbed from the entire offshore development area (**Table 5.14**).
678. Disturbance of harbour porpoise as a result of operation and maintenance vessels at East Anglia TWO (alone) would not on average exceed 10% (up to 3%) of the seasonal component of the SNS SAC. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Assessment in relation to the North Sea Management Unit

679. The estimated maximum number of harbour porpoise that could potentially be disturbed as a result of operation and maintenance vessels at East Anglia TWO (alone) is up to 0.08% of the NS MU reference population, based on the worst-case scenario (**Table 5.15**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**
680. For the two large vessels per day during operation and maintenance the number of harbour porpoise that could potentially be disturbed is 0.1 (0.00003% of NS MU). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

5.3.5.2.4 Possible vessel interaction (collision risk) during operation and maintenance at East Anglia TWO (alone)

681. The operation and maintenance ports to be used for East Anglia TWO are not yet known. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore the increased risk for any vessel interaction is primarily within the windfarm site and cable route. Indicative operational and maintenance vessel movements indicate that there could be up to 687 vessel round trips per year (average of 1-2 vessels per day) during operation and maintenance (**Table 5.1**).

682. The baseline conditions indicate an already relatively high level of shipping activity in and around East Anglia TWO. Therefore, based on an average of two vessel movements per day, the increase in vessels movements during construction would be relatively small compared to existing vessel traffic.
683. Following the precautionary worst-case scenario approach in **section 5.3.5.1.6**, the number of harbour porpoise that could be at increased collision risk with vessels during construction has been assessed based on 5-10% (taking the strandings data of 4-8% into account) of the number of animals that could be present in the East Anglia TWO offshore development area (**Table 5.17**).
684. This is very precautionary, as it is highly unlikely that all harbour porpoise present in the East Anglia TWO offshore development area would be at increased collision risk with vessels during operation and maintenance, especially taking into account the relatively small increase in number of vessel movements compared to existing vessel movements in the area.
685. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where harbour porpoise 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 harbour porpoise.
686. In addition, based on the assumption that harbour porpoise would be disturbed from the East Anglia TWO offshore development area as a result of underwater noise from operation and maintenance activities and vessels, as assessed above, there should be no potential for increased collision risk with vessels at the offshore development area during the operation and maintenance period.
687. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.2.5 Potential changes to prey resource during operation and maintenance at East Anglia TWO (alone)

688. Potential effects on fish species during operation and maintenance can result from permanent loss of habitat; introduction of hard substrate; operational noise; and electromagnetic fields (EMF).
689. The introduction of hard substrate, such as turbines, foundations and associated scour protection as well as cable protection, would increase habitat heterogeneity through the introduction of hard structures in an area predominantly characterised by soft substrate habitat. However, any hard substrate would occupy discrete areas and the relatively small areas of the infrastructure. During

operation, the worst-case total area of habitat loss has been estimated to be up to 2.02km² in total at East Anglia TWO, up to 0.5% of the East Anglia TWO offshore development area (**Table 5.1**).

690. Operational noise would include wind turbine vibration, the contact of waves with offshore structures and noise associated with increased vessel movement, which could result in an increase in underwater noise in respect of the existing baseline (i.e. pre-construction). However, based on studies at operational offshore windfarms, any increase above background noise levels during operation is expected to be small and localised, therefore there would be no significant effect on fish species. This is supported by the noise modelling, which indicates the maximum potential impact ranges in fish is less than 50m for dredging activity, drilling, cable laying, rock placement or trenching; less than 50m for large and medium vessels; and less than 50m for operational wind turbines, based on the Popper et al. (2014) thresholds and criteria (see ES **Appendix 11.4**). The maximum potential area of disturbance would be up to 0.47km² for all 75 250m wind turbines (using the modelled impact range for the 300m turbines as a worst case).
691. The areas potentially affected by EMFs generated by the worst-case scenario offshore cables are expected to be small, limited to the area of the windfarm site and the offshore cable corridor and restricted to the immediate vicinity of the cables (i.e. within metres). The estimated maximum area of disturbance is approximately 8.7km², based on worst-case of 10m each side of 435km maximum cable length EMFs are expected to attenuate rapidly in both horizontal and vertical planes with distance from the source. Therefore, any potential effect of EMF on fish species would not be expected to be significant.
692. The total area that prey species could be displaced from (hard substrates including scour protection, noise from operational turbines and EMF from cables) is estimated to be up to 11.2km².

Spatial assessment

693. As a worse-case scenario, the changes to prey resources during operation and maintenance have also been assessed based on the entire East Anglia TWO offshore development area (356km²), approximately 3% of the winter SNS SAC. This is very precautionary, as outlined above it is highly unlikely that any changes in prey resources could occur over the entire windfarm area and the offshore cable corridor. It is more likely that effects would be restricted to any areas of habitat loss (approximately 2km²), up to 0.02% of the SNS SAC winter area.
694. Any changes to prey availability resulting in the displacement of all harbour porpoise from the entire offshore development area would not exceed 20% (up to 3%) of the seasonal component of the SNS SAC. Therefore, under these

circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Seasonal averages

695. For the assessment, it is assumed, as the worst-case scenario that changes to prey availability could occur throughout the season (e.g. all 182 days in winter period) and that the changes in prey availability could be across the entire offshore development area (**Table 5.14**).
696. Displacement of all harbour porpoise as a result of any changes in prey availability from the entire windfarm site and cable corridor area would not on average exceed 10% (up to 3%) of the seasonal component of the SNS SAC over the duration of that season during operation and maintenance at East Anglia TWO (alone). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

Assessment in relation to the North Sea Management Unit

697. The estimated maximum number of harbour porpoise that could potentially be affected by any potential changes to prey availability at East Anglia TWO (alone) during operation and maintenance is up to 0.08% of the NS MU reference population, based on the worst-case scenario (**Table 5.15**).
698. Based on the worst case scenario for the total area that prey species could be displaced (loss of habitat, hard substrates including scour protection, noise from operational turbines and EMF from cables; up to 11.2km²), approximately eight harbour porpoise (0.002% of the North Sea MU reference population) could be affected, based on the site-specific density estimate. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

5.3.5.2.6 Potential changes to water quality during operation at East Anglia TWO (alone)

699. Throughout operation, best practice techniques and due diligence regarding the potential for pollution throughout operation and maintenance activities will be followed. The EMP will include the mitigation measures embedded into the design (see **section 5.2.2.2.2**).
700. Any risk of accidental release of contaminants (e.g. through spillage) will be mitigated in line with the EMP and any changes to water quality as a result of any accidental release of contaminants (e.g. through spillage or vessel collision) is negligible. Therefore, the potential for pollutants to be released into the environment is not considered further in this assessment.

701. Disturbance of seabed sediments during operation will be considerably less than that during construction (see **section 5.3.5.1.8**) and localised to specific foundations or sections of cable throughout the project lifetime. Therefore, in line with the conclusions of the construction phase assessment, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise** (either in relation to seasonal or spatial criteria).

5.3.5.2.7 Potential overall effects during operation and maintenance at East Anglia TWO (alone)

702. There would be no further overall effects during operation and maintenance, as the potential disturbance from underwater noise from operational turbines, maintenance activities, vessels and any changes to prey availability have all been based on the entire windfarm site and offshore cable corridor area.

5.3.5.3 Potential Effects during Decommissioning at East Anglia TWO (alone)

703. The potential effects during decommissioning of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the site in relation to the Conservation Objectives are:

- Disturbance resulting from the noise associated with foundation removal (e.g. cutting);
- Disturbance resulting from underwater noise and disturbance from vessels;
- Barrier effects as a result of underwater noise associated with activities above;
- Vessel interaction (collision risk);
- Changes to prey resource; and
- Changes to water quality.

704. Possible effects on harbour porpoise associated with the decommissioning stage(s) have been summarised; however, an assessment 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.

5.3.5.3.1 Potential disturbance from the underwater noise associated with foundation removal

705. Decommissioning would most likely involve 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 inter-array 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 (approximately 1-2m below the seabed).

706. 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).
707. A detailed decommissioning plan will be produced prior to decommissioning that will give details of the techniques to be employed and any relevant mitigation measures.
708. For this assessment, it is assumed that the potential effects from underwater noise during decommissioning would be less than those assessed for piling and comparable to those assessed for non-piling construction activities. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.3.2 Potential disturbance from vessels

709. For this assessment, it is assumed that the potential effects would be the same as for construction. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.3.3 Possible vessel interaction (collision risk)

710. For this assessment, it is assumed that the potential effects would be the same as for construction. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.3.4 Potential changes to prey resource

711. For this assessment, it is assumed that the potential effects would be the same as for construction. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.3.5 Potential changes to water quality

712. For this assessment, it is assumed that the potential effects would be the same as for construction. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

5.3.5.3.6 Potential overall effects during decommissioning at East Anglia TWO (alone)

713. There would be no further overall effects during decommissioning, as the potential disturbance from underwater noise during foundation removal,

disturbance from vessels and any changes to prey availability have all been based on the entire East Anglia TWO windfarm site and offshore cable corridor area.

5.3.5.4 Summary of potential effects of East Anglia TWO Alone

714. **Table 5.27** summarises the potential effects of East Anglia TWO alone.

Table 5.27 Summary of the potential effects of East Anglia TWO alone

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
Construction at East Anglia TWO (alone)			
Potential effects resulting from underwater noise associated with clearance of UXO at East Anglia TWO (alone)			
Risk of permanent auditory injury (PTS) associated with underwater noise during UXO clearance.	Without mitigation, up to 0.08% of NS MU reference population could be at increased risk.	N/A Assessment based on number of individuals at potential risk.	No with the implementation of MMMP for UXO clearance
Potential disturbance from underwater noise associated with UXO clearance.	0.5% or less of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would be less than 20% of the seasonal component of the SNS SAC area (up to 16% of the winter area; up to 0.2% of summer area) at any one time and on average would not exceed 10% (up to 7%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential effects resulting from underwater noise during piling at East Anglia TWO (alone)			
Risk of permanent auditory injury (PTS) associated with underwater noise during piling.	Without mitigation, up to 0.21% of the NS MU reference population could be at increased risk.	N/A Assessment based on number of individuals at potential risk.	No with the implementation of MMMP for piling
Potential disturbance from underwater noise during proposed mitigation (e.g. 10 minute ADD activation)	0.0005% or less of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would be less than 20% of the seasonal component of the SNS SAC area (up to 0.02% of the winter area) at any one time and on average would not exceed 10% (up to	No

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
		0.02%) of the seasonal component of the SNS SAC area over the duration of that season.	
Potential disturbance from underwater noise during piling.	0.85% or less of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would be less than 20% of the seasonal component of the SNS SAC area (up to 16% of the winter area; up to 0.2% of summer area) at any one time and on average would not exceed 10% (up to 4%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential disturbance from underwater noise during non-piling construction activities at East Anglia TWO (alone)			
Potential disturbance from underwater noise during non-piling construction activities.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Possible disturbance from construction vessels at East Anglia TWO (alone)			
Potential disturbance from vessels during construction.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
Potential barrier effects from underwater noise during construction at East Anglia TWO (alone)			
Potential barrier effects from underwater noise during construction at East Anglia TWO (alone)	Up to 0.9% of the NS MU reference population could be temporarily affected.	N/A Assessment based on number of individuals potentially affected.	No
Possible vessel interaction (collision risk) during construction at East Anglia TWO (alone)			
Possible vessel interaction (collision risk).	Up to 0.008% of the NS MU reference population could be at increased risk.	N/A	No
Potential changes to prey resource during construction at East Anglia TWO (alone)			
Potential changes to prey resource.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential changes to water quality during construction at East Anglia TWO (alone)			
Potential changes to water quality.	Up to 0.08% of the NS MU reference population could be temporarily affected.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential overall effects during UXO clearance and piling at East Anglia TWO (alone)			
UXO detonation in cable corridor and	Up to 0.9% of the reference population	Temporary displacement of harbour porpoise could exceed 20% of the seasonal component	No with implementation of the SIP

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
piling at windfarm site – winter	could be temporarily disturbed.	of the SNS SAC area (up to 29.5% of winter area) at any one time, and could on average exceed 10% (up to 10.1%) of the winter component of the SNS SAC, if all piling and UXO activities were to take place within the winter period.	which would set out the approach to deliver any project mitigation or management measures in relation to the SNS SAC for harbour porpoise, to ensure no adverse effect on the integrity of the SNS SAC for harbour porpoise.
UXO detonation in cable corridor and piling at windfarm site – summer	Less than 0.9% of the reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 0.6% of summer area) at any one time and would not on average exceed 10% (up to 0.13%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential overall effects during piling and construction activities at East Anglia TWO (alone)			
Piling at windfarm site and other construction activities and vessels in cable corridor	0.5% or less of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 17.9% of winter area; up to 0.2% of summer area) at any one time and on average would not exceed 10% (up to 7.9%) of the seasonal component of the SNS SAC area for the winter season.	No

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
Operation and maintenance at East Anglia TWO (alone)			
Potential disturbance from the underwater noise associated with operational turbines at East Anglia TWO (alone)			
Potential disturbance from the underwater noise associated with operational turbines.	0.05% or less of the NS MU reference population could be disturbed.	Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 2% of winter area) at any one time and on average would not exceed 10% (up to 2%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential disturbance from the underwater noise associated with maintenance activities at East Anglia TWO (alone)			
Potential disturbance from the underwater noise associated with maintenance activities.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential disturbance from vessels during operation and maintenance at East Anglia TWO (alone)			
Potential disturbance from vessels during operation and maintenance.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
Possible vessel interaction (collision risk) during operation and maintenance at East Anglia TWO (alone)			
Possible vessel interaction (collision risk).	Up to 0.008% of the NS MU reference population could be at increased risk.	N/A	No
Potential changes to prey resource during operation and maintenance at East Anglia TWO (alone)			
Potential changes to prey resource.	Up to 0.08% of the NS MU reference population could be displaced.	Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential changes to water quality during operation and maintenance at East Anglia TWO (alone)			
Potential changes to water quality.	Less than construction	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time and on average would not exceed 10% of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential overall effects during operation and maintenance at East Anglia TWO (alone)			
Potential overall effects during operation and maintenance.	Up to 0.08% of the NS MU reference population could be displaced.	Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
Decommissioning at East Anglia TWO (alone)			
Potential disturbance from the underwater noise associated with foundation removal			
Potential disturbance from the underwater noise associated with foundation removal.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential disturbance from vessels			
Potential disturbance from underwater noise and disturbance from vessels.	Up to 0.08% of the NS MU reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Possible vessel interaction (collision risk)			
Possible vessel interaction (collision risk).	Up to 0.008% of the NS MU reference population could be at increased risk.	N/A Assessment based on number of individuals potentially affected.	No
Potential changes to prey resource			
Potential changes to prey resource.	Up to 0.08% of the NS MU reference population could be temporarily displaced.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS SAC summer and winter areas	Potential adverse effect on site integrity
Potential changes to water quality			
Potential changes to water quality.	Up to 0.08% of the NS MU reference population could be temporarily affected.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No
Potential overall effects during decommissioning			
Potential overall effects during decommissioning.	Up to 0.08% of the NS MU reference population could be temporarily affected.	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area (up to 3% of winter area) at any one time and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS SAC area over the duration of that season.	No

5.3.5.5 Potential in-combination effects

715. The in-combination assessment considers plans or projects where the predicted effects have the potential to interact with effects from the proposed construction, operation and maintenance or decommissioning of the East Anglia TWO project.

716. The plans and projects included in the in-combination assessment are located in the harbour porpoise MU area. The identification of plans and projects included in the in-combination assessment was based on:

- Projects that are under construction;
- Permitted application(s) not yet implemented;
- Submitted application(s) not yet determined;
- All refusals subject to appeal procedures not yet determined;
- Projects on the National Infrastructure's programme of projects; and
- Projects identified in the relevant development plan (and emerging development plans with appropriate weight being given as they move closer

to adoption) recognising that much information on any relevant proposals will be limited.

717. The offshore plans or projects considered included:

- Offshore windfarms;
- Marine renewables (wave and tidal);
- Port and harbour developments;
- Marine aggregate extraction and dredging;
- Licensed disposal sites;
- Oil and gas exploration and extraction; and
- Subsea cables and pipelines.

718. Operational offshore windfarms were considered part of the baseline if they were operational at the time of the start of the East Anglia TWO site specific surveys (November 2015).

719. Commercial fisheries within the North Sea and underwater noise associated with vessels from industries other than offshore wind farms, have the potential to have an in-combination effect on marine mammals, including harbour porpoise, alongside the construction of the East Anglia TWO project, through both the direct impact of by-catch and the indirect impact through the loss of marine mammal prey species (from commercial fisheries) and the disturbance from underwater noise (from vessel presence).

720. By-catch as a result of commercial fisheries is recognised as a historic and continuing cause of harbour porpoise mortality in the southern North Sea and will therefore be a factor in shaping the size of the current North Sea MU population. The available prey resource for harbour porpoise has also been influenced by historic and continuing commercial fishing. Noise from vessels associated with plans or projects other than offshore wind farm industries, such as oil and gas, aggregates and commercial fisheries, are also considered to be part of the baseline conditions.

721. This approach is in accordance with the Planning Inspectorate Advice Note 17 Cumulative Effects Assessment, which states that:

“Where other projects are expected to be completed before construction of the proposed NSIP and the effects of those projects are fully determined, effects arising from them should be considered as part of the baseline”.

722. The potential for in-combination effects associated with commercial fisheries within the SNS SAC site has been considered in the recent draft HRA for the RoC

(which was consulted upon in November 2018; BEIS 2018). With regard to effects to habitats, the draft RoC HRA states that (note that the SNS SAC was designated as a SCI at the time of writing):

“19.152 There have been no quantified assessments undertaken on the extent impacts from commercial fishing may have within the SCI and therefore information to inform this assessment is not available.

19.154 Without knowing the extent of impact on the seabed arising from the fishing industry and aggregate extraction it is not possible to undertake an in-combination assessment that addresses all the potential impacts on the habitats within the SCI.”

723. The conservation status of harbour porpoise has not declined in the years that commercial fishing has been undertaken in the North Sea and remains at a favourable level within both North Sea and in UK waters as a whole; therefore, the historical and current levels of commercial fishing in the North Sea is not considered to have affected the conservation status of the species (BEIS 2018).

724. With regard to direct effects on harbour porpoise, the draft RoC HRA (BEIS 2018) also states that:

“19.213 Commercial fishing has occurred within the SCI for many years and has had, and will continue to have, direct and indirect impacts on harbour porpoise, their habitat and prey within the SCI. As the conservation status of harbour porpoise in UK waters and the SCI is considered favourable (JNCC 2016, 2017a) current and historical levels of fishing in the SCI are not considered to have affected the conservation status of the species.

19.214 There are no known plans to suggest that the level of fishing within the SCI 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 SCI will not increase.”

725. Examiners Authority’s Further Written Questions and Requests for information for Hornsea Project 3 (15th January 2019) (page 46, Q 2.2.73) was that:

“Where there is ongoing fishing activity in the site, it is important that the impacts of the activity are captured within the assessment in the context of the conservation objectives of the affected designated site(s). This assessment will likely take place as part of the baseline characterisation of the development area, however, as fishing activity is mobile, variable and subject to change, there may be instances whereby fishing impacts are not adequately captured in the baseline characterisation and therefore may need to be considered as part of the in-combination assessment. This could be due to a change in effort; change in

management; or a change in legislation amongst other things, and fishery managers (i.e. MMO and IFCAs) would be best placed to advise on this.

In relation to the assessment of impacts on the SNS SCI, Natural England..... are not currently aware of anything that would have significantly altered the levels of fishing activity within the site; any current plans for new fisheries, or changes to existing fisheries that have not been captured, but we would look to fisheries managers to advise more definitively on these points."

726. This, along with the draft RoC, suggests that by-catch has not affected a population considered to be in FCS, whilst Natural England acknowledge that there is currently no evidence to suggest that the current levels of fishing would significantly alter in the future, they are consulting with fisheries managers (i.e. MMO and IFCAs) for further advice.
727. Therefore, the potential effects from commercial fishing (including by-catch and loss of prey species) and from the underwater noise associated with other, non-offshore wind farm industries (including oil and gas, aggregates and commercial fisheries) are considered to be a part of the environmental baseline for marine mammals of the North Sea, including for harbour porpoise, and are screened out of further assessment for the East Anglia TWO project.
728. The assessment is based on the in-combination effects of projects using the tiered approach as outlined in **Table 5.28** and is based on JNCC and Natural England (2013a) and takes into consideration the Planning Inspectorate (2015) Advice Note 17. The tiers reflect the likely degree of certainty attached to each development, with Tier 1 being the most certain and Tier 5 and 6 the least certain and most likely to have limited publicly available information to inform assessments (Planning Inspectorate 2015).

Table 5.28 Tiers for Undertaking In-combination Assessment

Tier	Consenting or Construction Phase	Certainty and Data Availability
Tier 1	- Operational projects that were not operational when baseline data were collected (e.g. environmental characterisation surveys); and - Operational projects that could have any ongoing or residual impact.	Increased certainty, confidence in the project design envelope and timeline for construction is high. Data available, including ES, HRA, pre-construction and possibly post-construction survey data.
Tier 2	Projects under construction	Increased certainty, confidence in the project design envelope and timeline for construction is high. Data available, including ES, HRA and pre-construction survey data.

Tier	Consenting or Construction Phase	Certainty and Data Availability
Tier 3	Projects that have been consented, but construction has not yet commenced.	Slightly less certainty, confidence in the project design envelope and timeline for construction is medium, as there could be some changes prior to construction. Data available, including ES, HRA and possibly pre-construction survey data.
Tier 4	- Projects that have an application submitted to the appropriate regulatory body that have not yet been consented; and - Projects that have been consented, construction has not yet commenced and there is the potential for changes in what was consented and timelines.	Less certainty compared to tier 1 and 2. Confidence in the project design envelope and timeline for construction is medium to low, as there could be changes from what has been submitted and will be constructed, including programme schedules. Data available includes ES and HRA.
Tier 5	Projects that the regulatory body are expecting an application to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects).	Increased uncertainty and limited data or information. Confidence in the project design envelope and timeline for construction is low. Data available could possibly include environmental characterisation survey data (but strong likelihood that this data will not be publicly available at this stage).
Tier 6	Projects that have been identified in relevant strategic plans or programmes	High uncertainty and limited data or information. Confidence in the project design envelope and timeline for construction is very low. Data available could possibly include historic survey data collected for other purposes/by other projects or industries or at a strategic level.

729. The in-combination assessment considers three types of potential effect (underwater noise, indirect effects and direct interaction) from all stages of any plan or project where there is the potential to overlap with the proposed East Anglia TWO project. The plans and projects assessed for potential in-combination effects are located within (i) the agreed reference population boundary of the North Sea MU for harbour porpoise; and (ii) the SNS SAC or within 26km of the SNS SAC boundary.
730. It should be noted that a large amount of uncertainty is inherent in the completion of an in-combination assessment. For example, the potential for effects over wide spatial and temporal scales means that the uncertainty of a large number of plans or projects can lead to low confidence in the information used in the

assessment, but also the conclusions of the assessment itself. To take this uncertainty into account, where possible, a precautionary approach has been taken at multiple stages of the assessment process. However, it should be noted that building precaution on precaution can lead to unrealistic worst-case scenarios within the assessment. However, by taking a very precautionary approach, the assessments are robust and cover the current worst case scenarios. The in-combination scenarios for the effects presented below therefore present an indication of the magnitudes of effect based on best available evidence. However, the true magnitude of effects at the time of construction will depend upon actual construction techniques, design of infrastructure and any mitigation utilised for each project. Developing the SIP pre-construction will allow for the following assessments to be reviewed and resultant management to then be based upon accurate information at that time.

5.3.5.5.1 Potential disturbance from underwater noise during offshore windfarm piling

731. The in-combination assessment determines the potential for disturbance to harbour porpoise from underwater noise sources during the construction of the proposed East Anglia TWO project.
732. The commitment to the MMMP for UXO clearance (see **section 5.3.5.1.1.1**) and the MMMP for piling (see **section 5.3.5.1.2.1**) would reduce the risk for any potential permanent auditory injury (PTS). No other activities were identified that could lead to these effects on this receptor. As such, the proposed East Anglia TWO project would not contribute to any in-combination effects for permanent auditory injury (PTS), therefore the in-combination assessment for underwater noise only considers potential disturbance effects.
733. 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 (as outlined in **section 5.2.2**).
734. The potential disturbance of harbour porpoise has been estimated for each offshore windfarm project based on:
- The potential disturbance area during single pile installation, based on a radius of 26km from each piling location (2,124km² per project); and where applicable
 - The potential disturbance area during concurrent pile installation, based on a radius of 26km from two piling locations per project with no overlap in disturbance areas (4,248km² per project).
735. There is a high level of uncertainty in relation to the in-combination scenarios that will arise by the time of East Anglia TWO construction. The assessment has been undertaken based on the most realistic worst-case scenario of the offshore

windfarms that could be piling at the same time as the proposed East Anglia TWO project. This scenario is a precautionary approach using the maximum duration of potential piling periods, based on currently available information (**Table 5.29**).

736. It should be noted that developing the SIP pre-construction will allow for these assessments to be reviewed and updated based on the latest information for offshore windfarms could be piling at the same time as East Anglia TWO, taking into account any further mitigation or management measures, as well as embedded mitigation measures (as outlined in **section 5.2.2**).
737. The realistic worst-case scenario takes into account the most likely and most efficient build scenarios, based on certain assumptions e.g. developers of more than one site are unlikely to develop more than one site at a time, as it is more efficient and cost effective to develop one site and have it operational prior to constructing the next site. It has therefore been assumed that there will be no overlap in the piling of the Thanet Extension, Norfolk Vanguard and Norfolk Boreas, or between the East Anglia THREE, and the proposed East Anglia ONE North and East Anglia TWO projects, and that only two of the four Dogger Bank projects could be piling at the same time. It has however been assessed that these projects could have overlapping construction windows, and therefore all offshore wind farm projects with overlapping offshore construction windows with the East Anglia TWO project have been included for the assessment of other construction activities, unless they have previously been included within the assessment for cumulative piling with East Anglia TWO (i.e. projects that have overlapping overall construction windows with the East Anglia TWO project, but do not have overlapping piling periods, have been included in the other construction activities assessment).
738. The in-combination assessment has been based on single piling at the East Anglia TWO windfarm site, with single or concurrent piling in the other offshore windfarms.
739. For the in-combination assessment, the potential piling period for the proposed East Anglia TWO project has been based on the widest likely range of offshore construction dates between 2025 and 2027, as a very precautionary approach and to allow for any delays to the proposed schedule.
740. As outlined in **section 5.3.5.1.2.3**, the duration of potential disturbance, based on the worst-case scenario for the installation of 60 300m wind turbines with pin-piles, five platforms with pin-piles and 10 minute ADD activation per pile, would be up to 41.6 days. Therefore, the maximum active piling duration, based on the worst-case scenario would be approximately 9% of the approximate 27 month construction period.

741. These figures are typical of offshore wind projects and when comparing the potential in-combination effects of several projects it is important to note that the likelihood of several projects all piling at the same time is comparatively low as the length of active piling time per project construction period is relatively low (typically in the order 3-5% depending on construction programme). The likelihood of concurrent piling occurring between offshore windfarms is also affected by other factors including seasonality, vessel market conditions and by weather in the North Sea.

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Table 5.29 Offshore windfarms included in the In-Combination for the Potential Disturbance of Harbour Porpoise where there is the Potential of Piling Occurring at the Same Time as Piling at East Anglia TWO (all details presented are based on the most up to date information for each project at the time of writing)

Name and country of project	Distance from East Anglia TWO windfarm site (km)	Distance from offshore cable corridor (km)	Size (MW)	Maximum number of turbines	Date of consent (7yr construction window)	Dates of offshore construction / piling ¹	Realistic worst-case scenario of piling occurring at the same time as East Anglia TWO
East Anglia TWO	0	0	Up to 900	Up to 75	2020 (2020-2027)	2025 - 2027	Yes
Tier 3: consented							
Blyth Demonstration site (3A & 4), UK	394.1	377.0	58.4	10	2013 (2013-2020)	Unknown	No
Creyke Beck A, UK	268.5	258.2	1,200	200	Feb-15 (2015-2022)	2021-2027	Yes ²
Creyke Beck B, UK	291.3	280.6	1,200	200	Feb-15 (2015-2022)	2021-2028	No ²
East Anglia THREE, UK	47.7	45.1	1,200	172	Aug-17 (2017-2024)	Piling: 2020 – 2022	No
Hornsea Project Two, UK	180.4	167.7	1,386	165	Aug-16 (2016-2023)	2020-2022	No
Inch Cape, UK	523.7	506.9	784	110	2014 & 2017 (2017-2024)	2021-2022	No

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Name and country of project	Distance from East Anglia TWO windfarm site (km)	Distance from offshore cable corridor (km)	Size (MW)	Maximum number of turbines	Date of consent (7yr construction window)	Dates of offshore construction / piling ¹	Realistic worst-case scenario of piling occurring at the same time as East Anglia TWO
Moray Firth East	728.6	712.6	950	100	2014 (2014-2021)	2019-2022	No
Neart na Gaoithe, UK	523.8	506.9	448	75	2014 & 2017 (2017-2024)	2021	No
Sofia (formerly Teesside B), UK	288	278.2	1,200	200	Aug-15 (2015-2022)	2020-2028	Yes ²
Teesside A, UK	302.5	135.1	1,200	200	Aug-15 (2015-2022)	2021-2028	No ²
Triton Knoll phase 1-3, UK	151.8	135.1	1,200	288	Jul-13 (2013-2020)	2019-2022	No
Mermaid (Belgium)	44.1	61.1	235	28	2015 (2015-2022)	2017-2019	No
Northwester 2 (Belgium)	48.3	65.1	224	22-38	2015 (2015-2022)	Unknown	No
SeaStar, Belgium	57.0	74.1	252	30	2014 (2014-2021)	Unknown	No
Eoliennes du Calvados (France)	333.5	342.4	450	75	2016 (2016-2023)	Unknown	No

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Name and country of project	Distance from East Anglia TWO windfarm site (km)	Distance from offshore cable corridor (km)	Size (MW)	Maximum number of turbines	Date of consent (7yr construction window)	Dates of offshore construction / piling ¹	Realistic worst-case scenario of piling occurring at the same time as East Anglia TWO
Parc éolien en mer de Dieppe - Le Treport, France	175.3	180.4	496	62	2019 (2019-2026)	Unknown	No
Parc éolien en mer de Fécamp (France)	262.3	273.5	498	83	2016 (2016-2023)	Unknown	No
Borkum Riffgrund West II (Germany)	326.8	323.6	240	16-18	2017 (2017-2024)	Unknown	No
Gode Wind 03 (Germany)	379.8	377.6	110	7-8	2016 (2016-2023)	2020	No
Gode Wind 04 (Germany)	377.7	375.2	450	75	2009 (2009-2016)	2023	No
Kaskasi (Germany)	440.2	437.6	235	34	2018 (2018-2025)	2018-2022	No
Borssele I and II (Netherlands)	56.1	73.5	752	94	May-16 (2016-2023)	2019	No
Borssele III and IV (Netherlands)	45.6	62.8	731.5	77	May-16 (2016-2023)	2020	No

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Name and country of project	Distance from East Anglia TWO windfarm site (km)	Distance from offshore cable corridor (km)	Size (MW)	Maximum number of turbines	Date of consent (7yr construction window)	Dates of offshore construction / piling ¹	Realistic worst-case scenario of piling occurring at the same time as East Anglia TWO
Borssele Site V - Leeghwater - Innovation Plot (Netherlands)	45.6	62.8	20	2	May-16 (2016-2023)	2020	No
Hollandse Kust Zuid Holland I and II – Chinook (Netherlands)	115.0	126.7	648-780	58-126	2018 (2018-2025)	2023	No
Windpark Fryslan (Netherlands)	228.3	228.4	382.7	89	2018 (2018-2025)	2019-2021	No
Tier 4: application submitted or project on-hold							
Dounreay Tri	826.8	836.8	10	2	2017 (2017-2024)	Unknown	No
East Anglia ONE North	10.4	0	Up to 800	Up to 67	2020 (2020-2027)	2026 - 2028	No ⁴
Firth of Forth Phase 1 Seagreen Alpha & Bravo, UK	533.2	517.0	1,500	120	2014 & 2017 (2017-2024)	2021-2024	No
ForthWind Demo Phase 1	551.0	533.0	12	2	2016 (2016-2023)	Unknown	No

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Name and country of project	Distance from East Anglia TWO windfarm site (km)	Distance from offshore cable corridor (km)	Size (MW)	Maximum number of turbines	Date of consent (7yr construction window)	Dates of offshore construction / piling ¹	Realistic worst-case scenario of piling occurring at the same time as East Anglia TWO
Hornsea Project Three	164.7	156.3	2,400	319	2019 TBC (2019-2026)	Construction: 2022-2029 Piling: 2022-2023 and 2027-2028	No
Moray Firth West	724.4	708.3	750	90	2019 (2019-2026)	2022-2024 Piling: 2022-2023	No
Norfolk Boreas	78.1	71.7	1,800	90-200	2020 (2020-2027)	Construction and piling: 2025 – 2029	No ³
Norfolk Vanguard	63.0	55.1	1,800	90-200	2019 (2019-2026)	Construction and piling: 2024 – 2028	Yes ³
Thanet Extension	70.2	73.3	340	34	2019 (2019-2026)	2024-2028	No ³

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Name and country of project	Distance from East Anglia TWO windfarm site (km)	Distance from offshore cable corridor (km)	Size (MW)	Maximum number of turbines	Date of consent (7yr construction window)	Dates of offshore construction / piling ¹	Realistic worst-case scenario of piling occurring at the same time as East Anglia TWO
Tier 5: application in preparation							
Hornsea Project Four	183.7	169.8	Up to 1,000	Up to 180	2021 (2020-2027)	Unknown	No

¹Piling and offshore construction dates are based on the latest dates and information available.

²It is highly unlikely that all four Dogger Bank projects would be piling at the same time; therefore, the two projects that could be constructed at the same time (i.e. they have different developers) have been included in the realistic worst-case scenario.

³Based on the most efficient and most likely build scenario, Vattenfall would conduct piling at only one site at a time, with no concurrent piling between Thanet Extension, Norfolk Vanguard and Norfolk Boreas. Norfolk Vanguard has been chosen as has the most likely piling period overlap with East Anglia TWO of the three Vattenfall projects, based on the most recent and publicly available information and based on the assumption that Thanet Extension could be developed first, followed by Norfolk Vanguard and then Norfolk Boreas.

⁴Based on the most efficient and most likely build scenario, the Applicant would conduct piling at only one site at a time.

Spatial assessment

742. For each project, the area of potential disturbance for single and concurrent piling that overlaps the SNS SAC winter and summer areas has been estimated, based on the worst-case scenarios for the maximum, minimum and average overlap.
743. The offshore windfarms included in the assessment are located within the SNS SAC or less than 26km from the boundary of the SNS SAC (**Table 5.29**).
744. The realistic worst-case scenario takes into account the most likely and most efficient build scenarios. It is assumed that developers of more than one site would generally develop one site at a time, as it is more efficient and cost effective to develop one site and have it operational prior to constructing the next site. It has therefore been assumed, for example, that there will be no concurrent the piling for East Anglia TWO and East Anglia ONE North.
745. The realistic worst-case scenario for offshore windfarms that could be piling at the same time as East Anglia TWO in the North Sea MU includes three other UK offshore windfarms (**Table 5.29**):
- Creyke Beck A;
 - Sofia (formerly Teesside B); and
 - Norfolk Vanguard.
746. This assessment takes into account the overlap in the potential areas of disturbance based on the 26km radius at piling locations for each project and within each project for concurrent piling.
747. The estimated maximum, minimum and average overlap with the SNS SAC winter and summer areas if all four offshore windfarms were single piling at exactly the same time is outlined in **Table 5.30**, taking into account the overlap in disturbance areas (**Figures 9** and **10**). The assessment indicates that less than 20% of the SNS SAC winter and summer areas could be affected based on the minimum and average potential overlap for single piling at the four offshore windfarms. However, there is the potential to exceed 20% of the SNS SAC winter area based on the maximum potential overlap for single piling at the four offshore windfarms (**Table 5.30**).
748. For the realistic worst-case scenario, with single piling at East Anglia TWO and concurrent piling at Creyke Beck A, Sofia and Norfolk Vanguard (**Figures 11** and **12**), the assessment indicates that less than 20% of the SNS SAC winter and summer areas would be affected based on the minimum potential overlap. However, there is the potential to exceed 20% of the SNS SAC winter and

summer areas based on the maximum and average potential overlap (**Table 5.30**).

749. The scenario presented in this assessment is indicative of what the actual in-combination scenario could be, and it is considered unlikely that concurrent piling would occur at exactly the same time. Therefore, the assessment based on the concurrent piling scenario is highly conservative.
750. The approach to the in-combination assessment, based on the four offshore windfarms single piling, would allow for some of these sites not to be piling at the same time while others could be concurrent piling. This is considered to be the most realistic worst-case scenario, as it is highly unlikely that the other three windfarms would all be concurrently piling, for example, that all three windfarms would be piling two piles at exactly the same time as a pile being installed at East Anglia TWO.
751. As outlined above, although the potential piling duration for the proposed East Anglia TWO project has been assessed based on a precautionary maximum duration for construction, the actual piling time which could disturb harbour porpoise is only a very small proportion of this time, of up to approximately 41.6 days, which is approximately 5% of the estimated construction period, based on the estimated maximum duration to install individual piles.

Table 5.30 Estimated Maximum, Minimum and Average Overlap with SNS SAC Winter and Summer Areas for In-Combination Effects of Single and Concurrent Piling at East Anglia TWO, Sofia, Creyke Beck A and Norfolk Vanguard

In-combination assessment scenario	Maximum overlap with SNS SAC	Minimum overlap with SNS SAC	Average overlap with SNS SAC
4 offshore windfarms single piling	Maximum overlap with winter area* = 3,058km ² (22.9%)	Minimum overlap with winter area ¹ = 2,128km ² (15.9%)	Average overlap with winter area = 2,593km ² (19.4%)
	Maximum overlap with summer area ¹ = 5,261km ² (19.5%)	Minimum overlap with summer area ¹ = 3,500km ² (12.9%)	Average overlap with summer area = 4,381km ² (16.2%)
EA2 single piling and others concurrent piling	Maximum overlap with winter area* = 3,364km ² (25.2%)	Minimum overlap with winter area ¹ = 2,129km ² (15.9%)	Average overlap with winter area = 2,746km ² (20.5%)
	Maximum overlap with summer area* = 7,126km ² (26.4%)	Minimum overlap with summer area ¹ = 3,593km ² (13.3%)	Average overlap with summer area = 5,360km ² (19.8%)

¹using Norfolk Vanguard East as the worst-case scenario

*using Norfolk Vanguard West as the worst-case scenario

752. The Applicant is committed to working with the SNCBs and MMO in the development of a possible strategic approach to mitigation, if required subject to the final design and programme of the proposed East Anglia TWO project.
753. The Applicant assumes that, in line with the conclusions of the draft Review of Consents (BEIS 2018) a Site Integrity Plan will be developed for the proposed East Anglia TWO project and will set out the approach to deliver any project-level mitigation or management measures to ensure there is no adverse effect on the integrity of the Southern North Sea SAC with regard to any significant disturbance of harbour porpoise.
754. Any SIP developed would be in addition to the MMMP for piling. A combined outline SIP has been submitted with the DCO Application (document reference 8.17) for both UXO clearance and piling, however, two separate SIPs, one for piling and one for UXO clearance will be prepared in-consultation with the relevant SNCBs during the pre-construction period.
755. With the development of the SIP to deliver the appropriate mitigation and management measures across projects and managed by the MMO, it is considered that 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 effects from underwater noise during offshore windfarm piling.**

Seasonal averages

756. The seasonal averages have been calculated by multiplying the average of the minimum and maximum effect on any one day 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 SNS SAC and number of days piling per season).
757. This assessment follows the same approach as the East Anglia THREE HRA (EATL 2016) and is based on the following assumptions:
- The summer season (1st April – 30th September) is 183 days. It is assumed that at least a minimum of 5% of days would be lost due to poor weather during this season. This gives 173 full days on which pile driving could occur;
 - The winter season (1st October – 31st March) is 182 days (leap years have not been taken into account in the assessment). It is assumed that at least a minimum of 15% of days would be lost due to poor weather during this season. This gives a total of 154 full days on which pile driving could occur; and
 - 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.

758. The assessment indicates that on average, more than 10% of the SNS SAC over the duration of that season could be affected (**Table 5.31**), based on the average potential overlap of the winter and summer areas for piling at the four offshore windfarms occurring at the same time.
759. It should be noted, that piling would not be constant, with gaps between the installations of individual piles and periods when piling is not taking place when piles are brought out to the sites. There will also be potential down-time for weather or other technical issues. As such, the number of actual piling days for each project is likely to be considerably less than the worst-case scenario used in this assessment of 173 days in summer and 154 days in winter.
760. The assumptions outlined above are highly conservative and with management measures through the SIP, the number of piling days in each season could be managed. Therefore, with the appropriate measures in place, it is predicted that 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 effects from underwater noise during offshore windfarm piling.**

Table 5.31 Estimated Seasonal Averages based on Average Overlap with SNS SAC Winter and Summer Areas for In-Combination Effects of Single and Concurrent Piling at East Anglia TWO, Sofia, Creyke Beck A and Norfolk Vanguard

SNS SAC area	Number of potential piling days per season	Average overlap with SNS SAC	Estimated seasonal average
Winter area	154 days	Single piling = 19.4% Single piling at EA2 and concurrent piling at other sites = 20.5%	Single piling = 16.4% Single piling at EA2 and concurrent piling at other sites = 17.4%
Summer area	173 days	Single piling = 16.2% Single piling at EA2 and concurrent piling at other sites = 19.8%	Single piling = 15.5% Single piling at EA2 and concurrent piling at other sites = 18.7%

Assessment in relation to the North Sea Management Unit

761. For each project, the number of harbour porpoise in the potential area of disturbance for single and concurrent piling, has been estimated using the latest SCANS-III density estimates (Hammond et al. 2017) for the relevant survey block that the project 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.

762. The OWFs that were considered in this assessment were those located within the North Sea MU, not just in the SNS SAC or within 26km of the SNS SAC (**Table 5.29**).
763. This highly conservative realistic worst-case scenario for offshore windfarms that could be piling at the same time as East Anglia TWO in the North Sea MU includes three other UK offshore windfarms (**Table 5.29**):
- Creyke Beck A;
 - Sofia (formerly Teesside B); and
 - Norfolk Vanguard.
764. It should be noted that the potential areas of disturbance have not taken into account the potential overlap in the areas of disturbance between different projects when calculating the number of harbour porpoise in the MU that could be affected and therefore this assessment is highly conservative.
765. For the realistic worst-case scenario, with single piling at East Anglia TWO and concurrent piling at Creyke Beck A, Sofia and Norfolk Vanguard, the estimated maximum area of potential disturbance is up to 14,868km², without any overlap in the potential areas of disturbance at each windfarm or between windfarms. Therefore, maximum number of harbour porpoise that could potentially be temporarily disturbed is 12,605 individuals, which represents approximately 4% of the North Sea MU reference population (**Table 5.32**).
766. Based on a single pile installation at each of the four offshore windfarms, the estimated maximum area of potential disturbance is 8,496km², without any overlap in the potential areas of disturbance between windfarms. Therefore, the maximum number of harbour porpoise that could potentially be temporarily disturbed is 6,947 individuals which represent approximately 2% of the North Sea MU reference population (**Table 5.32**).

Table 5.32 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Porpoise During Single and Concurrent Piling of Offshore Windfarms for the Realistic Worst-Case Scenario Based on the Offshore Windfarm Projects Which Could be Piling at the Same Time as Single Piling at the Proposed East Anglia TWO project

Name of Project	SCANS-III survey block	SCANS-III density estimate (No/km ²)	Potential number of harbour porpoise disturbed during single piling (2,124km ²)	Potential number of harbour porpoise disturbed during concurrent piling with no overlap (4,248km ²)
East Anglia TWO	L	0.607	1,289	1,289 (single piling only)
Creyke Beck A	O	0.888	1,886	3,772
Sofia	O ²	0.888	1,886	3,772
Norfolk Vanguard	O ¹	0.888	1,886	3,772
Total			6,947	12,605
% of North Sea MU reference population (345,373 harbour porpoise)			2.0%	3.65%

¹Norfolk Vanguard East is located in SCANS-III survey block L, ¹Norfolk Vanguard West is located in both SCANS-III survey block L and survey block O; therefore, higher density estimate from survey block O is used.

²Sofia overlaps SCANS-III survey block O and N, but majority of site is in block O.

767. The approach to the in-combination assessment, based on the four offshore windfarms single piling, would allow for some of these sites not to be piling at the same time while others could be concurrent piling. This is also more realistic scenario, as the offshore windfarms all concurrently piling at exactly the same time is overly precautionary.
768. As outlined above, although the potential piling duration for East Anglia TWO has been assessed based on a precautionary maximum duration for construction, the actual piling time and ADD activation which could disturb harbour porpoise is only a very small proportion of this time (approximately 9% of the estimated construction period).
769. The potential temporary effects would be less than those assessed in this assessment as there is likely to be a great deal of variation in timing, duration, and hammer energy used throughout the various offshore windfarm construction periods. In addition, not all harbour porpoise would be displaced over the entire 26km potential disturbance range. 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% of the population and at 21km the abundance was reduced by just 2%.

770. With the development of the SIP to deliver the use of appropriate management measures to be implemented by the MMO, it is proposed that 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 effects from underwater noise during offshore windfarm piling.**
771. The confidence that this assessment is precautionary enough to comfortably encompass the likely uncertainty and variability is high. Throughout the assessment it has been made clear where multiple and compounding precautionary assumptions have been taken. Additionally, where possible the uncertainty in the data typically used to inform in-combination assessments and the quantification of impacts when based on published ESs has been removed by using a standard impact range for disturbance and the SCANS-III density estimates for all offshore windfarm sites.

5.3.5.5.2 Potential disturbance from other noise sources

772. During the construction period at East Anglia TWO, there are other potential noise sources in addition to offshore windfarm piling that could also disturb harbour porpoise, these sources include:
- UXO clearance;
 - Seismic surveys by the oil and gas industry;
 - Offshore windfarm construction activities and vessels (excluding piling); and
 - Offshore windfarm operation and maintenance, including vessels.
773. The HRA screening (**Appendix 1**) determined it was highly unlikely that the following activities could contribute significantly to the in-combination effects of the disturbance of harbour porpoise from underwater noise:
- Tidal and wave marine renewables developments (construction, operation and maintenance);
 - Aggregate extraction and dredging;
 - Offshore mining;
 - Oil and gas projects, other than potential seismic surveys;
 - Licenced disposal sites;
 - Navigation and shipping operations; and
 - Carbon capture projects.

5.3.5.5.2.1 Unexploded ordnance

774. The commitment to the MMMP for UXO clearance at East Anglia TWO, as outlined in **section 5.3.5.1.1.1**, would reduce the risk of permanent auditory injury (PTS). As such, the proposed East Anglia TWO project would not contribute to any in-combination effects for permanent auditory injury (PTS), therefore the in-combination assessment for underwater noise only considers behavioural avoidance effects.
775. The approach to the in-combination assessment for disturbance from underwater noise follows the current advice from SNCBs on the assessment of impacts on the SNS SAC, as outlined in **section 5.2.2**, and has been based on the following parameter:
- A distance of 26km around UXO clearance has been used to assess the area that harbour porpoise could potentially be disturbed.
776. This assessment has been based on the potential for disturbance from one UXO detonation in the North Sea area.
777. However, as outlined in BEIS (2018), 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 et al. 2010).
778. It is also unlikely that more than one UXO detonation would occur at exactly the same time as another UXO detonation, even if they had overlapping UXO clearance operation durations. Therefore, including the potential disturbance of 26km around one UXO detonation (2,124km²) in this assessment is considered a worst-case scenario.

Spatial assessment

779. If one UXO detonation was undertaken at a time, the potential area of disturbance could be (2,124km²) which would be approximately 16% of the winter area or 8% of summer area.
780. If required, following further assessment pre-construction any agreements on when UXO detonations are undertaken could be developed in the SIP, to ensure no adverse effect on the integrity of the Southern North Sea regarding the potential significant disturbance of harbour porpoise.
781. Displacement of harbour porpoise would not exceed 20% of the seasonal components of the SNS SAC area at any one time during single UXO detonations

in the summer and winter areas. 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.**

Seasonal averages

782. It is currently not possible to determine the number of days per season that UXO clearance, if undertaken, could be in the SNS SAC winter and summer areas. Therefore, it has been assumed, as worst-case scenario, that there could be approximately 80 days on which UXO are detonated for each UXO clearance operation, with up to 40 days in each season.
783. 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.
784. The assessment indicates on average less than 10% of the seasonal component of the SNS SAC over the duration of that season could be affected, if there was one UXO operation in the summer or winter area (**Table 5.33**). 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.**

Table 5.33 Estimated Maximum Seasonal Averages for In-Combination Effects of UXO Clearance Operations in the SNS SAC Winter and Summer Areas

SNS SAC area	Number of UXO clearance days per season	Maximum area within SNS SAC	Estimated seasonal averages
Winter area	One UXO operation = 40 days	One UXO operation = 16%	One UXO operation = 3.52%
Summer area	One UXO operation = 40 days	One UXO operation = 8%	One UXO operation = 1.75%

Assessment in relation to the North Sea Management Unit

785. The potential disturbance area during a single UXO detonation, based on a radius of 26km from each location is 2,124km².
786. The SCANS-III harbour porpoise density estimate for the North Sea MU is 0.52/km² (Hammond et al. 2017). Without knowing the actual location for any UXO clearance this has been used to estimate the number of harbour porpoise that could potentially be disturbed (**Table 5.34**).

787. The number of harbour porpoise that could potentially be disturbed during one UXO clearance operation would be up to 1,105 harbour porpoise (0.32% of the North Sea MU reference population).
788. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.34 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during UXO Clearance Operations in the North Sea MU

UXO Clearance	SCANS-III density estimate (No/km ²)	Area of potential disturbance	Potential number of harbour porpoise disturbed (% of reference population)
Up to one UXO detonation at a time	0.52	2,124km ²	1,105 (0.32%)

5.3.5.5.2.2 Seismic surveys

789. 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, as outlined in **section 5.2.2**, and has been based on the following parameter:
- A distance of 10km around seismic operations for the oil and gas industry has been used to assess the area that harbour porpoise could potentially be disturbed.
790. It should be noted that this assessment is based on the potential impacts for seismic surveys required by the oil and gas industry. The higher frequencies in shallow waters typically used for surveys for offshore windfarms generally fall outside the hearing frequencies of cetaceans and the sounds produced are likely to attenuate more quickly than the lower frequencies used in deeper waters (JNCC 2017e; see **section 5.3**).

Spatial assessment

791. It is currently not possible to estimate the number of potential seismic surveys that could be undertaken in the SNS SAC by the oil and gas industry. It has therefore been assumed as a very worst-case scenario that there could potentially be up to two seismic surveys by the oil and gas industry, one in the summer area and one in the winter area at any one time. As outlined in the BEIS (2018) draft RoC HRA, between 2005 and 2015 there were 40 seismic surveys by the oil and gas industry in the SNS SAC during the summer and winter periods, resulting in an average of four surveys per year. The average number of days per year was 61.3 days (up to 17% of 365 days per year). Taking this into account

it is unlikely that two or more seismic surveys by the oil and gas industry will be conducted in the southern North Sea at exactly the same time.

792. Based on a potential range of 10km, the area of disturbance could be up to 314km², approximately 2.5% of the winter area and approximately 1.2% of the summer area.
793. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time. 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.**

Seasonal averages

794. It is currently not possible to determine the number of days per season that seismic surveys by the oil and gas industry, if undertaken, would be in the SNS SAC summer and winter areas. Therefore, it has been assumed, as worst-case that each seismic survey by the oil and gas industry could be up to 10 days. For example, seismic surveys by the oil and gas industry were conducted over 10 days in two areas within the central Moray Firth, northeast Scotland in 2011 (Thompson et al. 2013). It should be noted that, the short-term disturbance by the seismic surveys by the oil and gas industry did not lead to long-term displacement of harbour porpoise, with animals typically detected at surveyed sites within a few hours, and the level of response declined through the 10 day survey (Thompson et al. 2013).
795. The assessment indicates on average less than 10% of the seasonal component of the SNS SAC over the duration of that season could be affected (**Table 5.35**). 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.**

Table 5.35 Estimated Maximum Seasonal Averages for In-Combination Effects of Seismic Surveys by the Oil and Gas Industry in the SNS SAC Winter and Summer Areas

SNS SAC area	Number of potential seismic survey days per season	Maximum overlap with SNS SAC area	Estimated seasonal average overlap with SNS SAC area
Winter area	One survey = 10 days	One survey = 2.5%	One survey = 0.14%
Summer area	One survey = 10 days	One survey = 1.2%	One survey = 0.07%

Assessment in relation to the North Sea Management Unit population

796. The potential disturbance area during a single seismic survey by the oil and gas industry, based on a radius of 10km from each location is 314km².
797. The SCANS-III harbour porpoise density estimate for the North Sea MU is 0.52/km² (Hammond et al. 2017). Without knowing the actual location for any seismic surveys this has been used to estimate the potential number of harbour porpoise that could potentially be disturbed (**Table 5.36**).
798. The number of harbour porpoise that could potentially be disturbed during one seismic survey by the oil and gas industry would be up to 163 harbour porpoise (0.05% of the North Sea MU reference population).
799. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.36 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during Seismic Surveys by the Oil and Gas Industry in the North Sea MU

Seismic surveys	SCANS-III density estimate (No/km ²)	Area of potential disturbance	Potential number of harbour porpoise disturbed (% of reference population)
Up to one seismic survey	0.52	314	163 (0.05%)

5.3.5.5.2.3 Offshore windfarm construction, other than piling

800. During piling at East Anglia TWO there is the potential overlap with underwater noise effects from the construction activities, other than piling, at other offshore windfarms. Noise sources which could cause potential disturbance during offshore windfarm construction activities, other than pile driving, can include vessels, seabed preparation, ploughing / jetting / pre-trenching or cutting for installation of cables and rock dumping for protection of the cable.
801. The potential ranges of these noise sources during offshore windfarm construction, other than piling, will be localised and significantly less than the ranges predicted for piling (**Table 5.13**).
802. As a precautionary approach, the in-combination assessment considered all UK and European offshore windfarms in the southern North Sea which could potentially have non-piling construction activities during the East Anglia TWO construction period (**Table 5.29**). This highly conservative approach identified six UK offshore windfarms:
- Creyke Beck B;

- Teesside A;
 - Thanet Extension;
 - Hornsea Project 3;
 - Norfolk Boreas; and
 - East Anglia ONE North.
803. There would be no additional cumulative impacts of underwater noise from other construction activities for those projects which also have overlapping piling with East Anglia TWO as the ranges for piling would be significantly greater than those from other construction noise sources.
804. The potential temporary disturbance during offshore windfarm construction activities, other than pile driving noise sources, has been based on the area of the offshore windfarm sites. This is a very precautionary approach, as it is highly unlikely that construction activities, other than piling activity would result in disturbance from the entire windfarm area. Any disturbance is likely to be limited to the area in and around where the activity is actually taking place. In addition, it is likely, as outlined for the in-combination assessment for piling, that developers of more than one site will develop one site at a time, as it is more efficient and cost effective to develop one site and have it operational prior to constructing the next site.

Spatial assessment

805. For each project within (wholly or partly) the SNS SAC, the area of the offshore windfarm site that overlaps the winter and summer areas has been estimated (**Table 5.37**).
806. The in-combination assessment indicates that if the six offshore windfarms were conducting non-piling construction activities, the estimated maximum in-combination area of disturbance, based on the worst-case scenario of the entire offshore windfarm area, is 2,779km² (**Table 5.37**).
807. Two of the offshore windfarms are located in or overlap with the winter area and the estimated maximum in-combination area of disturbance for the winter area is 239km², which represents approximately 1.9% of the winter SNS SAC area (**Table 5.37**).
808. Three of the offshore windfarms are located in or overlap with the summer area and the estimated maximum in-combination area of disturbance for the summer area is 1,347km², which represents approximately 5% of the summer SNS SAC area (**Table 5.37**).

809. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time. 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.**

Table 5.37 Spatial In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during Offshore Windfarm Construction Activities (other than piling) during Construction at East Anglia TWO

Name of Project	Area of OWF site (km ²)	Area in winter SAC area (km ²)	Area in summer SAC area (km ²)
Creyke Beck B	599	0	599
Teesside A	562	0	0
Thanet Extension	73	31	0
Hornsea Project 3	696	0	0
Norfolk Boreas	727	0	702
East Anglia ONE North	208	208	46
Total area	2,781	239	1,347
% of SNS SAC area		1.9%	5%

Seasonal averages

810. It is currently not possible to determine the number of days per season that construction activities, other than piling, could be conducted, therefore it has been assumed that they could be undertaken throughout both seasonal periods (e.g. 183 days in summer and 182 days in winter).
811. The assessment indicates on average less than 10% of the seasonal component of the SNS SAC over the duration of that season could be affected, based on 100% disturbance from the offshore windfarm areas (**Table 5.38**). 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.**

Table 5.38 Estimated Maximum Seasonal Averages for In-Combination Effects of Construction Activities, other than Piling, in the SNS SAC Winter and Summer Areas

SNS SAC area	Number of days per season	Maximum overlap with SNS SAC area	Estimated maximum seasonal average
Winter area	182 days	1.9%	1.9%
Summer area	183 days	5%	5%

Assessment in relation to the North Sea Management Unit

812. For each project, the number of harbour porpoise in the area of each OWF site has been estimated using the latest SCANS-III density estimates (Hammond et al. 2017) for the relevant survey block that the project 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.
813. The in-combination assessment indicates that if all six of these offshore windfarms in the southern North Sea were conducting non-piling construction activities at the same time, the estimated maximum in-combination area of disturbance is 2,864km² and the maximum number of harbour porpoise that could potentially be disturbed is 2,435 individuals, which represents approximately 0.71% of the North Sea MU reference population (**Table 5.39**). Therefore, under these circumstances there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.39 Quantified CIA for the Potential Disturbance of Harbour Porpoise During Construction Activities (Other Than Piling) at UK and European Offshore Windfarms During Construction for the Proposed East Anglia TWO Project

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed from entire WF area
Creyke Beck B	O	0.888	599	532
Teesside A	N	0.837	562	470
Thanet Extension	L	0.607	73	44
Hornsea Project 3	O	0.888	695	617
Norfolk Boreas	O ¹	0.888	727	646
East Anglia ONE North	L	0.607	208	126
Total			2,864	2,435

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed from entire WF area
% of North Sea MU reference population (345,373 harbour porpoise)				0.71%

*Source: <http://www.4coffshore.com/>

¹Norfolk Boreas overlaps SCANS-III survey block O and L; therefore, higher density estimate from survey block O is used.

5.3.5.5.2.4 Offshore windfarm operation and maintenance

814. There is the potential for disturbance from operational offshore windfarms as a result of any operational and maintenance activities, including operational turbines, vessels, additional rock dumping or cable re-burial, during the East Anglia TWO construction period.
815. The potential disturbance from operational and maintenance activities at offshore windfarms has also been based on the worst-case scenario of the entire area of the windfarm sites. This is again a very precautionary approach, as it is highly unlikely that operational windfarms and maintenance activities, including vessels, would result in disturbance from the entire wind farm area. Any disturbance is likely to be limited to the area in and around where the activity is taking place (see **Table 5.13** and **Table 5.16**).
816. Operational offshore windfarms were considered part of the baseline if they were operational at the time of the start of the East Anglia TWO site specific surveys (November 2015). Therefore, offshore windfarms were screened into the CIA as having the potential to be newly operational by the East Anglia TWO construction period, in that they are currently under construction or will be constructed and operational by 2025.

Spatial assessment

817. For operational UK and European offshore windfarms within (wholly or partly) the SNS SAC that could have potential in-combination effects during the East Anglia TWO construction period, the area of the windfarm that overlaps the winter and summer areas has been estimated.
818. The in-combination assessment indicates that, based on the potential worst-case scenario, six UK offshore windfarms located in the SNS SAC could potentially have disturbance from operational and maintenance activities during the East Anglia TWO construction period, the estimated maximum in-combination area of disturbance is 915km² (**Table 5.40**).
819. Three of these windfarms is located in or overlaps with the summer area and the estimated maximum area of disturbance is 649km², which represents approximately 2.4% of the summer area (**Table 5.40**).

820. Three of these windfarms are located in the winter area and the estimated maximum in-combination area is 521km², which represents approximately 4.1% of the winter area (**Table 5.40**).
821. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area at any one time, based on 100% disturbance for the entire offshore windfarm area of operational windfarms in the Southern North Sea. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.40 Spatial In-Combination Assessment for the Potential Disturbance of Harbour Porpoise During Operation and Maintenance Activities at Offshore Windfarms During Construction at East Anglia TWO

Name of Project	Area of OWF site (km ²)	Area in winter SAC area (km ²)	Area in summer SAC area (km ²)
Galloper	113	113	0
Hornsea Project One	407	0	50
Hornsea Project Two	462	0	298
East Anglia ONE	205	205	0
East Anglia THREE	301	203	301
Triton Knoll phase 1-3	146	0	0
Total	915	521	649
% of SNS SAC area		4.1%	2.4%

Seasonal averages

822. It has been assumed that underwater noise from operational and maintenance activities could be throughout both seasonal periods (e.g. 183 days in summer and 182 days in winter).
823. The assessment indicates on average less than 10% of the seasonal component of the SNS SAC over the duration of that season could be affected, based on 100% disturbance from the offshore windfarm areas (**Table 5.41**). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.41 Estimated Maximum Seasonal Averages for In-Combination Effects of Operational and Maintenance Activities at other Offshore Windfarms in the SNS SAC Winter and Summer Areas

SNS SAC area	Number of days per season	Average overlap with SNS SAC area	Estimated seasonal average
Winter area	182 days	4.1%	4.1%
Summer area	183 days	2.4%	2.4%

Assessment in relation to the North Sea Management Unit

824. Operational UK and European offshore windfarms in the southern North Sea that could have potential in-combination effects during the East Anglia TWO construction period have an estimated maximum potential in-combination area up to 4,975km² (based on disturbance from entire offshore windfarm area) and the maximum number of harbour porpoise that could be temporarily disturbed would be up to 2,808 individuals which represents approximately 0.8% of the North Sea MU reference population (**Table 5.42**). Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise**.

Table 5.42 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Porpoise During Operation and Maintenance Activities at Offshore Windfarms in the Southern North Sea During Construction at the Proposed East Anglia TWO Project

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed
Beatrice	S	0.152	131	20
Blyth Offshore Wind Demo 2 ¹	R	0.599	<1	1
Blyth Offshore Wind Demo 3A & 4 ²	R	0.599	4	2
Borkum Riffgrund II ²	N	0.837	36	30
Borkum Riffgrund West I ²	N	0.837	30	25
Borkum Riffgrund West II ²	N ³	0.837	16	13
Borssele I and II	N	0.837	113	95

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed
Borssele III and IV	N	0.837	122	102
Borssele Site V	N	0.837	1	1
Dan Tysk	M	0.277	66	18
Deutsche Bucht (DeBu)	N	0.837	18	15
Deutsche Bucht Pilot Park	N	0.837	1	0.8
Dounreay Tri	S	0.152	25	4
Dudgeon ¹	O	0.888	55	49
East Anglia ONE	L	0.607	205	124
East Anglia THREE	L	0.607	301	183
EnBW He Dreiht	M	0.277	62	17
EnBW Hohe See (Hochsee Windpark 'Nordsee')	M	0.277	40	11
Eneco Luchterduinen	N	0.837	16	13
Eoliennes du Calvados	C	0.213	78	17
European Offshore Wind Deployment Centre EOWDC (Aberdeen Demonstration)	R	0.599	20	12
Firth of Forth Phase 1 Seagreen Alpha & Bravo	5	0.599	391	234

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed
ForthWind Demo Phase 1	R	0.599	9	5
Galloper ¹	L	0.607	113	69
Gemini ¹	N	0.837	70	59
Global Tech I	M	0.277	42	12
Gode Wind 1 and 2 ¹	M	0.277	70	19
Gode Wind 03 ²	M	0.277	4	1
Gode Wind 04 ²	M	0.277	29	8
Hollandse Kust Zuid Holland II ²	N	0.837	103	86
Horns Rev 3 ²	M	0.277	144	40
Hornsea Project One	O	0.888	407	361
Hornsea Project Two	O	0.888	462	410
Humber Gateway Wind Farm	O	0.888	27	24
Hywind – Pilot Park ¹	R	0.599	15	9
Inch Cape	R	0.599	15	9
Kaskasi ²	M	0.277	17	5
Kentish Flats Extension	L	0.607	8	5
Kincardine	R	0.599	110	66
Kvitsøy Wind Turbine Demonstration Area ²	V	0.137	<1	0
Merkur ²	M	0.277	39	11

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed
Mermaid	N	0.837	16	13
Moray Firth East	S	0.152	295	45
Moray Firth West	S	0.152	226	34
Neart Na Gaoithe	5	0.599	105	63
Nisum Bredning Vind	P	0.823	5	4
Nobelwind	N	0.837	22	18
Nordergrunde ¹	M	0.277	3	1
Nordsee One (Innogy Nordsee I)	M	0.277	31	9
Nordsee Ost	M	0.277	36	10
Norther ²	L	0.607	38	23
Northwester 2 ²	L	0.607	12	7
OWP Albatros	M	0.277	11	3
OWP West ²	N	0.837	14	12
Parc eolien en mer de Dieppe - Le Treport	C	0.213	150	32
Parc éolien en mer de Fécamp	C	0.213	88	19
Race Bank ¹	O	0.888	62	55
Rampion Wind Farm	C	0.213	79	17
Rennesø Wind Turbine Demonstration Area ²	V	0.137	1	0

Name of Project	SCANS-III Survey Block	SCANS-III density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour porpoise disturbed
RENTEL ²	L	0.607	23	14
Sandbank ¹	M	0.277	47	13
Seastar	L	0.607	20	12
Trianel Windpark Borkum Phase 2 (aka Borkum West II phase 2)	M	0.277	33	9
Triton Knoll phase 1-3	O	0.888	146	130
UNITECH Zefryos	V	0.137	1	0.137
Veja Mate ¹	N	0.837	51	43
Westermeerwind	N	0.837	8	7
Windpark Fryslan	N	0.837	35	29
Total			4,975km²	2,808
% of North Sea MU reference population (345,373 harbour porpoise)				0.8%

*Source: <http://www.4coffshore.com/>

¹Operational after the start of the East Anglia TWO site specific surveys, but before the submission of the PEI

²Unknown date of project operation, but assumed to be before the construction of East Anglia TWO

5.3.5.5.3 Potential in-combination effects from underwater noise for offshore windfarm piling and all other noise sources

825. The potential in-combination effects from all noise sources including offshore windfarm piling during construction at East Anglia TWO is summarised in **Table 5.43**.

826. The maximum number of harbour porpoise that could potentially be temporarily disturbed, based on the very precautionary approach taken in the assessment is 13,458 individuals, which represents approximately 3.9% of the North Sea MU reference population (**Table 5.43**).

827. Based on the worst-case scenarios and very precautionary approach taken in the assessment, there is the potential for up to 45.6% of the winter area, with a

seasonal average of 26.04% or up to 32.8% of the summer area, with a seasonal average of 22.8%, to be affected.

828. With the development of the SIP to deliver the appropriate mitigation and management measures across projects and managed by the MMO, it is considered that 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.**

East Anglia TWO Offshore Windfarm

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Table 5.43 Quantified In-Combination Assessment for the Maximum Potential Disturbance of Harbour Porpoise in the North Sea MU and SNS SAC Summer and Winter Areas from Underwater Noise during Construction at East Anglia TWO

Potential noise sources during construction at East Anglia TWO	Area in winter SAC area (km ²) (% of seasonal area)	Area in summer SAC area (km ²) (% of seasonal area)	Seasonal average for winter SAC area	Seasonal average for summer SAC area	Potential number of harbour porpoise disturbed (% of NS MU)
Piling at offshore windfarm projects, based on worst-case scenario for projects that could be piling at the same time as East Anglia TWO (Creyke Beck A, Sofia and Norfolk Vanguard) for single pile installation at each site and average overlap with seasonal area	2,593km ² (19.4%)	4,381km ² (16.2%)	16.4%	15.5%	6,947 (2%)
Offshore windfarm construction activities, for windfarms that are not piling but potential for other construction activities during construction at East Anglia TWO, based on 100% disturbance from windfarm area and maximum overlap with seasonal area	239km ² (1.9%)	1,347km ² (5%)	1.9%	3%	2,435 (0.7%)
Offshore windfarm operation and maintenance, for windfarms operational after the start of the East Anglia TWO site specific surveys based on 100% disturbance from windfarm area and maximum overlap with seasonal area	521km ² (4.1%)	649km ² (2.4%)	4.1%	2.4%	2,808 (0.8%)
UXO clearance, based on up two locations, one in each seasonal area and maximum overlap with seasonal area	2,124km ² (16%)	2,124km ² (8%)	3.5%	1.8%	1,105 (0.3%)

Potential noise sources during construction at East Anglia TWO	Area in winter SAC area (km ²) (% of seasonal area)	Area in summer SAC area (km ²) (% of seasonal area)	Seasonal average for winter SAC area	Seasonal average for summer SAC area	Potential number of harbour porpoise disturbed (% of NS MU)
Seismic surveys, based on up to two locations, one in each seasonal area and maximum overlap with seasonal area	314km ² (2.5%)	314km ² (1.2%)	0.14%	0.07%	163 (0.05%)
Total (seasonal average based on up to 154 piling days in winter and 173 piling days in summer)	5,791 (45.6%)	8,815 (32.6%)	26.04%	22.8%	13,458 (3.9%)

5.3.5.5.4 Direct interaction: possible increased collision risk

829. An increase in vessel movements and wave / tidal arrays can pose a potential collision risk for harbour porpoise.
830. During the construction of offshore windfarms, vessel movements to and from any port will be incorporated within existing vessel routes and therefore the increased risk for any vessel interaction is within the windfarm site. Harbour porpoise in the area would be accustomed to the presence of vessels and therefore be expected to be able to detect and avoid construction vessels (see **section 5.3.5.1.6**).
831. Any increase in vessel movements during the operation and maintenance of offshore windfarms would be relatively small in relation to current ship movements in the area (see **section 5.3.5.2.4**). Therefore, there is unlikely to be a significant increase in collision risk during the operation and maintenance of offshore windfarms and as a result this has not been included in the in-combination assessment.
832. Wave and tidal arrays can pose a potential collision risk for harbour porpoise. The likelihood for collision may depend on many variables such as underwater visibility, detectability of the devices, the size and type of devices, the location, water depth and the rotation speed of the rotor blades. However, if there is the potential for significant collision risk for harbour porpoise then the wave or tidal development would be required to implement suitable mitigation to reduce the risk and any potential significant effects at the population level. Therefore, there should be no potential for any significant in-combination effects and as a result this has not been included in the in-combination assessment.
833. As a precautionary approach, the number of harbour porpoise that could be at increased collision risk with vessels has been assessed based on a 5% increased collision risk for the number of animals that could be present in the windfarm areas. This is very precautionary, as it is highly unlikely that 5% harbour porpoise present in the windfarm areas could be at increased collision risk with vessels.
834. In addition, based on the assumption that harbour porpoise would be disturbed as a result of underwater noise from piling, other construction activities, operational and maintenance activities and vessels, there should be no potential for increased collision risk with vessels.
835. The precautionary in-combination assessment has determined that the number of harbour porpoise that could have a potential increased collision risk with vessels in offshore windfarm sites in the North Sea MU during construction would be 204 individuals, which represents 0.06% of the North Sea MU reference population (**Table 5.44**). Therefore, under these circumstances, there is **no**

potential adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.

Table 5.44 Quantified In-Combination Assessment for the Possible Increased Collision Risk with Vessels for Harbour Porpoise in the North Sea MU during the East Anglia TWO construction period

Name of Project	SCANS-III survey block	SCANS-III density estimate (No/km ²)	Area of OWF site (km ²)*	Potential number of harbour porpoise based on 5% increased collision risk
East Anglia TWO	L	0.607	218	7
Creyke Beck A	O	0.888	515	23
Creyke Beck B	O	0.888	599	27
Teesside A	N	0.837	562	24
Sofia	O ²	0.888	593	26
Norfolk Vanguard	O ¹	0.888	592	26
Norfolk Boreas	O ³	0.888	727	32
Hornsea Project Three	O	0.888	695	31
Thanet Extension	L	0.607	73	2
East Anglia ONE North	L	0.607	208	6
Total				204
% of North Sea MU reference population (345,373 harbour porpoise)				0.06%

¹NV East is located in SCANS-III survey block L, NV West is located in both SCANS-III survey block L and survey block O; therefore, higher density estimate from survey block O is used.

²Dogger Bank Zone Teesside B overlaps SCANS-III survey block O & N, but majority of site is in block O.

³Norfolk Boreas overlaps SCANS-III survey block O & L; therefore, higher density estimate from survey block O is used.

*Source: <http://www.4coffshore.com/>

5.3.5.5.5 Indirect effects: potential changes in prey resources

836. Potential effects on prey species during construction can result from increased suspended sediment concentrations and sediment re-deposition and underwater noise (leading to mortality, physical injury, auditory injury or behavioural responses); the potential effects on fish species during operation and maintenance can include physical disturbance and loss or changes of seabed habitat, introduction of hard substrate, operational noise, and EMF; and during decommissioning potential effects on fish species can include physical

disturbance, loss or changes of habitat, increased suspended sediment concentrations, re-mobilisation of contaminated sediments and underwater noise. Some of the effects could be negative with fish species moving away or being lost from an area, while some effects could have a negative or positive effect, such as possible changes in species composition, and other effects could result in a positive effect, such as the aggregation of prey around seabed structures.

837. The potential effects on harbour porpoise as a result of any changes to prey availability can include changes in distribution, abundance and community structure, increased competition with other marine mammal species, increased susceptibility to disease and contaminants, and implications for reproductive success, which could potentially affect individuals throughout their range or at different times of the year. However, any changes to prey tend to be localised and temporary in nature. In addition, if prey species are disturbed from an area, it is highly likely that harbour porpoise will also be disturbed from the area over a potentially wider range than prey species.
838. The in-combination assessment on potential changes to prey availability has assumed that any potential effects on harbour porpoise prey species from underwater noise, including piling, would be the same or less than those for harbour porpoise. Therefore, there would be no additional effects other than those assessed harbour porpoise, i.e. if prey are disturbed from an area as a result of underwater noise, harbour porpoise will be disturbed from the same or greater area, therefore any changes to prey availability would not affect harbour porpoise as they would already be disturbed from the same area.
839. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Consequently, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise arising from changes in prey resources.**

5.3.5.5.6 Potential in-combination effects during operation and maintenance

840. The following in-combination effects could occur during the operational life of the proposed East Anglia TWO project:
- Underwater noise associated with the clearance of UXO (at locations other than the East Anglia TWO offshore development area);
 - Underwater noise during piling (at locations other than the East Anglia TWO offshore development area);

- Underwater noise during non-piling construction activities (at locations other than the East Anglia TWO offshore development area);
- Underwater noise and disturbance from vessels;
- Barrier effects as a result of underwater noise associated with activities above;
- Vessel interaction (collision risk);
- Changes to prey resource; and
- Changes to water quality.

841. The in-combination impact of any of the above during operation would be no worse than the in-combination impacts assessed above for the construction period of the proposed East Anglia TWO project. During times where there is limited or no construction in the North Sea, impacts will be intermittent, temporary and highly localised to the source project. Consequently, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise arising from any of the in-combination impacts listed above during the operational life of the proposed East Anglia TWO project.**

5.3.5.5.7 Summary of potential in-combination effects

842. **Table 5.45** summarises the potential in-combination effects for harbour porpoise during the construction period at East Anglia TWO. The in-combination effects during operation and maintenance or decommissioning would be less than those assessed for construction.

Table 5.45 Summary of the Potential In-Combination Effects for East Anglia TWO

Potential Effect	Assessment in relation to the North Sea MU population	Spatial assessment in relation to the SAC summer and winter areas	Seasonal average in relation to the SAC summer and winter areas	Potential adverse effect on site integrity
Disturbance from underwater noise	13,458 harbour porpoise (3.9% of NS MU)	Maximum overlap with winter area = 45.6% Maximum overlap with summer area = 32.6%	Seasonal average for winter area = 26.04% Seasonal average for summer area = 22.8%	The use of appropriate management measures to be implemented by the MMO would result in no significant disturbance and no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.

Potential Effect	Assessment in relation to the North Sea MU population	Spatial assessment in relation to the SAC summer and winter areas	Seasonal average in relation to the SAC summer and winter areas	Potential adverse effect on site integrity
Indirect effects – changes in prey resources	No additional effects to those assessed for underwater noise			
Direct interaction - collision risk	Less than 0.1% of the NS MU reference population	N/A	N/A	No Less than 0.1% of the NS MU reference population could be at increased collision risk, without taking into account the potential disturbance of harbour porpoise as a result of underwater noise.

5.3.6 Summary of potential effects for SNS SAC

843. The assessment of the potential effects during the construction of East Anglia TWO alone and in-combination has been summarised in relation to the Conservation Objectives of the SNS SAC where harbour porpoise are a qualifying feature (**Table 5.46**).
844. Mitigation will be considered, if required, to limit the potential for in-combination disturbance effects, taking into account the current SNCB guidance for the assessment of the potential effects on the Southern North Sea SAC for harbour porpoise that:
- Displacement of harbour porpoise should not exceed 20% of the seasonal component of the SAC area at any one time and / or on average exceed 10% of the seasonal component of the SAC area over the duration of that season.
845. The Applicant is confident that use of appropriate management measures can be implemented to ensure no effect on the integrity of the Southern North Sea SAC as defined by its conservation objectives from the proposed East Anglia TWO project alone.

Table 5.46 Summary of the Assessment of the Potential Effects of East Anglia TWO (Alone and In-Combination) on the Southern North Sea SAC in Relation to the Draft Conservation Objectives for Harbour Porpoise

Conservation Objectives	Project alone including overall effects at East Anglia TWO (alone)			In-combination with other projects and activities		
	Disturbance from underwater noise	Increased collision risk	Changes to prey resources	Disturbance from underwater noise	Increased collision risk	Changes to prey resources
Harbour porpoise is a viable component of the site	x	x	x	x	x	x
There is no significant disturbance of the species	x	x	x	x (with SIP, if required)	x	x
The condition of supporting habitats and processes and the availability of prey is maintained	x	x	x	x	x	x

x = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives

5.4 The Wash and North Norfolk Coast SAC

846. The Wash, on the east coast of England, is the largest embayment in the UK. The extensive intertidal flats here and on the North Norfolk Coast provide ideal conditions for harbour seal breeding and hauling-out. Harbour seal are a primary reason for selection of this site (JNCC 2017d).
847. The Wash and North Norfolk SAC is located approximately 111km from the East Anglia TWO windfarm site at the closest point, 93km from the cable corridor and 108km from the landfall site. The Wash and North Norfolk Coast SAC was screened in to the HRA to take into account the movements of harbour seal along the east coast of England.
848. For the purposes of this assessment, the potential effects are considered in relation to the SAC Conservation Objectives; as outlined in **Table 5.47**.

Table 5.47 Potential Effects of East Anglia TWO in Relation to the Conservation Objectives for the Wash and North Norfolk Coast SAC

Conservation Objective	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 associated with East Anglia TWO 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 (e.g. from UXO clearance, piling, other construction activities, vessels, O&M noise, and noise associated with decommissioning phase works) have the potential to have an effect on the seals foraging at sea and will be considered further.

5.4.1 Harbour Seal Status and Ecology

849. The harbour seal count for the Wash in 2017 was 3,210 plus 399 harbour seal at Blakeney Point; a total of 3,609 harbour seal at the main haul-out sites within The Wash and North Norfolk Coast SAC (SCOS 2018). This will be used as the site population of which any potential effects will be assessed against, referred to as 'the Wash and Blakeney Point count'.

5.4.1.1 Reference populations

850. The reference population for the project-alone assessment is the south-east England MU of 4,965 harbour seal (SCOS 2018).

851. 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 (IAMMWG 2013; SCOS 2018) and the Wadden Sea region (Galatius et al. 2018).

852. The reference population for the in-combination assessments is therefore 44,965 harbour seal, 4,965 from the south-east England MU (SCOS 2018) plus 40,000 for The Wadden Sea (Galatius et al. 2018).

5.4.1.2 Density estimates

853. 18 individual seals were recorded during the aerial surveys for the proposed East Anglia TWO project, from November 2015 to April 2016, from September 2016 to October 2017, and May to August 2018 (24 months), one of which was identified to be a grey seal and none were identified to be harbour seal (see **Appendix 11.2** of the ES (SPR 2019)).
854. As the number of sightings were too low within the marine mammal survey area to determine a robust site-specific density estimate for harbour and grey seal, the SMRU seals at-sea density data (Russell et al. 2017) has been used in the assessment, as agreed with the marine mammal ETG (meeting 6th March 2018).
855. The harbour seal density estimates for the East Anglia TWO offshore cable corridor, windfarm site and offshore development area have been calculated from the 5km x 5km cells (Russell et al. 2017) based on the area of overlap with the offshore development area. The upper at-sea density estimates for these areas have been used in the assessment:
- The East Anglia TWO windfarm site the density of harbour seal is estimated to be 0.0007/km²
 - The offshore cable corridor the density is estimated to be 0.018 harbour seal per km²; and
 - The overall density estimate for the offshore development area is 0.007 harbour seal per km².

5.4.2 Assessment of Potential Effects on The Wash and North Norfolk Coast SAC

856. The potential effects during the construction, operation and decommissioning of the proposed East Anglia TWO project to be assessed as part of the HRA process for The Wash and North Norfolk Coast SAC have been agreed in consultation with the marine mammal ETG as part of the EPP.
857. The potential effects of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the site in relation to the Conservation Objectives for harbour seal are:

- Potential disturbance of foraging seals from underwater noise;
- Possible increased collision risk with vessels;
- Potential changes in prey availability; and
- Any in-combination effects.

5.4.2.1 Potential disturbance of foraging seals from underwater noise

5.4.2.1.1 Potential disturbance of foraging seals from underwater noise during UXO clearance at East Anglia TWO (alone)

5.4.2.1.1.1 Risk of permanent auditory injury during UXO clearance

858. Underwater noise modelling (**Appendix 11.4** of the ES) has been undertaken to estimate the potential impact ranges for marine mammals likely to arise during UXO clearance, based on the maximum UXO charge sizes that could be located at East Anglia TWO (**Table 5.48**).

859. The maximum number of harbour seal that could potentially be at increased risk of permanent auditory injury (PTS) has been estimated, based on the maximum potential impact ranges for UXO clearance of the maximum potential charge size (**Table 5.48**).

860. The use of NOAA (NMFS 2018) weighted SEL is considered more suitable, especially over long ranges, as it takes into account the hearing sensitivity of the species. However, as a precautionary approach, the assessment has been based on the worst-case scenarios for the unweighted peak Sound Pressure Levels (SPL_{peak}) predicted PTS impact ranges for harbour seal (**Table 5.48**).

Table 5.48 Potential Effects of Permanent Auditory Injury (PTS) on Harbour Seal during UXO Clearance without Mitigation

Potential effect	Criteria threshold	Possible maximum charge weight			
		200kg	300kg	500kg	700kg
		Maximum predicted impact range (km) and area* (km ²)			
Permanent auditory injury (PTS) – without mitigation	SPL _{peak} unweighted (NMFS 2018) 218 dB re 1 µPa Impulsive criteria	1.7km (9.08km ²)	1.9km (11.34km ²)	2.3km (16.62km ²)	2.6km (21.24km ²)
	SEL weighted (NMFS 2018) 185 dB re 1 µPa ² s Impulsive criteria	1.0km (3.14km ²)	1.2km (4.52km ²)	1.5km (7.07km ²)	1.8km (10.18km ²)

Potential effect	Criteria threshold	Possible maximum charge weight			
		200kg	300kg	500kg	700kg
		Maximum predicted impact range (km) and area* (km ²)			
	SEL weighted (NMFS 2018) 201 dB re 1 μ Pa ² s Non-impulsive criteria	0.06km (0.01km ²)	0.08km (0.02km ²)	0.1km (0.03km ²)	0.11km (0.04km ²)
Maximum number of harbour seal (based on 0.007/km ² density in the offshore development area) and % of SE England MU based on maximum impact area* (21.24km ²) for PTS unweighted SPL _{peak}		Up to 0.15 harbour seal (0.003% of SE England MU; 0.004% of The Wash and Blakeney Point count).			
Number of harbour seal (based on 0.007/km ² density in the offshore development area) and % of SE England MU based on maximum impact area* (10.18km ²) for PTS weighted SEL impulsive criteria		Up to 0.07 harbour seal (0.0014% of SE England MU; 0.002% of The Wash and Blakeney Point count).			

*Maximum area based on area of circle with maximum impact range for radius as worst-case scenario.

Mitigation

861. As outlined in **section 5.3.5.1.1.1**, 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 (PTS) 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, in consultation with the MMO and relevant SNCBs.
862. The effective implementation of the UXO MMMP will reduce the risk of permanent auditory injury (PTS) to harbour seal during any underwater detonations at East Anglia TWO (alone), therefore, there would be **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

5.4.2.1.1.2 Potential disturbance from the underwater noise associated with UXO clearance

863. The SNCBs currently recommend that a potential disturbance range of 26km (approximate area of 2,124km²) around UXO detonations is used to assess harbour porpoise disturbance in the SNS SAC. This approach has also been

used to assess the potential disturbance of seals, following the same approach used for Norfolk Vanguard. As UXO clearance could be undertaken in the offshore windfarm site or the offshore cable corridor, the density estimates are based on the offshore development area (**Table 5.49**).

Table 5.49 Estimated Number of Harbour Seal Potentially Disturbed during UXO Clearance at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2,124km ²) during underwater UXO clearance - based on 26km	15 harbour seal (based on 0.007/km ² density in the offshore development area).	0.30% of the South-East England MU (0.42% of The Wash and Blakeney Point count).	No Temporary effect. 0.30% or less of the harbour seal SE England MU, could be temporarily disturbed during any UXO clearance at East Anglia TWO (alone), based on the worst-case scenario.

864. Disturbance from any UXO detonations would be temporary and for a short-duration (i.e. the detonation). For the estimated worst-case, it is predicted that there could be up to 80 clearance operations in the East Anglia TWO offshore development area. As a precautionary worst-case scenario, the maximum number of days of UXO clearance could be up to 80 days, based on one detonation per day within the overall UXO clearance operation, which could be conducted over several months.
865. Density estimates (Russell et al. 2017), tagging studies (Russell and McConnell 2014; Russell 2016) and site surveys at the East Anglia TWO windfarm site and other offshore windfarms in the area (see ES **Chapter 11 Marine Mammals**) indicate that the number of harbour seal is relatively low and infrequent.
866. It is highly unlikely that all harbour seal in the East Anglia TWO offshore development area would be from The Wash and Blakeney Point, which is located over 93km from the offshore development area. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.
867. Under these circumstances, there is no potential for any significant disturbance of harbour seal foraging in and around the East Anglia TWO offshore

development area. Therefore, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.2 Potential disturbance from the underwater noise associated with piling

5.4.2.1.2.1 Risk of permanent auditory injury during piling

868. Underwater noise modelling has been undertaken to estimate the maximum potential impact ranges for underwater noise that could arise during construction of East Anglia TWO (**Appendix 11.4** of the ES) and determine the potential effects on harbour seal. The modelling has been based on the worst-case scenarios for:
- Monopile up to 15m diameter with maximum hammer energy applied of 4,000kJ and starting hammer energy of 10% maximum hammer energy (400kJ); and
 - Pin-piles up to 4.6m diameter with maximum hammer energy applied of 2,400kJ and starting hammer energy of 10% maximum hammer energy (240kJ).
869. The underwater noise modelling results for the maximum predicted ranges (and areas) for permanent auditory injury (PTS) in harbour and grey seal, based on the NOAA (NMFS 2018) criteria for unweighted peak sound pressure levels (SPL_{peak}) and PTS from weighted sound exposure levels (SEL), which take into account the species hearing sensitivity, for single strike (SEL_{ss}) and cumulative exposure (SEL_{cum}) are presented in **Table 5.50**.
870. The number of seals that could potentially be affected has been estimated based on the density estimates for the East Anglia TWO windfarm site ($0.0007/km^2$ for harbour seal).
871. Without any mitigation, the estimated maximum number of harbour seal that could potentially be at risk of PTS as a result of a single strike of the maximum monopile or pin-pile hammer energy is 0.000007 individuals (0.0000001% of the South-East England MU; 0.0000002% of The Wash and Blakeney Point count; **Table 5.50**).
872. The number of harbour seal that could potentially be at risk of PTS as a result of cumulative exposure during piling of pin-piles with a maximum hammer energy to be applied of 2,400kJ is 0.08 harbour seal (0.0016% of the South-East England MU; 0.002% of The Wash and Blakeney Point count).

Table 5.50 Maximum Predicted Impact Ranges (and Areas) for Permanent Auditory Injury (PTS) for Harbour Seal from a Single Strike and from Cumulative Exposure during Piling at East Anglia TWO

Potential effect	Criteria threshold	Maximum predicted impact range (km) and area* (km ²)			
		Monopile with starting hammer energy of 400kJ	Monopile with maximum hammer energy of 4,000kJ	Pin-pile with starting hammer energy of 240kJ	Pin-pile with maximum hammer energy of 2,400kJ
PTS without mitigation – single strike	NMFS (2018) unweighted SPL _{peak} 218 dB re 1 µPa	<0.05km (<0.01km ²)	0.06km (0.01km ²)	<0.05km (<0.01km ²)	0.06km (0.01km ²)
Number of harbour seal (based on the 0.0007/km ² density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area (0.01km²) for PTS unweighted SPL _{peak}		0.000007 harbour seal (0.0000001% of the South-East England MU; 0.0000002% of The Wash and Blakeney Point count).			
PTS without mitigation – single strike	NMFS (2018) SEL _{ss} weighted 185 dB re 1 µPa ² s	<0.05km (<0.01km ²)	0.06km (0.01km ²)	<0.05km (<0.01km ²)	0.06km (0.01km ²)
Number of harbour seal (based on the 0.0007/km ² density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area (0.01km²) for PTS weighted SEL _{ss}		0.000007 harbour seal (0.0000001% of the South-East England MU; 0.0000002% of The Wash and Blakeney Point count).			
PTS from cumulative SEL (including soft-start and ramp-up)	NMFS (2018) SEL _{cum} weighted 185 dB re 1 µPa ² s	N/A	4.9km (57km ²)	N/A	6.8km (110km ²)
Number of harbour seal (based on the 0.0007/km ² density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area (110km²) for PTS weighted SEL _{cum}		0.08 harbour seal (0.0016% of the South-East England MU; 0.002% of The Wash and Blakeney Point count).			

*areas for maximum hammer energies for monopile and pin-pile based on modelled contour area; area for starting hammer energy based on precautionary area of circle with maximum impact range as radius
N/A = not applicable

Mitigation

873. As outlined in **section 5.3.5.1.1.1**, the MMMP for piling will be developed pre-construction in consultation with the MMO and relevant SNCBs and will be based on the best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will detail the proposed mitigation measures to reduce the risk of permanent auditory injury (PTS) to harbour seal during piling.
874. The MMMP for piling will reduce the risk of permanent auditory injury to harbour seal as a result of underwater noise during piling at East Anglia TWO (alone), therefore, there would be **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.2.2 Potential disturbance during proposed mitigation

875. During the implementation of the proposed mitigation, for example the activation of ADDs for up to 10 minutes it is estimated that animals would move 0.9km (based on a precautionary average marine mammal swimming speed of 1.5m/s), a potential disturbance area of 2.54km².

Table 5.51 Estimated Number of Harbour Seal Potentially Disturbed during ADD Activation at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2.54km ²) during ADD activation	0.002 harbour seal (based on 0.0007/km ² density in the windfarm site).	0.00004% of the South-East England MU (0.00006% of The Wash and Blakeney Point count).	No Temporary effect. 0.00004% or less of the harbour seal South-East England MU, could be temporarily disturbed during ADD activation at East Anglia TWO (alone).

876. The example ADD activation, based on up to 10 minutes per pile, would be up to 57.3 hours (approximately 2.4 days) for up to 344 pin-piles for wind turbines and platforms.
877. It is highly unlikely that all harbour seal in the East Anglia TWO windfarm site would be from The Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

878. Taking into account the temporary, intermittent and short-duration of the potential disturbance from ADD activation, along with the relatively low and infrequent number of harbour seal in and around the East Anglia TWO windfarm site, there is no potential for any significant disturbance of foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour**.
879. It should be noted that the disturbance as a result of the proposed mitigation, prior to piling would be part of the 26km disturbance range for piling and is therefore not an additive effect to the overall area of potential disturbance. However, the duration of the proposed mitigation prior to piling has been taken into account, as a worst-case scenario, in the assessment of the duration of potential disturbance for piling.

5.4.2.1.2.3 Potential disturbance during piling

880. Data from tagged harbour seals in The Wash indicate that seals were not excluded from the vicinity of Lincs Offshore Wind Farm during the overall construction phase, but that there was clear evidence of avoidance during pile driving, with significantly reduced levels of seal activity at ranges up to 25km from piling sites (Russell et al. 2016; SCOS 2016, 2017). Therefore, a 26km disturbance range has been used to assess the potential disturbance of grey and harbour seal (**Table 5.52**). It is acknowledged that this is not Natural England's advice; however, this approach was agreed by the ETG.
881. In addition, the number of harbour seal that could be disturbed during underwater piling at East Anglia TWO has been estimated based on the maximum potential for temporary auditory injury (TTS) / fleeing response. Although not all individuals within the maximum TTS range will have temporary hearing impairment, it is assumed as a worst-case scenario that all animals could be disturbed.

Table 5.52 Estimated Number of Harbour Seal Potentially Disturbed during Piling at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2,124km ²) during piling - based on 26km	1.5 harbour seal (based on 0.0007/km ² density in the windfarm site).	0.03% of the South-East England MU (0.04% of The Wash and Blakeney Point count).	No Temporary effect. 0.03% or less of the harbour seal South-East England MU, could be temporarily disturbed during piling at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
			(alone), based on the worst-case scenario.
Maximum area of potential TTS onset / fleeing response for single strike – based on weighted SEL _{ss} (170 dB re 1 µPa ² s impulsive criteria; NMFS 2018)	Up to 2.4km ² for monopiles (4,000kJ) and pin-piles (2,400kJ) 0.002 harbour seal (based on 0.0007/km ² density in the windfarm site).	0.00003% of the South-East England MU (0.00006% of The Wash and Blakeney Point count).	No Temporary effect. 0.00003% or less of the harbour seal South-East England MU, could be temporarily disturbed during piling at East Anglia TWO (alone).
Maximum area of potential TTS onset / fleeing response for cumulative exposure over 24 hrs – based on weighted SEL _{cum} (140 dB re 1 µPa ² s impulsive criteria; NMFS 2018).	Up to 1,300km ² for monopiles (4,000kJ) 0.9 harbour seal (based on 0.0007/km ² density in the windfarm site).	0.02% of the South-East England MU (0.025% of The Wash and Blakeney Point count).	No Temporary effect. 0.02% or less of the harbour seal South-East England MU, could be temporarily disturbed during piling at East Anglia TWO (alone).
	Up to 1,600km ² for pin-piles (2,400kJ) 1.1 harbour seal (based on 0.0007/km ² density in the windfarm site).	0.02% of the South-East England MU (0.03% of The Wash and Blakeney Point count).	No Temporary effect. 0.02% or less of the seal South-East England MU, could be temporarily disturbed during piling at East Anglia TWO (alone).

882. The duration of potential disturbance for active piling, based on the worst-case scenario for the installation of 60 300m turbines with pin-piles, six platforms with pin-piles and 10 minute ADD activation per pile, would be up to 41.6 days within the offshore construction period.
883. It is highly unlikely that all harbour seal in the East Anglia TWO windfarm site would be from The Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

884. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low and infrequent number of harbour and grey seal in and around the East Anglia TWO windfarm site, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.3 Potential disturbance from underwater noise during non-piling construction and maintenance activities

885. Possible sources of underwater noise during non-piling construction activities, include seabed preparation, rock dumping and cable installation.

886. The requirements for any potential maintenance work, such as additional rock dumping or cable re-burial, are currently unknown, however the work required and associated effects would be less than those during construction.

887. The results of the underwater noise modelling (**Table 5.53**) indicate that harbour seal would have to remain in close proximity over a 24 hour period to be exposed to levels of sound that are sufficient to induce PTS or TTS from cumulative exposure based on the NMFS (2018) threshold criteria.

888. The potential risk of any auditory injury as a result of dredging or cable laying activity is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction and maintenance activities, other than piling.

Table 5.53 Maximum Predicted Impact Ranges for Permanent Auditory Injury (PTS) and Temporary Auditory Injury (TTS) / Fleeing Response from Non-Piling Construction and Maintenance Activities

Potential Impact	Criteria and threshold	The modelled impact ranges (m) for each offshore construction activity				
		Dredging	Drilling	Cable Laying	Rock Placement	Trenching
Permanent auditory injury (PTS) from 24 hour cumulative exposure	NMFS (2018) 201 dB re 1 μ Pa ² s non-impulsive criteria Pinnipeds in Water (PW) SEL _{cum}	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)

Potential Impact	Criteria and threshold	The modelled impact ranges (m) for each offshore construction activity				
		Dredging	Drilling	Cable Laying	Rock Placement	Trenching
Temporary auditory injury (TTS) / fleeing response from 24 hour cumulative exposure	NMFS (2018) 181 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)
0.0002 harbour seal (0.000004% of the South-East England MU; 0.000006% of The Wash and Blakeney Point count) based on the 0.007/km ² density estimate for the offshore development area.						

889. As a very precautionary worst-case scenario, the assessment for the disturbance as a result of underwater noise during construction and maintenance activities, other than piling and vessel movements, has been assessed based on the entire offshore development area (**Table 5.54**). This is very precautionary, as it is highly unlikely that non-piling construction and maintenance activities could result in disturbance from the entire offshore development area. Any disturbance is likely to be limited to the area in and around where the activity is taking place.

Table 5.54 Estimated Number of Harbour Seal Potentially Disturbed from Offshore Development Area

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Offshore development area (356km²)	2.5 harbour seal (based on 0.007/km ² density in the offshore development area).	0.05% of the South-East England MU (0.07% of The Wash and Blakeney Point count).	No Temporary effect. 0.05% or less of the harbour seal South-East England MU, could be temporarily disturbed during construction activities, other than piling, at East Anglia TWO (alone).

890. It is highly unlikely that all harbour seal in the offshore development area would be from The Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

891. Any disturbance from construction and maintenance activities, other than piling, would be temporary, localised, intermittent duration and at different locations within the offshore development area. Taking this into account, along with the relatively low and infrequent number of harbour seal in and around the East Anglia TWO windfarm site, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.4 Potential disturbance from vessels during construction, operation and maintenance

892. During construction, there will be an increase in the number of vessels associated with installation of the turbine foundations, associated sub-structures and installation of the array and export cables, therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the offshore development area. During construction, the approximate number of vessels on site at any one time during construction is estimated to be 74 vessels.
893. The requirements for any potential maintenance work are currently unknown, however the work required and effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than those during construction. It is estimated that there could be up to 1-2 vessels trips per day.
894. The results of the underwater noise modelling (**Table 5.55**) indicate that harbour seal would have to remain in close proximity to vessels over a 24 hour period, to be exposed to noise levels that are sufficient to induce PTS or TTS from cumulative exposure based on the NMFS (2018) threshold criteria.
895. The potential risk of any auditory injury in marine mammals as a result of vessels is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction vessels.

Table 5.55 Maximum Predicted Impact Ranges for Permanent Auditory Injury (PTS) and Temporary Auditory Injury (TTS) / Fleeing Response from Vessels

Potential Impact	Criteria and threshold	The modelled impact ranges (m) for each offshore construction activity	
		Large vessels	Medium sized vessels
Permanent auditory injury (PTS) from cumulative exposure	NMFS (2018) 201 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)	<0.1km (<0.031km ²)

Potential Impact	Criteria and threshold	The modelled impact ranges (m) for each offshore construction activity	
		Large vessels	Medium sized vessels
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 181 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)	<0.1km (<0.031km ²)
Disturbance from 74 vessels (2.3km ²) = 0.02 harbour seal (0.0003% of the South-East England MU; 0.0006% of The Wash and Blakeney Point count) based on the 0.007/km ² density estimate for the offshore development area.			

896. The assessment for vessels assumes a very precautionary worst-case scenario, that harbour seal in the offshore development area could be disturbed (**Table 5.54**). However, any disturbance is likely to be limited to the immediate vicinity around the vessel, as indicated by the noise modelling (**Table 5.55**).
897. The baseline conditions indicate an already relatively high level of shipping activity in and around East Anglia TWO. Therefore, based on an average of 4.5 vessel movements per day during construction and an average of two vessels per day during operation and maintenance would be relatively small compared to existing vessel traffic.
898. Any disturbance from construction and maintenance vessels would be temporary, localised, intermittent duration and at different locations within the offshore development area. Taking this into account, along with the relatively low and infrequent number of harbour seal in and around the offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

5.4.2.1.5 Potential disturbance from underwater noise associated with operational wind turbines

899. Currently available data indicates that there is no lasting disturbance or exclusion of seals around windfarm sites during operation (McConnell et al. 2012; Russell et al. 2014). Data collected suggests that any behavioural responses for seals may only occur up to a few hundred metres away from the source of disturbance (McConnell et al. 2012). Seals have been shown to forage within operational windfarm sites (e.g. Russell et al. 2014).
900. Underwater noise modelling was undertaken to assess the potential impact ranges of operational turbines on marine mammals. The underwater noise

propagation modelling used measured sound source data scaled to relevant parameters for the proposed East Anglia TWO project (see **Appendix 11.4** of the ES for further information).

901. The modelling results indicate that at the source levels predicted for operational underwater noise, any harbour seal would have to remain in very close proximity to a wind turbine over a 24 hour period to be exposed to levels of sound that are sufficient to result in PTS or TTS from cumulative exposure (**Table 5.56**).
902. The potential risk of any auditory injury in marine mammals as a result of underwater noise from operational wind turbines is considered highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with operational wind turbines.

Table 5.56 Maximum Predicted Impact Ranges for Permanent Auditory Injury (PTS) and Temporary Auditory Injury (TTS) / Fleeing Response from Operational Wind Turbines

Potential Impact	Criteria and threshold	Operational wind turbines (300,)
Permanent auditory injury (PTS) from cumulative exposure	NMFS (2018) 201 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 181 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)
Disturbance from 75 turbines (2.33km ²) = 0.002 harbour seal (0.00004% of the South-East England MU; 0.00006% of The Wash and Blakeney Point count) based on the 0.0007/km ² density estimate for the windfarm site.		

903. The assessment for operational wind turbines assumes a very precautionary worst-case scenario, that all harbour seal in the East Anglia TWO windfarm site could potentially be disturbed (**Table 5.57**). However, in reality any disturbance is likely to be limited to the immediate vicinity around the turbines, as indicated by the noise modelling (**Table 5.56**).

Table 5.57 Estimated Number of Harbour Seal Potentially Disturbed from East Anglia TWO windfarm site

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
East Anglia TWO windfarm site (218.4km ²)	0.15 harbour seal (based on 0.0007/km ² density in the windfarm site).	0.003% of the South-East England MU (0.004% of The Wash and Blakeney Point count).	No Temporary effect. 0.003% or less of the harbour seal South-East England MU, could be temporarily disturbed from the East Anglia TWO windfarm site.

904. It is highly unlikely that all harbour seal in the East Anglia TWO windfarm site would be from the Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

905. Taking into account evidence of seal foraging in operational windfarms, along with the relatively low and infrequent number of harbour seal in and around the East Anglia TWO windfarm site, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.6 Potential disturbance from underwater noise during decommissioning

906. The potential underwater noise effects during decommissioning of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the site in relation to the Conservation Objectives are:

- Disturbance resulting from the noise associated with foundation removal (e.g. cutting);
- Disturbance resulting from underwater noise and disturbance from vessels; and
- Barrier effects as a result of underwater noise associated with activities above.

907. 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 and UXO clearance).

908. A detailed decommissioning plan will be provided prior to decommissioning that will give details of the techniques to be employed and any relevant mitigation measures.
909. For this assessment, it is assumed that the potential effects from underwater noise during decommissioning would be less than those assessed for piling and comparable to those assessed for other construction activities (as assessed above). Therefore, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.7 Potential overall noise disturbance effects on foraging seals from the proposed East Anglia TWO project (alone)

5.4.2.1.7.1 Potential overall effects during UXO clearance

910. It is not anticipated that piling would be undertaken at the same time as UXO clearance, however, as a worst-case scenario it has been assumed that UXO clearance could be undertaken, for example in the offshore cable corridor while piling could be undertaken at the East Anglia TWO windfarm site.
911. It is assumed that only one UXO could be detonated at a time during piling and there would be no concurrent piling. The maximum potential area of disturbance is 4,248km², based on 26km disturbance range around each pile location and UXO location, and assuming no overlap in the potential impact areas.
912. The maximum number of harbour seal that could potentially be disturbed is 29.7, based on 0.007/km² density in the offshore development area. This represents 0.6% of the South-East England MU population or, as a worst-case scenario, 0.8% of the population from The Wash and Blakeney Point in The Wash and North Norfolk Coast SAC.
913. It is highly unlikely that all harbour seal in the offshore development area would be from the Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

914. Disturbance from any UXO detonations would be temporary and for a short-duration. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low and infrequent number of harbour seal in and around the offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging harbour and grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.7.2 Potential overall effects during piling at East Anglia TWO

915. This assessment assumes piling in the East Anglia TWO windfarm site at the same time as other construction activities, including vessels, in the offshore cable corridor. Disturbance from piling would be up to 2,124km² (based on 26km EDR) with 147km² of cable corridor not overlapped by piling impact area, giving a maximum potential area of disturbance is up to 2,271km².
916. The maximum number of harbour seal that could potentially be disturbed is 16, based on 0.007/km² density in the offshore development area. This represents 0.3% of the South-East England MU or, as a worst-case scenario, 0.4% of the 3,801 harbour seal from The Wash and Blakeney Point in The Wash and North Norfolk Coast SAC.
917. It is highly unlikely that all harbour seal in the offshore development area would be from the Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.
918. Disturbance from construction activities and vessels would be temporary and for a short-duration. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low and infrequent number of harbour seal in and around the offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.7.3 Other potential overall effects during construction at East Anglia TWO

919. There would be no further overall effects during construction other than those assessed above, as the potential disturbance from underwater noise during construction has been based on the entire offshore development area, as has any potential disturbance from vessels. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

5.4.2.1.7.4 Potential overall effects during operation and maintenance at East Anglia TWO

920. There would be no further overall effects during operation and maintenance, as the potential disturbance from underwater noise from operational turbines, maintenance activities and vessels all been based on the entire offshore development area. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

5.4.2.1.7.5 Potential overall effects during decommissioning

250. There would be no further overall effects during decommissioning, as the potential disturbance from underwater noise during foundation removal, disturbance from vessels and any changes to prey availability will be based on the entire offshore development area. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of The Wash and North Norfolk Coast in relation to the conservation objectives for harbour seal**.

5.4.2.1.8 Potential in-combination disturbance effects on foraging seals

5.4.2.1.8.1 Potential in-combination disturbance effects during piling

921. There is a high level of uncertainty in relation to the in-combination scenarios that will arise at the time of the proposed East Anglia TWO project construction. The assessment has been undertaken based on the most realistic worst-case scenario of the offshore windfarms that could be piling at the same time as the proposed East Anglia TWO project. See **section 5.2.5.5**.

922. This scenario is a precautionary approach using the maximum duration of potential piling periods, based on currently available information (see **section 5.4.2.1.1**). Based upon **Table 5.29** this scenario includes three other UK offshore windfarms:

- Creyke Beck A;
- Sofia (formerly Teesside B); and
- Norfolk Vanguard.

923. The number of harbour seal in the potential impact areas, for single and concurrent piling, has been estimated using the latest seals-at-sea usage maps to estimate densities (Russell et al. 2017) for the relevant area that each project is located.
924. For the potential worst-case scenario, with single piling at East Anglia TWO and concurrent piling at Creyke Beck A, Sofia and Norfolk Vanguard, the estimated maximum area of potential disturbance is up to 14,868km², using the 26km EDR without any overlap in the potential areas of disturbance at each windfarm or between windfarms.
925. The maximum number of harbour seal that could potentially be temporarily disturbed is 21.3 individuals (**Table 5.63**). This represents 0.43% of the South-East England MU or, as a worst-case scenario, 0.59% of the 3,609 harbour seal from the Wash and Blakeney Point in the Wash and North Norfolk Coast SAC. However, it is highly unlikely that all harbour seal in the windfarm sites would be from the Wash and Blakeney Point. To take into account the windfarm locations, movements and ranges of harbour seal, it is more appropriate to use the in-combination reference population to cover the wider area (see **section 5.5.1.1**). Therefore, 0.05% of the in-combination reference population (44,965 harbour seal) could potentially be temporarily disturbed.
926. Based on the more likely single pile installation at each of the four offshore windfarms, the estimated maximum area of potential disturbance is 8,496km², without any overlap in the potential areas of disturbance between windfarms. The maximum number of harbour seal that could potentially be temporarily disturbed is 12.8 individuals, which represents 0.03% of the in-combination reference population (**Table 5.63**).
927. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low percentage of the reference populations that could be temporarily affected, there is no potential for any significant disturbance or barrier effects to foraging harbour seal. Therefore, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

Table 5.58 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Seal During Single and Concurrent Piling at Offshore Windfarms which could be Piling at the Same Time as East Anglia TWO

Name of Project	Harbour seal density estimate (No/km ²) ¹	Potential number of harbour seal disturbed	
		single piling	concurrent piling
East Anglia TWO	0.002	4.2	4.2 (single piling)
Creyke Beck A	0.003	6.4	12.7
Sofia	0.001	2	4
Norfolk Vanguard	0.0001	0.2	0.4
Total		12.8	21.3
% of Wash and Blakeney Point (3,609 harbour seal)		0.35%	0.59%
% of South-East England MU (4,965 harbour seal)		0.26%	0.43%
% of in-combination reference population (44,965 harbour seal)		0.03%	0.05%

¹The densities included are based on a 26km buffer around the offshore windfarm, using the 5x5km grid squares of the seals-at-sea total usage data that intersect with the projects and 26km buffer; based on Russell et al. (2017).

5.4.2.1.8.2 Potential in-combination disturbance effects during offshore windfarm construction

928. During the construction of the proposed East Anglia TWO project, there is the potential to overlap with impacts from the construction activities, other than piling, at other offshore windfarms. Noise sources which could cause potential disturbance impacts during offshore windfarm construction activities, other than pile driving, can include vessels, seabed preparation, ploughing / jetting / pre-trenching or cutting for installation of cables and rock dumping for protection of the cable.

929. The assessment includes offshore windfarms which could potentially have construction activities, other than piling, during the East Anglia TWO construction period (**Table 5.29**). This precautionary realistic worst-case scenario includes six UK offshore windfarms:

- Creyke Beck B;
- Teesside A;
- Thanet Extension;
- Hornsea Project 3;
- Norfolk Boreas; and
- East Anglia ONE North.

930. The potential temporary disturbance during offshore windfarm construction activities, other than pile driving noise sources, has been based on the area of the offshore windfarm sites. This is a very precautionary approach, as it is highly unlikely that construction activities, other than piling activity, would result in disturbance from entire windfarm sites. Any disturbance is likely to be limited to the area in and around where the activity is taking place.
931. There would be no additional cumulative impacts of underwater noise from other construction activities for those projects which also have overlapping piling with East Anglia TWO as the ranges for piling would be significantly greater than those from other construction noise sources.
932. The assessment indicates that if all six of these offshore windfarms were conducting non-piling construction activities, at the same time, the estimated maximum cumulative area of disturbance is 2,864km² (based on disturbance from the entire offshore windfarm areas).
933. The maximum number of harbour seal that could potentially be disturbed is up to 11 individuals, which represents approximately 0.02% of the in-combination reference population or 0.3% of the Wash and Blakeney Point count (**Table 5.59**).
934. Considering the temporary disturbance and intermittent duration of underwater noise from construction activities, along with the relatively low percentage of the reference populations that could be temporarily affected, there is no potential for any significant disturbance or barrier effects to foraging harbour seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

Table 5.59 Quantified In-Combination for the Potential Disturbance of Harbour Seal During Construction Activities (Other Than Piling) at Offshore Windfarms during Construction for the Proposed East Anglia TWO Project

Name of Project	Harbour seal density estimate (No/km ²) ¹	Area of windfarm site (km ²)*	Potential number of harbour seal disturbed from entire windfarm area
Creyke Beck B	0.008	599	5
Teesside A	0.00004	562	0.02
Thanet Extension	0.06	73	4
Hornsea Project 3	0.002	695	1.4
Norfolk Boreas	0.00006	727	0.04

Name of Project	Harbour seal density estimate (No/km ²) ¹	Area of windfarm site (km ²)*	Potential number of harbour seal disturbed from entire windfarm area
East Anglia ONE North	0.0004	208	0.08
Total		2,864	10.54
% of Wash and Blakeney Point (3,609 harbour seal)			0.30%
% of South-East England MU (4,965 harbour seal)			0.21%
% of in-combination reference population (44,965 harbour seal)			0.02%

*Source: <http://www.4coffshore.com/>

¹based on seal density grid cells that overlap with the OWF site boundary only (Source: Russell et al. 2017).

5.4.2.1.8.3 Potential in-combination disturbance effects during operation and maintenance

935. There is the potential for disturbance from operational offshore windfarms as a result of any operational and maintenance activities, including operational turbines, vessels, additional rock dumping or cable re-burial, during the East Anglia TWO construction period.
936. The potential disturbance from operational and maintenance activities at offshore windfarms has also been based on the worst-case scenario of the entire area of the windfarm sites. This is again a very precautionary approach, as it is highly unlikely that operational windfarms and maintenance activities, including vessels, would result in disturbance from the entire wind farm area. Any disturbance is likely to be limited to the area in and around where the actual activity is actually taking place.
937. Operational offshore windfarms were considered part of the baseline if they were in the in-combination reference population area and they were operational at the time of the start of the East Anglia TWO site specific surveys (November 2015). Therefore, the only offshore windfarms screened into the CIA were those with potential to be newly operational by the East Anglia TWO construction period, in that they are currently under construction or will be constructed and operational by 2025.
938. Operational UK and European offshore windfarms in the southern North Sea that could have potential in-combination effects during the East Anglia TWO construction period have an estimated maximum potential in-combination area up to 1,867km² (based on disturbance from entire offshore windfarm area).

939. The maximum number of harbour seal that could potentially be disturbed is 89 individuals, which represents approximately 0.27% of the in-combination reference population or 3.35% of The Wash and Blakeney Point count (**Table 5.60**). However, it is highly unlikely that all harbour seal would be from the Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant in-combination reference population as well as SAC counts.
940. Taking into account that seals have been recorded foraging in operational windfarm sites, along with the relatively low percentage of the reference populations that could be temporarily affected, there is no potential for any significant disturbance or barrier effects to foraging harbour seal. Therefore, under these circumstances, **there is no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

Table 5.60 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Seal During Operation and Maintenance Activities at Offshore Windfarms in the Southern North Sea During Construction of the Proposed East Anglia TWO Project

Name of Project	Harbour seal density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour seal disturbed from entire WF area
Dudgeon ¹	0.2	55	11
East Anglia ONE	0.0003	205	0.06
East Anglia THREE	0.001	301	0.3
Galloper ¹	0.001	113	0.1
Hornsea Project One	0.05	407	19
Hornsea Project Two	0.08	462	36
Humber Gateway Wind Farm	0.01	27	0.3
Kentish Flats Extension	0.1	8	0.8
Nordergreunde	0	3	0
Norther ²	0.0001	38	0.004
Northwester 2 ²	0.0002	12	0.002
Race Bank	0.19	62	12
RENTEL ²	0.0002	23	0.005
Triton Knoll phase 1-3	0.28	146	41

Name of Project	Harbour seal density estimate (No/km ²)	Area of WF site (km ²)*	Potential number of harbour seal disturbed from entire WF area
Total		1,867km ²	121
% of Wash and Blakeney Point (3,609 harbour seal)			3.35%
% of South-East England MU (4,965 harbour seal)			2.44%
% of reference population (44,965 harbour seal)			0.27%

*Source: <http://www.4coffshore.com/>

¹Operational after the start of the East Anglia TWO site specific surveys, but before the submission of the PEI

²Unknown date of project operation, but assumed to be before the construction of East Anglia TWO

5.4.2.1.8.4 Potential in-combination disturbance effects on during UXO clearance

941. As outlined in **section 5.4.2.1**, it is currently not possible to estimate the number of potential UXO clearance operations that could be undertaken during the proposed East Anglia TWO project construction period. This assessment has been based on the potential for disturbance from one UXO detonation in the North Sea area. It is highly unlikely that more than one UXO detonation would occur at exactly the same time or on the same day as another UXO detonation, even if they had overlapping UXO clearance operation durations. Therefore, including the potential disturbance of 26km around one UXO detonation (2,124km²) in this assessment is considered a worst-case scenario.
942. Without knowing the actual location for any UXO clearance, the mean density estimate is based on the average seal at sea density estimates for the areas of the UK and EU offshore windfarms. This is 0.02 harbour seal per km². This is based on the seal-at-sea maps (Russell et al. 2017) and an average density based on a 50km buffer around all offshore windfarms (UK and EU) included within the in-combination assessment.
943. One UXO detonation could potentially disturb up to 42.5 harbour seal (0.09% of the in-combination reference population; or 0.86% of the South-East England MU; or 1.18% of the Wash and Blakeney Point count). However, it is highly unlikely that all harbour seal would be from the Wash and Blakeney Point.
944. Disturbance from any UXO detonations would be temporary, for a short-duration and intermittent at different locations, therefore, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Under these circumstances, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal.**

5.4.2.1.8.5 Potential in-combination disturbance effects during seismic surveys

945. As outlined in **section 5.4.2.1**, it is currently not possible to estimate the number of potential seismic surveys by the oil and gas industry that could be undertaken during the construction and potential piling activity at East Anglia TWO. It has therefore been assumed as a worst-case scenario that there could potentially be one seismic survey by the oil and gas industry during the East Anglia TWO construction period.
946. The potential disturbance area during a single seismic survey by the oil and gas industry, based on a radius of 10km from each location is 314km².
947. Without knowing the actual location for any seismic surveys by the oil and gas industry, the mean density estimates have been based on the average seal at sea density estimate has been used, as outlined above, this is 0.02 harbour seal per km².
948. One seismic survey by the oil and gas industry could potentially disturb up to 6.3 harbour seal (0.014% of the in-combination reference population; or 0.13% of the South-East England MU; or 0.17% of the Wash and Blakeney Point count). However, it is highly unlikely that all harbour seal would be from the Wash and Blakeney Point.
949. Disturbance from any seismic surveys by the oil and gas industry would be temporary, for a relatively short-duration and at different locations, therefore, there is unlikely to be any significant disturbance or barrier effects for foraging harbour seal. Under these circumstances, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

5.4.2.1.9 Summary of potential disturbance effects from underwater noise (alone and in-combination)

950. **Table 5.61** summarises the potential effects of East Anglia TWO alone and in-combination with other projects and activities on foraging harbour seal in the context of the Wash and North Norfolk Coast SAC.
951. Disturbance from underwater noise for East Anglia TWO alone and in-combination with other projects and activities is unlikely to result any significant disturbance or barrier effects for foraging harbour seal, especially when taking into account the proposed mitigation approach for harbour porpoise in the SNS SAC. Under these circumstances, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

Table 5.61 Potential Effects from East Anglia TWO Alone and In-Combination with Other Project and Activities on Foraging Harbour Seal in the context of The Wash and North Norfolk Coast SAC

Potential effect	Assessment for harbour seal in relation to reference population	Potential adverse effect on site integrity
Potential disturbance from the underwater noise associated with UXO clearance at East Anglia TWO (alone)		
Potential disturbance from underwater noise associated with UXO clearance (2,124km ²).	15 harbour seal (based on offshore development area density 0.007/km ²) 0.30% of the South-East England MU (4,965 harbour seal); or 0.42% of the Wash and Blakeney Point count (3,609 harbour seal).	No
Potential disturbance from the underwater noise associated with piling at East Anglia TWO (alone)		
Potential disturbance during proposed mitigation (ADD activation for 10 minutes prior to soft-start).	0.002 harbour seal (based on offshore windfarm site density 0.0007/km ²) 0.0004% of the South-East England MU; or 0.00006% of the Wash and Blakeney Point count.	No
Potential disturbance from underwater noise during piling (2,124km ²).	1.5 harbour seal (based on offshore windfarm site density) 0.03% of the South-East England MU; or 0.04% of the Wash and Blakeney Point count.	No
Potential disturbance from underwater noise during construction and maintenance activities, other than piling, at East Anglia TWO (alone)		
Potential disturbance from underwater noise during construction activities,	2.5 harbour seal (based on offshore development area density)	No

Potential effect	Assessment for harbour seal in relation to reference population	Potential adverse effect on site integrity
other than piling (356km ² offshore development area).	0.05% of the South-East England MU; or 0.07% of the Wash and Blakeney Point count.	
Potential disturbance from vessels during construction, operation and maintenance at East Anglia TWO (alone)		
Potential disturbance from vessels during construction (356km ² offshore development area).	2.5 harbour seal (based on offshore development area density) 0.05% of the South-East England MU; or 0.07% of the Wash and Blakeney Point count.	No
Potential disturbance from underwater noise associated with operational turbines at East Anglia TWO (alone)		
Potential disturbance from the underwater noise associated with operational turbines (218km ² windfarm site).	0.15 harbour seal (based on offshore windfarm site density) 0.003% of the South-East England MU; or 0.004% of the Wash and Blakeney Point count.	No
Potential disturbance from underwater noise during decommissioning at East Anglia TWO (alone)		
Potential disturbance from the underwater noise associated with foundation removal, decommissioning activities and vessels (356km ² offshore development area).	2.5 harbour seal (based on offshore development area density) 0.05% of the South-East England MU; or 0.07% of the Wash and Blakeney Point count.	No

Potential effect	Assessment for harbour seal in relation to reference population	Potential adverse effect on site integrity
Potential overall noise effects during UXO clearance and piling at East Anglia TWO (alone)		
UXO detonation in cable corridor and piling at windfarm site (4,248km ²).	29.7 harbour seal (based on offshore development area density) 0.6% of the South-East England MU; or 0.8% of the Wash and Blakeney Point count.	No
Potential overall noise effects during piling and construction activities at East Anglia TWO (alone)		
Piling at windfarm site (2,124km ²) and other construction activities and vessels in cable corridor (up to 147km ²).	16 harbour seal (based on offshore development area density) 0.3% of the South-East England MU; or 0.4% of the Wash and Blakeney Point count.	No
Potential in-combination disturbance effects during piling at East Anglia TWO and other offshore windfarms		
Piling at offshore windfarm projects (2,124km ²), based on worst-case scenario for projects that could be piling at the same time as East Anglia TWO (Creyke Beck A, Sofia and Norfolk Vanguard) for single pile installation at each site (8,496km ²).	12.8 harbour seal (based on density at each windfarm) 0.03% of in-combination reference population (0.26% of the South-East England MU; or 0.35% of the Wash and Blakeney Point count).	No It is highly unlikely that all harbour seal would be from the Wash and Blakeney Point. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.

Potential effect	Assessment for harbour seal in relation to reference population	Potential adverse effect on site integrity
Potential in-combination disturbance effects during offshore windfarm construction at East Anglia TWO and other offshore windfarms		
Offshore windfarm construction activities and vessels, for windfarms that are not piling but potential for other construction activities during construction at East Anglia TWO, based on 100% disturbance from windfarm area (2,864km ²).	Up to 11 harbour seal (based on density at each windfarm) 0.02% of in-combination reference population (0.21% of the South-East England MU; or 0.30% of the Wash and Blakeney Point count).	No It is highly unlikely that all harbour seal would be from the Wash and Blakeney Point. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects during offshore windfarm operation and maintenance at other offshore windfarms		
Offshore windfarm operation and maintenance, including vessels, for windfarms operational after the start of the East Anglia TWO site specific surveys based on 100% disturbance from windfarm area (1,867km ²).	121 harbour seal (based on density at each windfarm) 0.27% of in-combination reference population (2.44% of the South-East England MU; or 3.35% of the Wash and Blakeney Point count).	No It is highly unlikely that all harbour seal would be from the Wash and Blakeney Point. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects on foraging seals during UXO clearance		
UXO clearance, based on one detonation at a time (2,124km ²).	42.5 harbour seal (based on density of 0.02/km ²) 0.09% of in-combination reference population (0.86% of the South-East England MU; or 1.18% of the Wash and Blakeney Point count).	No It is highly unlikely that all harbour seal would be from the Wash and Blakeney Point. It is more appropriate to use the in-combination

Potential effect	Assessment for harbour seal in relation to reference population	Potential adverse effect on site integrity
		reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects on foraging seals during seismic surveys by the oil and gas industry		
Seismic surveys by the oil and gas industry, based on one survey at a time (314km ²).	6.3 harbour seal (based on density of 0.02/km ²); 0.014% of in-combination reference population (0.13% of the South-East England MU; or 0.17% of the Wash and Blakeney Point count)	No It is highly unlikely that all harbour seal would be from the Wash and Blakeney Point. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Overall potential in-combination disturbance effects including East Anglia TWO on foraging seals		
Piling at offshore windfarm projects; offshore windfarm construction activities and vessels; offshore windfarm operation and maintenance, including vessels; one UXO detonation at a time; and one seismic survey by the oil and gas industry (maximum total = 15,665km ²).	Maximum of 193.6 harbour seal 0.43% of in-combination reference population (3.9% of the South-East England MU; or 5.4% of the Wash and Blakeney Point count).	No It is expected that management measures outlined for harbour porpoise in SNS SAC implemented by MMO would also reduce this impact.

5.4.2.2 Possible vessel interaction (increased collision risk)

5.4.2.2.1 East Anglia TWO (alone)

952. As a precautionary worst-case scenario approach, as outlined in **section 5.3.5.1.6**, the number of harbour seal that could be at increased collision risk with vessels during construction, operation, maintenance and decommissioning has been assessed based on 5% of the number of animals that could be present in the offshore development area (**Table 5.80**).

Table 5.62 Estimated Number of Harbour Seal that Could at Potential Increased Vessel Collision Risk in the Offshore Development Area

Potential effect area	Estimated number at potential collision risk based on 5% increased risk	% of reference populations	Potential adverse effect on site integrity
Total offshore development area (356km ²)	0.1 harbour seal	0.003% of the South-East England MU; or 0.003% of the Wash and Blakeney Point count.	No

953. This is very precautionary, as it is highly unlikely that harbour seal present in the offshore development area would be at increased collision risk with vessels, especially taking into account the relatively small increase vessel movements compared to existing vessel movements in the area.

954. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where harbour seal 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 harbour porpoise.

955. In addition, based on the assumption that harbour seal would be disturbed from the offshore development area as a result of underwater noise from construction, maintenance and decommissioning activities and vessels, there should be no potential for increased collision risk within the offshore development area.

956. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

5.4.2.2.2 In-combination

957. The precautionary in-combination assessment has determined that the number of harbour seal that could have a potential increased collision risk with vessels in offshore windfarm sites in the North Sea could be 0.6 harbour seal (0.001% of the in-combination reference population; or 0.01% of the South-East England MU; or 0.02% of the Wash and Blakeney Point count; **Table 5.82**).

958. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Wash and North Norfolk Coast in relation to the conservation objectives for harbour seal.**

Table 5.63 Quantified In-Combination Assessment for the Potential Increased Collision Risk with Vessels for Harbour Seal During Offshore Windfarm Construction

Name of Project	Harbour seal density estimate (No/km ²) ¹	Area of windfarm site (km ²)	Potential number of harbour seal impacted based on 5% collision risk
East Anglia TWO	0.0004	218	0.004
Creyke Beck A	0.0004	515	0.01
Creyke Beck B	0.008	599	0.2
Teesside A	0.00004	562	0.001
Sofia	0.00004	593	0.001
Norfolk Vanguard	0.0001	592	0.003
Hornsea Project Three	0.002	695	0.07
Thanet Extension	0.06	73	0.2
Norfolk Boreas	0.00006	727	0.002
East Anglia ONE North	0.0004	208	0.004
Total		4,780	0.6
% of Wash and Blakeney Point (3,609 harbour seal)			0.02%
% of South-East England MU (4,965 harbour seal)			0.01%
% of in-combination reference population (44,965 harbour seal)			0.001%

¹based on seal density grid cells that overlap with the OWF site boundary only (Source: Russell et al. 2017).

5.4.2.3 Potential changes in prey availability

5.4.2.3.1 East Anglia TWO (alone)

959. Potential effects on fish species during construction can result from physical disturbance and temporary loss of seabed habitat; increased suspended sediment concentrations and sediment re-deposition; and underwater noise (that could lead to mortality, physical injury, auditory injury or behavioural responses) (see **section 5.3.5.5.5**).

960. Potential effects on fish species during operation and maintenance can result from permanent loss of habitat; introduction of hard substrate; operational noise; and electromagnetic fields (EMF).
- The introduction of hard substrate, such as turbines, foundations and associated scour protection as well as cable protection, would increase habitat heterogeneity through the introduction of hard structures in an area predominantly characterised by soft substrate habitat. However, any hard substrate would occupy discrete areas and the relatively small areas of the infrastructure (see **section 5.2.1**).
 - Operational noise would include wind turbine vibration, the contact of waves with offshore structures and noise associated with increased vessel movement, which could result in increase in underwater noise in respect of the existing baseline (i.e. pre-construction). However, based on studies at operational offshore wind farms, any increase above background noise levels during operation is expected to be small and localised, therefore there would be no significant effect on fish species. This is supported by the noise modelling (see **ES Appendix 11.4**).
 - The areas potentially affected by EMFs generated by the worst-case scenario offshore cables are expected to be small, limited to the area of the OWF sites and the offshore cable corridor and restricted to the immediate vicinity of the cables (i.e. within metres). In addition, EMFs are expected to attenuate rapidly in both horizontal and vertical planes with distance from the source. Therefore, any potential effect of EMF on fish species would not be expected to be significant.
961. For this decommissioning, it is assumed that the potential effects would be the same or less than for construction.
962. As a worse-case scenario, the changes to prey resources during construction, operation, maintenance and decommissioning have been assessed based on the entire East Anglia TWO offshore development area (356km²).
963. The number of harbour seal that could be present in the area is 2.5 (based on 0.007/km² density). This represents 0.05% of the South-East England MU or, as a worst-case scenario, 0.07% of The Wash and Blakeney Point count in The Wash and North Norfolk Coast SAC.
964. It is highly unlikely that all harbour seal in the East Anglia TWO offshore development area would be from The Wash and Blakeney Point. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as

SAC counts. There would be no direct effect or overlap with the Wash and North Norfolk Coast SAC area.

965. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Consequently, there would be **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal arising from changes in prey resources.**

5.4.2.3.2 In-combination

966. Potential effects on prey species during construction, operation, maintenance and during decommissioning could be negative with fish species moving away or being lost from an area, while some effects could have a negative or positive effect, such as possible changes in species composition, and other effects could result in a positive effect, such as the aggregation of prey around seabed structures.
967. The potential effects on harbour seal as a result of any changes to prey availability can include changes in distribution, abundance and community structure, increased competition with other marine mammal species, increased susceptibility to disease and contaminants, and implications for reproductive success, which could potentially affect individuals throughout their range or at different times of the year. However, any changes to prey tend to be localised and temporary in nature. In addition, if prey species are disturbed from an area, it is highly likely that harbour seal will also be disturbed from the area over a potentially wider range than prey species.
968. The in-combination assessment on potential changes to prey availability has assumed that any potential effects on harbour seal prey species from underwater noise, including piling, would be the same or less than those for harbour seal. Therefore, there would be no additional effects other than those assessed for harbour seal, i.e. if prey are disturbed from an area as a result of underwater noise, harbour seal will be disturbed from the same or greater area, therefore any changes to prey availability would not additionally affect harbour seal as they would already be disturbed from the same area.
969. There would be no direct effect or overlap with the Wash and North Norfolk Coast SAC area.
970. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a

small percentage of the potential habitat in the surrounding area. Consequently, there would be **no potential adverse effect on the integrity of The Wash and North Norfolk Coast SAC** in relation to the conservation objectives for harbour seal arising from changes in prey resources.

5.4.3 Summary of Potential Effects for The Wash and North Norfolk Coast SAC

971. The assessment of the potential effects during the construction, operation and decommissioning of the proposed East Anglia TWO project alone and in combination has been summarised in relation to the Conservation Objectives of the Wash and North Norfolk Coast SAC where harbour seal are a qualifying feature (**Table 5.64**).

Table 5.64 Summary of the Assessment of the Potential Effects of East Anglia TWO and In-Combination Effects on The Wash and North Norfolk Coast SAC in Relation to the Conservation Objectives for Harbour Seal

Conservation Objectives	Disturbance of foraging harbour seals		Vessel interaction (increased collision risk)		Changes in prey availability	
	Project alone (including total effects)	In-combination	Project alone (including total effects)	In-combination	Project alone (including total effects)	In-combination
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	x	x	x	x	x	x
The structure and function (including typical species) of qualifying natural habitats.	x	x	x	x	x	x
The structure and function of the habitats of qualifying species.	x	x	x	x	x	x
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	x	x	x	x	x	x
The populations of qualifying species.	x	x	x	x	x	x
The distribution of qualifying species within the site.	x	x	x	x	x	x

x = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives.

5.5 Humber Estuary SAC

972. The Humber is the second-largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. Grey seal are present as a qualifying feature, but not a primary reason for site selection (JNCC 2017c).
973. The Humber Estuary SAC is located 188km from the East Anglia TWO windfarm site and 164km from the offshore cable corridor (at closest point). The Humber Estuary SAC was screened in to the HRA to take into account the movements of grey seal along the east coast of England.
974. For the purposes of this assessment, the potential effects are considered in relation to the SAC Conservation Objectives; as outlined in **Table 5.65**.

Table 5.65 Potential effects of East Anglia TWO in relation to the Conservation Objectives for the Humber Estuary SAC

Conservation Objective	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 associated with the East Anglia TWO development area 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 (e.g. from UXO clearance, piling, other construction activities, vessels, O&M noise, and noise associated with decommissioning phase works) have the potential to have an effect on the seals foraging at sea and will be considered further.

5.5.1 Grey Seal Status and Ecology

975. Donna Nook is located in the Humber Estuary SAC and the most recent August count at the site in 2017 was 6,526 grey seals (SCOS 2018).

5.5.1.1 Reference populations

976. The reference population for grey seal that encompasses Humber Estuary SAC is the south-east England MU (IAMMWG 2013). The latest grey seal count from the south-east England MU in August 2016 was 8,716 (SCOS 2018). The reference population to be used in the assessment for the Humber Estuary SAC will be the Donna Nook haul-out count of 6,526 grey seal.

977. 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 and north-east England MUs (IAMMWG 2013; SCOS 2018) and the Wadden Sea region (Brauseur et al. 2018).

978. The reference population for the in-combination assessment is therefore 21,864 grey seal, based on the most recent estimates for:

- South-east England MU = 8,716 grey seal (SCOS 2018);
- North-east England MU = 7,004 grey seal (SCOS 2018); and
- Wadden Sea area = 6,144 grey seal (Brauseur et al. 2018).

5.5.1.2 Density Estimates

979. The grey seal density estimates for the East Anglia TWO offshore cable corridor, windfarm site and offshore development area have been calculated from the 5km x 5km cells (Russell et al. 2017) based on the area of overlap with the East Anglia TWO offshore development area. The upper at-sea density estimates for these areas have been used in the assessment:

- The East Anglia TWO windfarm site density is estimated to be 0.02 grey seal per km²;
- The offshore cable corridor density is estimated to be 0.08 grey seal per km²; and
- The overall density estimate for the East Anglia TWO offshore development is 0.04 grey seal per km².

5.5.2 Assessment of Potential Effects on Humber Estuary SAC

980. The potential effects during the construction, operation and decommissioning of the proposed East Anglia TWO project to be assessed as part of the HRA process for the Humber Estuary SAC have been agreed in consultation with the marine mammal ETG as part of the EPP.

981. The potential effects of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the site in relation to the Conservation Objectives for grey seal are:

- Potential disturbance of foraging seals from underwater noise;
- Possible increased collision risk with vessels;
- Potential changes in prey availability; and
- Any in-combination effects.

982. An assessment of the potential risk of PTS for grey seal has been conducted in the ES **Chapter 11 Marine Mammals**. As outlined in **sections 5.3.5.1.1.1** and **5.3.5.1.2.1**, the risk of permanent auditory injury (PTS) during UXO clearance and piling will be reduced with the implementation of the MMMPs.

5.5.2.1 Potential disturbance of foraging seals from underwater noise

5.5.2.1.1 Potential disturbance of foraging seals from underwater noise during UXO clearance at East Anglia TWO (alone)

5.5.2.1.1.1 Risk of permanent auditory injury during UXO clearance

983. Underwater noise modelling (**Appendix 11.4** of the ES) has been undertaken to estimate the potential impact ranges for marine mammals likely to arise during UXO clearance, based on the maximum UXO charge sizes that could be located at East Anglia TWO (**Table 5.66**).

984. The maximum number of grey seal that could potentially be at increased risk of permanent auditory injury (PTS) has been estimated, based on the maximum potential impact ranges for UXO clearance of the maximum potential charge size (**Table 5.66**).

985. The use of NOAA (NMFS 2018) weighted SEL is considered more suitable, especially over long ranges, as it takes into account the hearing sensitivity of the species. However, as a precautionary approach, the assessment has been based on the worst-case scenarios for the unweighted peak Sound Pressure Levels (SPL_{peak}) predicted PTS impact ranges for grey seal (**Table 5.66**).

Table 5.66 Potential Effects of Permanent Auditory Injury (PTS) on Grey Seal during UXO Clearance without Mitigation

Potential effect	Criteria threshold	Possible maximum charge weight			
		200kg	300kg	500kg	700kg
		Maximum predicted impact range (km) and area* (km ²)			
Permanent auditory injury (PTS) – without mitigation	SPL _{peak} unweighted (NMFS 2018) 218 dB re 1 µPa Impulsive criteria	1.7km (9.08km ²)	1.9km (11.34km ²)	2.3km (16.62km ²)	2.6km (21.24km ²)
	SEL weighted (NMFS 2018) 185 dB re 1 µPa ² s Impulsive criteria	1.0km (3.14km ²)	1.2km (4.52km ²)	1.5km (7.07km ²)	1.8km (10.18km ²)
	SEL weighted (NMFS 2018) 201 dB re 1 µPa ² s Non-impulsive criteria	0.06km (0.01km ²)	0.08km (0.02km ²)	0.1km (0.03km ²)	0.11km (0.04km ²)
Maximum number of grey seal (based on 0.04/km ² density in the offshore development area) and % of SE England MU based on maximum impact area* (21.24km ²) for PTS unweighted SPL _{peak}		Up to 0.85 grey seal (0.0098% of SE England MU; 0.01% of the Donna Nook count).			
Number of grey seal (based on 0.04/km ² density in the offshore development area) and % of SE England MU based on maximum impact area* (10.18km ²) for PTS weighted SEL impulsive criteria		Up to 0.41 grey seal (0.005% of SE England MU; 0.006% of the Donna Nook count).			

*Maximum area based on area of circle with maximum impact range for radius as worst-case scenario.

Mitigation

986. As outlined in **section 5.3.5.1.1.1**, 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 (PTS) 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, in consultation with the MMO and relevant SNCBs.

987. The effective implementation of the UXO MMMP will reduce the risk of permanent auditory injury (PTS) to grey seal during any underwater detonations at East Anglia TWO (alone), therefore, there would be **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.1.2 Potential disturbance from the underwater noise associated with UXO clearance

988. The SNCBs currently recommend that a potential disturbance range of 26km (approximate area of 2,124km²) around UXO detonations is used to assess harbour porpoise disturbance in the SNS SAC. This approach has also been used to assess the potential disturbance of seals. As UXO clearance could be undertaken in the offshore windfarm site or the offshore cable corridor, the density estimates are based on the offshore development area (**Table 5.67**).

Table 5.67 Estimated Number of Grey Seal Potentially Disturbed during UXO Clearance at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2,124km ²) during underwater UXO clearance - based on 26km	85 grey seal (based on 0.04/km ² density in the offshore development area).	0.98% of the South-East England MU (1.3% of the Donna Nook count).	No Temporary effect. Less than 1% of the grey seal SE England MU could be temporarily disturbed during any UXO clearance at East Anglia TWO (alone), based on the worst-case scenario.

989. Disturbance from any UXO detonations would be temporary and for a short-duration (i.e. the detonation). For the estimated worst-case, it is predicted that there could be up to 80 clearance operations in the East Anglia TWO offshore development area. As a precautionary worst-case scenario, the maximum number of days of UXO clearance could be up to 80 days, based on one detonation per day within the overall UXO clearance operation, which could be conducted over several months.
990. Density estimates (Russell et al. 2017), tagging studies (Russell and McConnell 2014; Russell 2016) and site surveys at the East Anglia TWO windfarm site and other offshore windfarms in the area (see ES **Chapter 11 Marine Mammals**) indicate that the number of grey seal is relatively low and infrequent.
991. It is highly unlikely that all grey seal in the East Anglia TWO offshore development area would be from the Humber Estuary, which is located over 171km from the offshore development area. There is the potential for seals to be from other haul-

out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with the Humber Estuary SAC area.

992. Under these circumstances, there is no potential for any significant disturbance of grey seal foraging in and around the East Anglia TWO offshore development area. Therefore, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.2 Potential disturbance from the underwater noise associated with piling

5.5.2.1.2.1 Risk of permanent auditory injury during piling

993. Underwater noise modelling has been undertaken to estimate the maximum potential impact ranges for underwater noise that could arise during construction of East Anglia TWO (**Appendix 11.4** of the ES) and determine the potential effects on grey seal. The modelling has been based on the worst-case scenarios for:
- Monopile up to 15m diameter with maximum hammer energy applied of 4,000kJ and starting hammer energy of 10% maximum hammer energy (400kJ); and
 - Pin-piles up to 4.6m diameter with maximum hammer energy applied of 2,400kJ and starting hammer energy of 10% maximum hammer energy (240kJ).
994. The underwater noise modelling results for the maximum predicted ranges (and areas) for permanent auditory injury (PTS) in grey seal, based on the NOAA (NMFS 2018) criteria for unweighted peak sound pressure levels (SPL_{peak}) and PTS from weighted sound exposure levels (SEL), which take into account the species hearing sensitivity, for single strike (SEL_{ss}) and cumulative exposure (SEL_{cum}) are presented in **Table 5.68**.
995. The number of seals that could potentially be affected has been estimated based on the density estimates for the East Anglia TWO windfarm site (0.02/km² for grey seal).
996. Without any mitigation, the estimated maximum number of grey seal that could potentially be at risk of PTS as a result of a single strike of the maximum monopile or pin-pile hammer energy is 0.0002 individuals (0.000002% of the South-East England MU; 0.000003% of the Donna Nook count; **Table 5.68**).
997. The number of grey seal that could potentially be at risk of PTS as a result of cumulative exposure during piling of pin-piles with a maximum hammer energy

to be applied of 2,400kJ is 2.2 grey seal (0.025% of the South-East England MU; 0.034% of the Donna Nook count).

Table 5.68 Maximum Predicted Impact Ranges (and Areas) for Permanent Auditory Injury (PTS) for Grey Seal from a Single Strike and from Cumulative Exposure during Piling at East Anglia TWO

Potential effect	Criteria threshold	Maximum predicted impact range (km) and area* (km ²)			
		Monopile with starting hammer energy of 400kJ	Monopile with maximum hammer energy of 4,000kJ	Pin-pile with starting hammer energy of 240kJ	Pin-pile with maximum hammer energy of 2,400kJ
PTS without mitigation – single strike	NMFS (2018) unweighted SPL _{peak} 218 dB re 1 µPa	<0.05km (<0.01km ²)	0.06km (0.01km ²)	<0.05km (<0.01km ²)	0.06km (0.01km ²)
Number of grey seal (based on the 0.02/km ² density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area (0.01km²) for PTS unweighted SPL _{peak}		0.0002 grey seal (0.000002% of the South-East England MU; 0.000003% of the Donna Nook count).			
PTS without mitigation – single strike	NMFS (2018) SEL _{ss} weighted 185 dB re 1 µPa ² s	<0.05km (<0.01km ²)	0.06km (0.01km ²)	<0.05km (<0.01km ²)	0.06km (0.01km ²)
Number of grey seal (based on the 0.02/km ² density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area (0.01km²) for PTS weighted SEL _{ss}		0.0002 grey seal (0.000002% of the South-East England MU; 0.000003% of the Donna Nook count).			
PTS from cumulative SEL (including soft-start and ramp-up)	NMFS (2018) SEL _{cum} weighted 185 dB re 1 µPa ² s	N/A	4.9km (57km ²)	N/A	6.8km (110km ²)

Potential effect	Criteria threshold	Maximum predicted impact range (km) and area* (km ²)			
		Monopile with starting hammer energy of 400kJ	Monopile with maximum hammer energy of 4,000kJ	Pin-pile with starting hammer energy of 240kJ	Pin-pile with maximum hammer energy of 2,400kJ
Number of grey seal (based on the 0.02/km ² density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area (110km²) for PTS weighted SEL _{cum}		2.2 grey seal (0.025% of the South-East England MU; 0.034% of the Donna Nook count).			

*areas for maximum hammer energies for monopile and pin-pile based on modelled contour area; area for starting hammer energy based on precautionary area of circle with maximum impact range as radius
N/A = not applicable

Mitigation

998. As outlined in **section 5.3.5.1.1.1**, the MMMP for piling will be developed pre-construction in consultation with the MMO and relevant SNCBs and will be based on the best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will detail the proposed mitigation measures to reduce the risk of permanent auditory injury (PTS) to grey seal during piling.
999. The MMMP for piling will reduce the risk of permanent auditory injury to grey seal as a result of underwater noise during piling at East Anglia TWO (alone), therefore, there would be **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.2.2 Potential disturbance during proposed mitigation

1000. During the implementation of the proposed mitigation, for example the activation of ADDs for up to 10 minutes, it is estimated that animals would move 0.9km (based on a precautionary average marine mammal swimming speed of 1.5m/s), a potential disturbance area of 2.54km².

Table 5.69 Estimated Number of Grey Seal Potentially Disturbed during ADD Activation at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2.54km ²) during ADD activation	0.05 grey seal (based on 0.02/km ² density in the windfarm site).	0.0006% of the South-East England MU (0.0008% of the Donna Nook count).	No Temporary effect. 0.0006% or less grey seal South-East England MU could be temporarily disturbed during ADD activation at East Anglia TWO (alone).

1001. The example ADD activation, based on up to 10 minutes per pile, would be up to 57.3 hours (approximately 2.4 days) for up to 344 pin-piles for wind turbines and platforms.
1002. It is highly unlikely that all grey seal in the East Anglia TWO windfarm site would be from the Humber Estuary. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with the Humber Estuary SAC area.
1003. Taking into account the temporary, intermittent and short-duration of the potential disturbance from ADD activation, along with the relatively low and infrequent number of grey seal in and around the East Anglia TWO windfarm site, there is no potential for any significant disturbance of foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**
1004. It should be noted that the disturbance as a result of the proposed mitigation, prior to piling, would be part of the 26km disturbance range for piling and is therefore not an additive effect to the overall area of potential disturbance. However, the duration of the proposed mitigation prior to piling has been taken into account, as a worst-case scenario, in the assessment of the duration of potential disturbance for piling.

5.5.2.1.2.3 Potential disturbance during piling

1005. Data from tagged harbour seals in The Wash indicate that seals were not excluded from the vicinity of Dudgeon Offshore Windfarm during the overall construction phase, but that there was clear evidence of avoidance during pile driving, with significantly reduced levels of seal activity at ranges up to 25km from piling sites (Russell et al. 2016; SCOS 2016, 2017). Therefore, a 26km disturbance range has been used to assess the potential disturbance of grey seal

(**Table 5.70**). It is acknowledged that this is not Natural England's advice; however, this approach was agreed by the ETG.

1006. In addition, the number of grey seal that could be disturbed during underwater piling at East Anglia TWO has been estimated based on the maximum potential for temporary auditory injury (TTS) / fleeing response. Although not all individuals within the maximum TTS range will have temporary hearing impairment, it is assumed as a worst-case scenario that all animals could be disturbed.

Table 5.70 Estimated Number of Grey Seal Potentially Disturbed during Piling at East Anglia TWO

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Area of disturbance (2,124km ²) during piling - based on 26km	42.5 grey seal (based on 0.02/km ² density in the windfarm site).	0.49% of the South-East England MU (0.65% of the Donna Nook count).	No Temporary effect. 0.5% or less of the grey seal South-East England MU could be temporarily disturbed during piling at East Anglia TWO (alone), based on the worst-case scenario.
Maximum area of potential TTS onset / fleeing response for single strike – based on weighted SEL _{ss} (170 dB re 1 µPa ² s impulsive criteria; NMFS 2018)	Up to 2.4km ² for monopiles (4,000kJ) and pin-piles (2,400kJ) 0.05 grey seal (based on 0.02/km ² density in the windfarm site).	0.0006% of the South-East England MU (0.0008% of the Donna Nook count).	No Temporary effect. 0.0006% or less of the grey seal South-East England MU could be temporarily disturbed during piling at East Anglia TWO (alone).
Maximum area of potential TTS onset / fleeing response for cumulative exposure over 24 hrs – based on weighted SEL _{cum} (140 dB re 1 µPa ² s impulsive criteria; NMFS 2018).	Up to 1,300km ² for monopiles (4,000kJ) 26 grey seal (based on 0.02/km ² density in the windfarm site).	0.30% of the South-East England MU (0.40% of Donna Nook count).	No Temporary effect. 0.3% or less of the grey seal South-East England MU could be temporarily disturbed during piling at East Anglia TWO (alone).
	Up to 1,600km ² for pin-piles (2,400kJ) 32 grey seal (based on 0.02/km ² density in the windfarm site).	0.38% of the South-East England MU (0.49% of the Donna Nook count).	No Temporary effect. 0.4% or less of the grey seal South-East England MU could be temporarily disturbed during piling at East Anglia TWO (alone).

1007. The duration of potential disturbance for active piling, based on the worst-case scenario for the installation of 60 300m turbines with pin-piles, six platforms with pin-piles and 10 minute ADD activation per pile, would be up to 41.6 days within the offshore construction period.
1008. It is highly unlikely that all grey seal in the East Anglia TWO windfarm site would be from the Donna Nook haul-out site. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with The Humber Estuary SAC area.
1009. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low and infrequent number of grey seal in and around the East Anglia TWO windfarm site, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.3 Potential disturbance from underwater noise during non-piling construction and maintenance activities

1010. Possible sources of underwater noise during non-piling construction activities, include seabed preparation, rock dumping and cable installation.
1011. The requirements for any potential maintenance work, such as additional rock dumping or cable re-burial, are currently unknown, however the work required and associated effects would be less than those during construction.
1012. The results of the underwater noise modelling (**Table 5.71**) indicate that grey seal would have to remain in close proximity over a 24 hour period to be exposed to levels of sound that are sufficient to induce PTS or TTS from cumulative exposure based on the NMFS (2018) threshold criteria.
1013. The potential risk of any auditory injury as a result of dredging or cable laying activity is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction and maintenance activities, other than piling.

Table 5.71 Maximum Predicted Impact Ranges for Permanent Auditory Injury (PTS) and Temporary Auditory Injury (TTS) / Fleeing Response from Non-Piling Construction and Maintenance Activities

Potential Impact	Criteria and threshold	The modelled impact ranges (m) for each offshore construction activity				
		Dredging	Drilling	Cable Laying	Rock Placement	Trenching
Permanent auditory injury (PTS) from 24 hour cumulative exposure	NMFS (2018) 201 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria Pinnipeds in Water (PW) SEL_{cum}	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)
Temporary auditory injury (TTS) / fleeing response from 24 hour cumulative exposure	NMFS (2018) 181 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL_{cum}	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)	<0.1km (0.031km ²)
0.0012 grey seal (0.00001% of the South-East England MU; 0.00002% of the Donna Nook count) based on the 0.04/km ² density estimate for the offshore development area.						

1014. As a very precautionary worst-case scenario, the assessment for the disturbance as a result of underwater noise during construction and maintenance activities, other than piling and vessel movements, has been assessed based on the entire offshore development area (**Table 5.72**). This is very precautionary, as it is highly unlikely that non-piling construction and maintenance activities could result in disturbance from the entire offshore development area. Any disturbance is likely to be limited to the area in and around where the activity is taking place.

Table 5.72 Estimated Number of Grey Seal Potentially Disturbed from Offshore Development Area

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
Offshore development area (356km ²)	14 grey seal (based on 0.04/km ² density in the offshore development area).	0.16% of the South-East England MU (0.21% of the Donna Nook count).	No Temporary effect. 0.2% or less of the grey seal South-East England MU could be temporarily disturbed during construction activities, other than piling, at East Anglia TWO (alone).

1015. It is highly unlikely that all grey seal in the offshore development area would be from the Donna Nook haul-out site. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with the Humber Estuary SAC area.
1016. Any disturbance from construction and maintenance activities, other than piling, would be temporary, localised, intermittent duration and at different locations within the offshore development area. Taking this into account, along with the relatively low and infrequent number of grey seal in and around the East Anglia TWO offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.4 Potential disturbance from vessels during construction, operation and maintenance

1017. During construction, there will be an increase in the number of vessels associated with installation of the turbine foundations, associated sub-structures and installation of the array and export cables, therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the offshore development area. During construction, the approximate number of vessels on site at any one time during construction is estimated to be 74 vessels.
1018. The requirements for any potential maintenance work are currently unknown, however the work required and effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than those during construction. It is estimated that there could be up to 1-2 vessels trips per day.
1019. The results of the underwater noise modelling (**Table 5.73**) indicate that grey seal would have to remain in close proximity to vessels over a 24 hour period, to be exposed to noise levels that are sufficient to induce PTS or TTS from cumulative exposure based on the NMFS (2018) threshold criteria.
1020. The potential risk of any auditory injury in marine mammals as a result of vessels is highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with construction vessels.

Table 5.73 Maximum Predicted Impact Ranges for Permanent Auditory Injury (PTS) and Temporary Auditory Injury (TTS) / Fleeing Response from Vessels

Potential Impact	Criteria and threshold	The modelled impact ranges (m) for each offshore construction activity	
		Large vessels	Medium sized vessels
Permanent auditory injury (PTS) from cumulative exposure	NMFS (2018) 201 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)	<0.1km (<0.031km ²)
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 181 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)	<0.1km (<0.031km ²)
Disturbance from 74 vessels (2.3km ²) = 0.09 grey seal (0.001% of the South-East England MU; 0.001% of the Donna Nook count) based on the 0.04/km ² density estimate for the offshore development area.			

1021. The assessment for vessels assumes a very precautionary worst-case scenario, that grey seal in the offshore development area could be disturbed (**Table 5.72**). However, any disturbance is likely to be limited to the immediate vicinity around the vessel, as indicated by the noise modelling (**Table 5.73**).
1022. The baseline conditions indicate an already relatively high level of shipping activity in and around East Anglia TWO. Therefore, based on an average of 4.5 vessel movements per day during construction and an average of two vessels per day during operation and maintenance would be relatively small compared to existing vessel traffic.
1023. Any disturbance from construction and maintenance vessels would be temporary, localised, intermittent duration and at different locations within the offshore development area. Taking this into account, along with the relatively low and infrequent number of grey seal in and around the offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary Coast SAC in relation to the conservation objectives for grey seal**.

5.5.2.1.5 Potential disturbance from underwater noise associated with operational wind turbines

1024. Currently available data indicates that there is no lasting disturbance or exclusion of seals around windfarm sites during operation (McConnell et al. 2012; Russell et al. 2014). Data collected suggests that any behavioural responses for seals

may only occur up to a few hundred metres away from the source of disturbance (McConnell et al. 2012). Seals have been shown to forage within operational windfarm sites (e.g. Russell et al. 2014).

1025. Underwater noise modelling was undertaken to assess the potential impact ranges of operational turbines on marine mammals. The underwater noise propagation modelling used measured sound source data scaled to relevant parameters for the proposed East Anglia TWO project (see **Appendix 11.4** of the ES for further information).
1026. The modelling results indicate that at the source levels predicted for operational underwater noise, any grey seal would have to remain in very close proximity to a wind turbine over a 24 hour period to be exposed to levels of sound that are sufficient to result in PTS or TTS from cumulative exposure (**Table 5.74**).
1027. The potential risk of any auditory injury in marine mammals as a result of underwater noise from operational wind turbines is considered highly unlikely. Disturbance is therefore the only potential underwater noise effect associated with operational wind turbines.

Table 5.74 Maximum Predicted Impact Ranges for Permanent Auditory Injury (PTS) and Temporary Auditory Injury (TTS) / Fleeing Response from Operational Wind Turbines

Potential Impact	Criteria and threshold	Operational wind turbines (300,)
Permanent auditory injury (PTS) from cumulative exposure	NMFS (2018) 201 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 181 dB re 1 $\mu\text{Pa}^2\text{s}$ non-impulsive criteria PW SEL _{cum}	<0.1km (<0.031km ²)
Disturbance from 60 x 300m turbines (1.86km ²) = 0.04 grey seal (0.0005% of the South-East England MU; 0.0006% of the Donna Nook count) based on the 0.02/km ² density estimate for the windfarm site.		

1028. The assessment for operational wind turbines assumes a very precautionary worst-case scenario, that all grey seal in the East Anglia TWO windfarm site could potentially be disturbed (**Table 5.75**). However, in reality any disturbance is likely to be limited to the immediate vicinity around the turbines, as indicated by the noise modelling (**Table 5.74**).

Table 5.75 Estimated Number of Grey Seal Potentially Disturbed from East Anglia TWO windfarm site

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
East Anglia TWO windfarm site is 218.4km ²	4.4 grey seal (based on 0.02/km ² density in the windfarm site).	0.05% of the South-East England MU (0.07% of the Donna Nook count).	No Temporary effect. 0.05% or less of the grey seal South-East England MU could be temporarily disturbed from the East Anglia TWO windfarm site.

1029. It is highly unlikely that all grey seal in the East Anglia TWO windfarm site would be from the Donna Nook haul-out site. There would be no direct effect or overlap with the Humber Estuary SAC area.

1030. Taking into account evidence of seal foraging in operational windfarms, along with the relatively low and infrequent number of grey seal in and around the East Anglia TWO windfarm site, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.6 Potential disturbance from underwater noise during decommissioning

1031. The potential underwater noise effects during decommissioning of the proposed East Anglia TWO project that have the potential to adversely affect the integrity of the site in relation to the Conservation Objectives are:

- Disturbance resulting from the noise associated with foundation removal (e.g. cutting);
- Disturbance resulting from underwater noise and disturbance from vessels; and
- Barrier effects as a result of underwater noise associated with activities above.

1032. 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 and UXO clearance).

1033. A detailed decommissioning plan will be provided prior to decommissioning that will give details of the techniques to be employed and any relevant mitigation measures.

1034. For this assessment, it is assumed that the potential effects from underwater noise during decommissioning would be less than those assessed for piling and comparable to those assessed for other construction activities (as assessed above). Therefore, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.7 Potential overall noise disturbance effects on foraging grey seals from the proposed East Anglia TWO project (alone)

5.5.2.1.7.1 Potential overall effects during UXO clearance

1035. It is not anticipated that piling would be undertaken at the same time as UXO clearance, however, as a worst-case scenario it has been assumed that UXO clearance could be undertaken, for example in the offshore cable corridor while piling could be undertaken at the East Anglia TWO windfarm site.

1036. It is assumed that only one UXO could be detonated at a time during piling and there would be no concurrent piling. The maximum potential area of disturbance is 4,248km², based on 26km disturbance range around each pile location and UXO location, and assuming no overlap in the potential impact areas.

1037. The maximum number of grey seal that could potentially be disturbed is 170, based on 0.04/km² density in the offshore development area. This represents 1.95% of the South-East England MU or, as a worst-case scenario, 2.60% of the population from Donna Nook in the Humber Estuary SAC.

1038. It is highly unlikely that all grey seal in the offshore development area would be from the Donna Nook haul-out site. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with the Humber Estuary SAC area.

1039. Disturbance from any UXO detonations would be temporary and for a short-duration. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low and infrequent number of grey seal in and around the offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.7.2 Potential overall effects during piling at East Anglia TWO

1040. This assessment assumes piling in the East Anglia TWO windfarm site at the same time as other construction activities, including vessels, in the offshore cable

corridor. Disturbance from piling would be up to 2,124km² (based on 26km EDR) with 147km² of cable corridor not overlapped by piling impact area, giving a maximum potential area of disturbance is up to 2,271km².

1041. The maximum number of grey seal that could potentially be disturbed is 91, based on 0.04/km² density in the offshore development area. This represents 1.04% of the South-East England MU or, as a worst-case scenario, 1.39% of the grey seal count from the Donna Nook haul-out site within the Humber Estuary SAC.
1042. It is highly unlikely that all grey seal in the offshore development area would be from Donna Nook. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant reference populations as well as SAC counts. There would be no direct effect or overlap with the Humber Estuary SAC area.
1043. Disturbance from construction activities and vessels would be temporary and for a short-duration. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low and infrequent number of grey seal in and around the offshore development area, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.7.3 Other potential overall effects during construction at East Anglia TWO

1044. There would be no further overall effects during construction other than those assessed above, as the potential disturbance from underwater noise during construction has been based on the entire offshore development area, as has any potential disturbance from vessels. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.7.4 Potential overall effects during operation and maintenance at East Anglia TWO

1045. There would be no further overall effects during operation and maintenance, as the potential disturbance from underwater noise from operational turbines, maintenance activities and vessels all been based on the entire offshore development area. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.7.5 Potential overall effects during decommissioning

1046. There would be no further overall effects during decommissioning, as the potential disturbance from underwater noise during foundation removal, disturbance from vessels and any changes to prey availability will be based on the entire offshore development area. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.8 Potential in-combination disturbance effects on foraging grey seals

5.5.2.1.8.1 Potential in-combination disturbance effects during piling

1047. There is a high level of uncertainty in relation to the in-combination scenarios that will arise at the time of the proposed East Anglia TWO project construction. The assessment has been undertaken based on the most realistic worst-case scenario of the offshore windfarms that could be piling at the same time as the proposed East Anglia TWO project.

1048. This scenario is a precautionary approach using the maximum duration of potential piling periods, based on currently available information (see **section 5.3.5.5.1**). Based upon **Table 5.29** this scenario includes three other UK offshore windfarms:

- Creyke Beck A;
- Sofia (formerly Teesside B); and
- Norfolk Vanguard.

1049. The number of grey seal in the potential impact areas, for single and concurrent piling, has been estimated using the latest seals-at-sea usage maps to estimate densities (Russell et al. 2017) for the relevant area that each project is located.

1050. For the potential worst-case scenario, with single piling at East Anglia TWO and concurrent piling at Creyke Beck A, Sofia and Norfolk Vanguard, the estimated maximum area of potential disturbance is up to 14,868km², using the 26km EDR without any overlap in the potential areas of disturbance at each windfarm or between windfarms.

1051. The maximum number of grey seal that could potentially be temporarily disturbed is 766 individuals (**Table 5.76**). This represents 8.8% of the South-East England MU or, as a worst-case scenario, 11.7% of the 6,526 grey seal count from the Donna Nook haul-out site in the Humber Estuary SAC. However, it is highly unlikely that all grey seal in the windfarm sites would be from the Donna Nook site. To take into account the windfarm locations, movements and ranges of grey seal, it is more appropriate to use the in-combination reference population to cover the wider area (see **section 5.5.1.1**). Therefore, 3.5% of the in-

combination reference population (21,864 grey seal) could potentially be temporarily disturbed.

1052. Based on the more likely single pile installation at each of the four offshore windfarms, the estimated maximum area of potential disturbance is 8,496km², without any overlap in the potential areas of disturbance between windfarms. The maximum number of grey seal that could potentially be temporarily disturbed is 401 individuals, which represents 1.8% of the in-combination reference population (**Table 5.76**).

1053. Taking into account the temporary disturbance and intermittent duration of underwater noise from piling, along with the relatively low percentage of the reference population that could be temporarily affected, there is no potential for any significant disturbance or barrier effects to foraging grey seal. Therefore, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal**.

Table 5.76 Quantified In-Combination Assessment for the Potential Disturbance of Grey Seal During Single and Concurrent Piling at Offshore Windfarms which could be Piling at the Same Time as East Anglia TWO

Name of Project	Grey seal density estimate (No/km ²) ¹	Potential number of grey seal disturbed	
		single piling	concurrent piling
East Anglia TWO	0.017	36	36 (single piling)
Creyke Beck A	0.08	170	340
Sofia	0.09	191	382
Norfolk Vanguard	0.002	4	8
Total		401	766
% of Donna Nook count (6,526 grey seal)		6.1%	11.7%
% of South-East England MU (8,716 grey seal)		4.6%	8.8%
% of in-combination reference population (21,864 grey seal)		1.8%	3.5%

¹The densities included are based on a 26km buffer around the offshore windfarm, using the 5x5km grid squares of the seals-at-sea total usage data that intersect with the projects and 26km buffer; based on Russell et al. (2017).

5.5.2.1.8.2 Potential in-combination disturbance effects during offshore windfarm construction

1054. During the construction of the proposed East Anglia TWO project, there is the potential to overlap with impacts from the construction activities, other than piling, at other offshore windfarms. Noise sources which could cause potential

disturbance impacts during offshore windfarm construction activities, other than pile driving, can include vessels, seabed preparation, ploughing / jetting / pre-trenching or cutting for installation of cables and rock dumping for protection of the cable.

1055. The assessment includes offshore windfarms which could potentially have construction activities, other than piling, during the East Anglia TWO construction period (**Table 5.29**). This precautionary realistic worst-case scenario includes six UK offshore windfarms:

- Creyke Beck B;
- Teesside A;
- Thanet Extension;
- Hornsea Project 3;
- Norfolk Boreas; and
- East Anglia ONE North.

1056. The potential temporary disturbance during offshore windfarm construction activities, other than pile driving noise sources, has been based on the area of the offshore windfarm sites. This is a very precautionary approach, as it is highly unlikely that construction activities, other than piling activity, would result in disturbance from entire windfarm sites. Any disturbance is likely to be limited to the area in and around where the activity is taking place.

1057. There would be no additional cumulative impacts of underwater noise from other construction activities for those projects which also have overlapping piling with East Anglia TWO as the ranges for piling would be significantly greater than those from other construction noise sources.

1058. The assessment indicates that if all six of these offshore windfarms were conducting construction activities, other than piling, at the same time, the estimated maximum cumulative area of disturbance is 2,864km² (based on disturbance from the entire offshore windfarm areas).

1059. The maximum number of grey seal that could potentially be disturbed is 158.6 individuals, which represents approximately 0.73% of the in-combination reference population or up to 2.4% of the Donna Nook count (**Table 5.77**). However, it is highly unlikely that all grey seal would be from the Donna Nook site within the Humber Estuary SAC. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant in-combination reference population as well as SAC counts.

1060. Considering the temporary disturbance and intermittent duration of underwater noise from construction activities, along with the relatively low percentage of the reference population that could be temporarily affected, there is no potential for any significant disturbance or barrier effects to foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

Table 5.77 Quantified In-Combination for the Potential Disturbance of Grey Seal During Construction Activities (Other Than Piling) at Offshore Windfarms during Construction for the Proposed East Anglia TWO Project

Name of Project	Grey seal density estimate (No/km ²) ¹	Area of windfarm site (km ²)*	Potential number of grey seal disturbed from entire windfarm area
Creyke Beck B	0.2	599	120
Teesside A	0.02	562	11
Thanet Extension	0.02	73	1
Hornsea Project 3	0.037	695	26
Norfolk Boreas	0.0006	727	0.4
East Anglia ONE North	0.0009	208	0.2
Total		2,864	158.6
% of Donna Nook count (6,526 grey seal)			2.4%
% of South-East England MU (8,716 grey seal)			1.8%
% of in-combination reference population (21,864 grey seal)			0.73%

*Source: <http://www.4coffshore.com/>

¹based on seal density grid cells that overlap with the OWF site boundary only (Source: Russell et al. 2017).

5.5.2.1.8.3 Potential in-combination disturbance effects during operation and maintenance

1061. There is the potential for disturbance from operational offshore windfarms as a result of any operational and maintenance activities, including operational turbines, vessels, additional rock dumping or cable re-burial, during the East Anglia TWO construction period.

1062. The potential disturbance from operational and maintenance activities at offshore windfarms has also been based on the worst-case scenario of the entire area of the windfarm sites. This is again a very precautionary approach, as it is highly unlikely that operational windfarms and maintenance activities, including vessels,

would result in disturbance from the entire wind farm area. Any disturbance is likely to be limited to the area in and around where the actual activity is actually taking place.

1063. Operational offshore windfarms were considered part of the baseline if they were in the in-combination reference population area and they were operational at the time of the start of the East Anglia TWO site specific surveys (November 2015). Therefore, the only offshore windfarms screened into the CIA were those with potential to be newly operational by the East Anglia TWO construction period, in that they are currently under construction or will be constructed and operational by 2025.
1064. Operational UK and European offshore windfarms in the southern North Sea that could have potential in-combination effects during the East Anglia TWO construction period have an estimated maximum potential in-combination area up to 1,867km² (based on disturbance from entire offshore windfarm area).
1065. The maximum number of grey seal that could potentially be disturbed is 377 individuals, which represents approximately 1.7% of the in-combination reference population, or up to 5.8% of the Donna Nook site count (**Table 5.78**). However, it is highly unlikely that all grey seal would be from the Humber Estuary SAC. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant in-combination reference population as well as SAC counts.
1066. Taking into account that seals have been recorded foraging in operational windfarm sites, along with the relatively low percentage of the reference populations that could be temporarily affected, there is no potential for any significant disturbance or barrier effects to foraging grey seal. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal**.

Table 5.78 Quantified In-Combination Assessment for the Potential Disturbance of Grey Seal During Operation and Maintenance Activities at Offshore Windfarms in the Southern North Sea During Construction of the Proposed East Anglia TWO Project

Name of Project	Grey seal density estimate (No/km ²) ¹	Area of WF site (km ²)*	Potential number of grey seal disturbed from the entire windfarm area
Blyth Offshore Wind Demo 2 ²	0.015	<1	0.015
Blyth Offshore Wind Demo 3A & 4 ²	0.06	4	0.2
Dudgeon ¹	0.1	55	5.5

Name of Project	Grey seal density estimate (No/km ²) ¹	Area of WF site (km ²)*	Potential number of grey seal disturbed from the entire windfarm area
East Anglia ONE	0.0006	205	0.1
East Anglia THREE	0.0001	301	0.03
Galloper ²	0.007	113	0.7
Hornsea Project One	0.4	407	164
Hornsea Project Two	0.17	462	80
Humber Gateway Wind Farm	3.9	27	106
Kentish Flats Extension	0.074	8	0.6
Nordergreunde	0	3	0
Norther ³	0.0003	38	0.01
Northwester 2 ³	0.0004	12	0.005
Race Bank	0.08	62	5
RENTEL ³	0.0004	23	0.009
Triton Knoll phase 1-3	0.1	146	15
Total		1,867km²	377
% of Donna Nook count (6,526 grey seal)			5.8%
% of South-East England MU (8,716 grey seal)			4.3%
% of reference population (21,864 grey seal)			1.7%

*Source: <http://www.4coffshore.com/>

¹Density is based on grids overlapping with the project only (source: Russell et al. 2017)

²Operational after the start of the East Anglia TWO site specific surveys, but before the submission of the ES

³Unknown date of project operation, but assumed to be before the construction of East Anglia TWO

5.5.2.1.8.4 Potential in-combination disturbance effects on during UXO clearance

1067. As outlined in **section 5.3.5.5.2.1**, it is currently not possible to estimate the number of potential UXO clearance operations that could be undertaken during the proposed East Anglia TWO project construction period. This assessment has been based on the potential for disturbance from one UXO detonation in the North Sea area. It is highly unlikely that more than one UXO detonation would occur at exactly the same time or on the same day as another UXO detonation, even if they had overlapping UXO clearance operation durations. Therefore,

including the potential disturbance of 26km around one UXO detonation (2,124km²) in this assessment is considered a worst-case scenario.

1068. Without knowing the actual location for any UXO clearance, the mean density estimate is based on the average seal at sea density estimates for the areas of the UK and EU offshore windfarms. This is 0.1 grey seal per km² based on the seal-at-sea maps (Russell et al. 2017) and an average density based on a 50km buffer around all offshore windfarms (UK and EU) included within the in-combination assessment.
1069. One UXO detonation could potentially disturb up to 212 grey seal (0.97% of the in-combination reference population; or 2.43% of the South-East England MU; or 3.25% of the Donna Nook count). However, it is highly unlikely that all grey seal would be from the Donna Nook haul-out site within the Humber Estuary SAC. There is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant in-combination reference population as well as SAC counts.
1070. Disturbance from any UXO detonations would be temporary, for a short-duration and intermittent at different locations, therefore, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.8.5 Potential in-combination disturbance effects during seismic surveys

1071. As outlined in **section 5.3.5.5.2.2**, it is currently not possible to estimate the number of potential seismic surveys by the oil and gas industry that could be undertaken during the construction and potential piling activity at East Anglia TWO. It has therefore been assumed as a worst-case scenario that there could potentially be one seismic survey by the oil and gas industry during the East Anglia TWO construction period.
1072. The potential disturbance area during a single seismic survey by the oil and gas industry, based on a radius of 10km from each location is 314km².
1073. Without knowing the actual location for any seismic surveys by the oil and gas industry, the mean density estimates have been based on the average seal at sea density estimate has been used, as outlined above, this is 0.1 grey seal per km².
1074. One seismic survey by the oil and gas industry could potentially disturb up to 31.4 grey seal (0.14% of the in-combination reference population; or 0.36% of the South-East England MU; or 0.48% of the Donna Nook count). However, it is highly unlikely that all grey seal would be from the Humber Estuary SAC. There

is the potential for seals to be from other haul-out sites outwith the SAC, which is why assessments have been made for the relevant in-combination reference population as well as SAC counts.

1075. Disturbance from any seismic surveys by the oil and gas industry would be temporary, for a relatively short-duration and at different locations, therefore, there is unlikely to be any significant disturbance or barrier effects for foraging grey seal. Under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.1.9 Summary of potential disturbance effects from underwater noise (alone and in-combination)

1076. **Table 5.79** summarises the potential effects of East Anglia TWO alone and in-combination with other projects and activities on foraging grey seal in the context of the Humber Estuary SAC.

1077. Disturbance from underwater noise for East Anglia TWO, alone and in-combination with other projects and activities, is unlikely to result any significant disturbance or barrier effects for foraging grey seal, especially when taking into account the proposed mitigation approach for harbour porpoise in the SNS SAC. Under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

Table 5.79 Summary of Potential Effects from East Anglia TWO Alone and In-Combination with Other Project and Activities on Foraging Grey Seal in the context of the Humber Estuary SAC

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
Potential disturbance from the underwater noise associated with UXO clearance at East Anglia TWO (alone)		
Potential disturbance from underwater noise associated with UXO clearance (2,124km ²).	85 grey seal (based on offshore development area density) 0.97% of the South-East England MU; or 1.3% of the Donna Nook count.	No
Potential disturbance from the underwater noise associated with piling at East Anglia TWO (alone)		
Potential disturbance during proposed mitigation (ADD)	0.05 grey seal	No

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
activation for 10 minutes prior to soft-start).	0.0006% of the South-East England MU; or 0.0008% of the Donna Nook count.	
Potential disturbance from underwater noise during piling (2,124km ²).	42 grey seal (based on offshore windfarm site density) 0.49% of the South-East England MU; or 0.64% of the Donna Nook count.	No
Potential disturbance from underwater noise during construction and maintenance activities, other than piling, at East Anglia TWO (alone)		
Potential disturbance from underwater noise during construction activities, other than piling (356km ² offshore development area).	14 grey seal 0.16% of the South-East England MU; or 0.21% of the Donna Nook count.	No
Potential disturbance from vessels during construction, operation and maintenance at East Anglia TWO (alone)		
Potential disturbance from vessels during construction (356km ² offshore development area).	14 grey seal 0.16% of the South-East England MU; or 0.21% of the Donna Nook count.	No
Potential disturbance from underwater noise associated with operational turbines at East Anglia TWO (alone)		
Potential disturbance from the underwater noise associated with operational turbines (218.4km ² windfarm site).	4 grey seal 0.05% of the South-East England MU; or 0.06% of the Donna Nook count.	No
Potential disturbance from underwater noise during decommissioning at East Anglia TWO (alone)		
Potential disturbance from the underwater noise associated with foundation removal, decommissioning activities and vessels (356km ² offshore development area).	14 grey seal 0.16% of the South-East England MU; or 0.21% of the Donna Nook count.	No

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
Potential overall noise effects during UXO clearance and piling at East Anglia TWO (alone)		
UXO detonation in cable corridor and piling at windfarm site (4,248km ²).	170 grey seal 1.95% of the South-East England MU; or 2.6% of the Donna Nook count.	No
Potential overall noise effects during piling and construction activities at East Anglia TWO (alone)		
Piling at windfarm site (2,124km ²) and other construction activities and vessels in cable corridor (up to 147km ²).	91 grey seal 1.04% of the South-East England MU; or 1.4% of the Donna Nook count.	No
Potential in-combination disturbance effects during piling		
Piling at offshore windfarm projects, based on worst-case scenario for projects that could be piling at the same time as East Anglia TWO (Creyke Beck A, Sofia and Norfolk Vanguard) for single pile installation at each site (8,496km ²).	401 grey seal 1.8% of in-combination reference population (4.6% of the South-East England MU; or 6.1% of the Donna Nook count).	No It is highly unlikely that all harbour and grey seal would be from the Donna Nook. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects during offshore windfarm construction		
Offshore windfarm construction activities and vessels, for windfarms that are not piling but potential for other construction activities during construction at East Anglia TWO, based on 100% disturbance from windfarm area (2,864km ²).	158.6 grey seal 0.73% of in-combination reference population (1.8% of the South-East England MU; or 2.4% of the Donna Nook count).	No It is highly unlikely that all harbour and grey seal would be from the Donna Nook. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects during offshore windfarm operation and maintenance		
Offshore windfarm operation and maintenance, including vessels, for windfarms operational after	377 grey seal	No

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
the start of the East Anglia TWO site specific surveys based on 100% disturbance from windfarm area (1,867km ²).	1.8% of in-combination reference population (4.3% of the South-East England MU; or 5.7% of the Donna Nook count).	It is highly unlikely that all harbour and grey seal would be from the Donna Nook. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects during UXO clearance		
UXO clearance, based on one detonation at a time (2,124km ²).	212 grey seal 0.97% of in-combination reference population (2.4% of the South-East England MU; or 3.2% of the Donna Nook count).	No It is highly unlikely that all harbour and grey seal would be from the Donna Nook. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Potential in-combination disturbance effects during seismic surveys by the oil and gas industry		
Seismic survey by the oil and gas industry (314km ²).	63 grey seal 0.29% of in-combination reference population (0.72% of the South-East England MU; or 0.97% of the Donna Nook count)	No It is highly unlikely that all harbour and grey seal would be from the Donna Nook. It is more appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Overall potential in-combination disturbance effects		
Piling at offshore windfarm projects; offshore windfarm construction activities and vessels; offshore windfarm operation and maintenance, including vessels; one UXO detonation; and one seismic survey by the oil and gas industry (maximum total = 16,871.6km ²).	Maximum of 1,212 grey seal 5.5% of in-combination reference population (13.9% of the South-East England MU; or 18.6% of the Donna Nook count).	No It is expected that management measures outlined for harbour porpoise in SNS SAC implemented by MMO would also reduce this impact.

5.5.2.2 Possible vessel interaction (increased collision risk)

5.5.2.2.1 East Anglia TWO (alone)

1078. During the construction of the proposed East Anglia TWO project there will be an increase in vessel traffic, with an estimated average of 115 trips per month. Vessels will follow established shipping routes, where possible, between the offshore development area and the relevant ports in order to minimise vessel traffic in the wider area. There would be an average of four vessel movements per day, the increase in vessels movements during construction would be relatively small compared to existing vessel traffic. Although there could be approximately 74 vessels on site at any one time, most vessels once on site would remain within the offshore development area.
1079. The operation and maintenance ports to be used for East Anglia TWO are not yet known. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore the increased risk for any vessel interaction is primarily within the offshore development area. Indicative operational and maintenance vessel movements indicate that there could be up to 687 vessel round trips per year (average of 1-2 vessels per day).
1080. For decommissioning, it is assumed that the potential number of vessels and vessel movements would be the same or less than for construction.
1081. As a precautionary worst-case scenario approach the number of grey seal that could be at increased collision risk with vessels during construction, operation, maintenance and decommissioning has been assessed based on 5% of the number of animals that could be present in the offshore development area (**Table 5.80**).

Table 5.80 Estimated Number of Grey Seal that Could be at Potential Increased Vessel Collision Risk in the East Anglia Two Offshore Development Area

Potential effect area	Estimated number at potential collision risk based on 5% increased risk	% of reference populations	Potential adverse effect on site integrity
Total offshore project area (356km ²)	0.7 grey seal	0.008% of the South-East England MU; or 0.01% of the Donna Nook count.	No

1082. This is very precautionary, as it is highly unlikely that grey seal present in the offshore development area would be at increased collision risk with vessels, especially taking into account the relatively small increase in number of vessel movements compared to existing vessel movements in the area.
1083. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where grey seal 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 harbour porpoise.

1084. In addition, based on the assumption that grey seal would be disturbed from the offshore development area as a result of underwater noise from construction, maintenance and decommissioning activities and vessels, as assessed above, there should be no potential for increased collision risk with vessels within the offshore development area.
1085. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.5.2.2.2 In-combination

1086. During the construction of offshore windfarms, vessel movements to and from any port will be incorporated within existing vessel routes and therefore the increased risk for any vessel interaction is within the offshore development areas. Grey seal in the area would be accustomed to the presence of vessels and therefore be expected to be able to detect and avoid construction vessels.
1087. Any increase in vessel movements during the operation and maintenance of offshore windfarms would be relatively small in relation to current ship movements in the area. Therefore, there is unlikely to be a significant increase in collision risk during the operation and maintenance of offshore windfarms and as a result this has not been included in the in-combination assessment.
1088. As a precautionary approach, the number of grey seal that could be at increased collision risk with vessels has been assessed based on a 5% increased collision risk. This is very precautionary, as it is highly unlikely that 5% grey seal present in the windfarm areas could be at increased collision risk with vessels.
1089. In addition, based on the assumption that grey seal would be disturbed as a result of underwater noise from piling, other construction activities and vessels, there should be no potential for increased collision risk with vessels.
1090. The precautionary in-combination assessment has determined that the number of grey seal that could have a potential increased collision risk with vessels in offshore windfarm sites in the North Sea could be up to 10 grey seal (0.05% of the in-combination reference population; or 0.11% of the South-East England MU; or 0.15% of the Donna Nook count; **Table 5.81**).

1091. Therefore, under these circumstances, there is **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

Table 5.81 Quantified In-Combination Assessment for the Potential Increased Collision Risk with Vessels for Grey Seal During Offshore Windfarm Construction

Name of Project	Grey seal density estimate (No/km ²)	Area of windfarm site (km ²)	Potential number of grey seal impacted based on 5% collision risk
East Anglia TWO	0.005	218	0.05
Creyke Beck A	0.05	515	1.29
Creyke Beck B	0.2	599	6
Teesside A	0.01	562	0.28
Sofia	0.04	593	1.2
Norfolk Vanguard	0.001	592	0.03
Hornsea Project Three	0.04	695	1.4
Thanet Extension	0.02	73	0.07
Norfolk Boreas	0.0006	727	0.02
East Anglia ONE North	0.0009	208	0.01
Total		4,782	10
% of Donna Nook count (6,526 grey seal)			0.15%
% of South-East England MU (8,716 grey seal)			0.11%
% of in-combination reference population (21,864 grey seal)			0.05%

¹based on seal density grid cells that overlap with the OWF site boundary only (Source: Russell et al. 2017).

5.5.2.3 Potential changes in prey availability

5.5.2.3.1 East Anglia TWO (alone)

1092. The assessment of effects for the potential changes to prey availability for foraging grey seal follows the same approach as set out above (**section 5.4.2.3**) for foraging harbour seal. Therefore, as a worse-case scenario, the changes to prey resources during construction, operation, maintenance and decommissioning have been assessed based on the entire offshore development area (356km²).

1093. The number of grey seal that could be present in the offshore development area is 14, based on 0.04/km² density. This represents 0.16% of the South-East England MU or, as a worst-case scenario, 0.21% of the 6,526 grey seals from

Donna Nook in the Humber Estuary SAC. However, it is highly unlikely that all grey seal in the East Anglia TWO offshore development area would be from Donna Nook, which is located approximately 198km from the offshore development area. There would be no direct effect or overlap with the Humber SAC area.

1094. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Consequently, there would be **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal arising from changes in prey resources.**

5.5.2.3.2 In-combination

1095. Potential effects on prey species during construction, operation, maintenance and during decommissioning could be negative with fish species moving away or being lost from an area, while some effects could have a negative or positive effect, such as possible changes in species composition, and other effects could result in a positive effect, such as the aggregation of prey around seabed structures.
1096. The potential effects on grey seal as a result of any changes to prey availability can include changes in distribution, abundance and community structure, increased competition with other marine mammal species, increased susceptibility to disease and contaminants, and implications for reproductive success, which could potentially affect individuals throughout their range or at different times of the year. However, any changes to prey tend to be localised and temporary in nature. In addition, if prey species are disturbed from an area, it is highly likely that grey seal will also be disturbed from the area over a potentially wider range than prey species.
1097. The in-combination assessment on potential changes to prey availability has assumed that any potential effects on grey seal prey species from underwater noise, including piling, would be the same or less than those for grey seal. Therefore, there would be no additional effects other than those assessed grey seal, i.e. if prey are disturbed from an area as a result of underwater noise, grey seal will be disturbed from the same or greater area, therefore any changes to prey availability would not additionally affect grey seal as they would already be disturbed from the same area.
1098. There would be no direct effect or overlap with the Humber SAC area.

1099. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Consequently, there would be **no potential adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal arising from changes in prey resources.**

5.5.3 Summary of Potential Effects for Humber Estuary SAC

1100. The assessment of the potential effects during the construction, operation and decommissioning of the proposed East Anglia TWO project alone and in combination has been summarised in relation to the Conservation Objectives of the Humber Estuary where grey seal are a qualifying feature (**Table 5.82**).

Table 5.82 Summary of the Assessment of the Potential Effects of East Anglia TWO and In-Combination Effects on the Humber Estuary SAC in Relation to the Conservation Objectives for Grey Seal

Conservation Objectives	Disturbance of foraging grey seal		Vessel interaction (increased collision risk)		Changes in prey availability	
	Project alone (including total effects)	In-combination	Project alone (including total effects)	In-combination	Project alone (including total effects)	In-combination
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	x	x	x	x	x	x
The structure and function (including typical species) of qualifying natural habitats.	x	x	x	x	x	x
The structure and function of the habitats of qualifying species.	x	x	x	x	x	x
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	x	x	x	x	x	x
The populations of qualifying species.	x	x	x	x	x	x
The distribution of qualifying species within the site.	x	x	x	x	x	x

x = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives.

5.6 Other European Designated Sites Where Grey and Harbour Seal are a Qualifying Feature

1101. **Table 5.83** summarises the assessment of potential disturbance of foraging seals from underwater noise for other European Designated Site that were screened in for further assessment as grey and / or harbour seal are a qualifying feature.
1102. All these European Designated Site use the OSPAR Conservation Objectives, with some sites also having sites reiterate individual objectives (**Table 5.83**):
- To maintain, conserve or restore biodiversity, natural heritage, habitats, species or landscapes with legal protections status;
 - To maintain key ecological functions (Spawning areas, nursery grounds, feeding zones, resting areas, areas of high productivity, etc.);
 - To manage the exploitation of natural resources;
 - To improve governance on MPA territory;
 - To educate on environmental issues and improve public awareness;
 - To foster scientific research; and
 - To create added socio-economic values.
1103. The assessment uses the same approach as the assessment of the potential disturbance of foraging grey and harbour seal for The Wash and North Norfolk Coast SAC (**section 5.4.2**).
1104. As summarised in **Table 5.61**, piling at offshore windfarm projects; offshore windfarm construction activities and vessels; offshore windfarm operation and maintenance, including vessels; up to two UXO clearance operations; and up to two seismic surveys by the oil and gas industry has a maximum total area of up to 15,665km², as a worst-case scenario, for harbour seal, and up to 16,871.6km² for grey seal. This leads to a maximum of 193.6 harbour seal (0.43% of in-combination reference population) and up to 1,207 grey seal (5.6% of in-combination reference population) could potentially be temporarily disturbed.
1105. Disturbance from underwater noise for East Anglia TWO alone and in-combination with other projects and activities is unlikely to result any significant disturbance or barrier effects for foraging harbour or grey seal, especially taking into the proposed mitigation approach for harbour porpoise in the SNS SAC. Under these circumstances, there is **no potential adverse effect on the integrity of the other European Designated Sites in relation to the conservation objectives for grey seal and harbour seal.**

East Anglia TWO Offshore Windfarm

Information to Support AA Report

Table 5.83 Assessment of potential disturbance of foraging seals from underwater noise for other European Designated Site that were screened in for grey and / or harbour seal

European Designated Site	Distance from East Anglia TWO	Screened in for	Species Status and Ecology	European Designated Site Conservation Objectives	Assessment of potential disturbance of foraging seals	Potential adverse effect on site integrity in relation to the conservation objectives
Vlaamse Banken SAC in Belgium	Approximately 59km from the East Anglia TWO windfarm site and 72km from the offshore cable corridor	Harbour seal Grey seal	Harbour seal population = unknown Grey seal population = unknown	OSPAR Conservation Objectives	Maximum of 193.6 harbour seal (0.43% of in-combination reference population) and up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No
SBZ 1 / ZPS 1 SPA in Belgium	Approximately 94km from the East Anglia TWO windfarm site and 107km from the offshore cable corridor	Grey seal	Grey seal population = unknown	OSPAR Conservation Objectives	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No
SBZ 2 / ZPS 2 SPA in Belgium	Approximately 84km from the East Anglia TWO windfarm site and 100km from the	Grey seal	Grey seal population = unknown	OSPAR Conservation Objectives	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No

East Anglia TWO Offshore Windfarm

Information to Support AA Report

European Designated Site	Distance from East Anglia TWO	Screened in for	Species Status and Ecology	European Designated Site Conservation Objectives	Assessment of potential disturbance of foraging seals	Potential adverse effect on site integrity in relation to the conservation objectives
	offshore cable corridor					
SBZ 3 / ZPS 3 SPA in Belgium	Approximately 92km from the East Anglia TWO windfarm site and 108km from the offshore cable corridor	Grey seal	Grey seal population = unknown	OSPAR Conservation Objectives	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No
Vlakte van de Raan SCI in Belgium	Approximately 89km from the East Anglia TWO windfarm site and 107km from the offshore cable corridor	Grey seal	Grey seal population = unknown	OSPAR Conservation Objectives	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No
Vlakte van de Raan SAC in the Netherlands	Approximately 82km from the East Anglia TWO windfarm site and 99km from the offshore cable corridor	Grey seal	Grey seal population = 0-400 Grey seal have distribution across whole North Sea. VvdR site is an important area, especially for foraging and migration.	OSPAR Conservation Objectives	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No

European Designated Site	Distance from East Anglia TWO	Screened in for	Species Status and Ecology	European Designated Site Conservation Objectives	Assessment of potential disturbance of foraging seals	Potential adverse effect on site integrity in relation to the conservation objectives
			Seals move between Westerschelde, through Vlakte van de Raan and Voordelta into the North Sea and Waddensea. Therefore, Vlakte van de Raan is a small part of a much larger habitat for seals.			
Voordelta SAC and SPA in the Netherlands	Approximately 84km from the East Anglia TWO windfarm site and 101km from the offshore cable corridor	Grey seal	Grey seal population = 0-400	OSPAR Conservation Objectives, plus to maintain the habitat extent and quality, maintain population levels.	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No
Bancs des Flandres SAC in France	Approximately 82km from the East Anglia TWO windfarm site and 93km from the offshore cable corridor	Grey seal	Grey seal population = unknown	OSPAR Conservation Objectives	Up to 1,212 grey seal (5.5% of in-combination reference population). Not all from this site alone.	No

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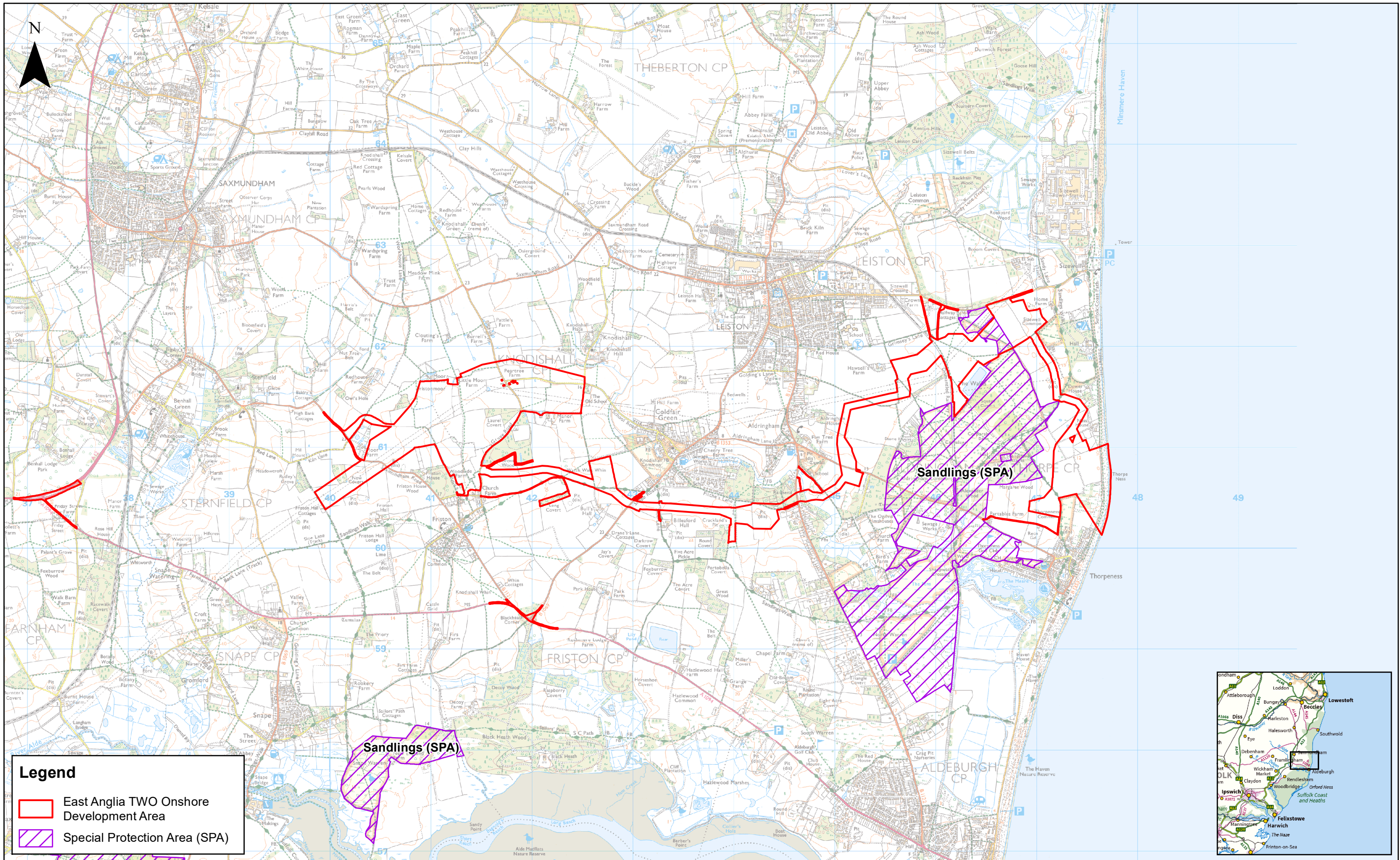
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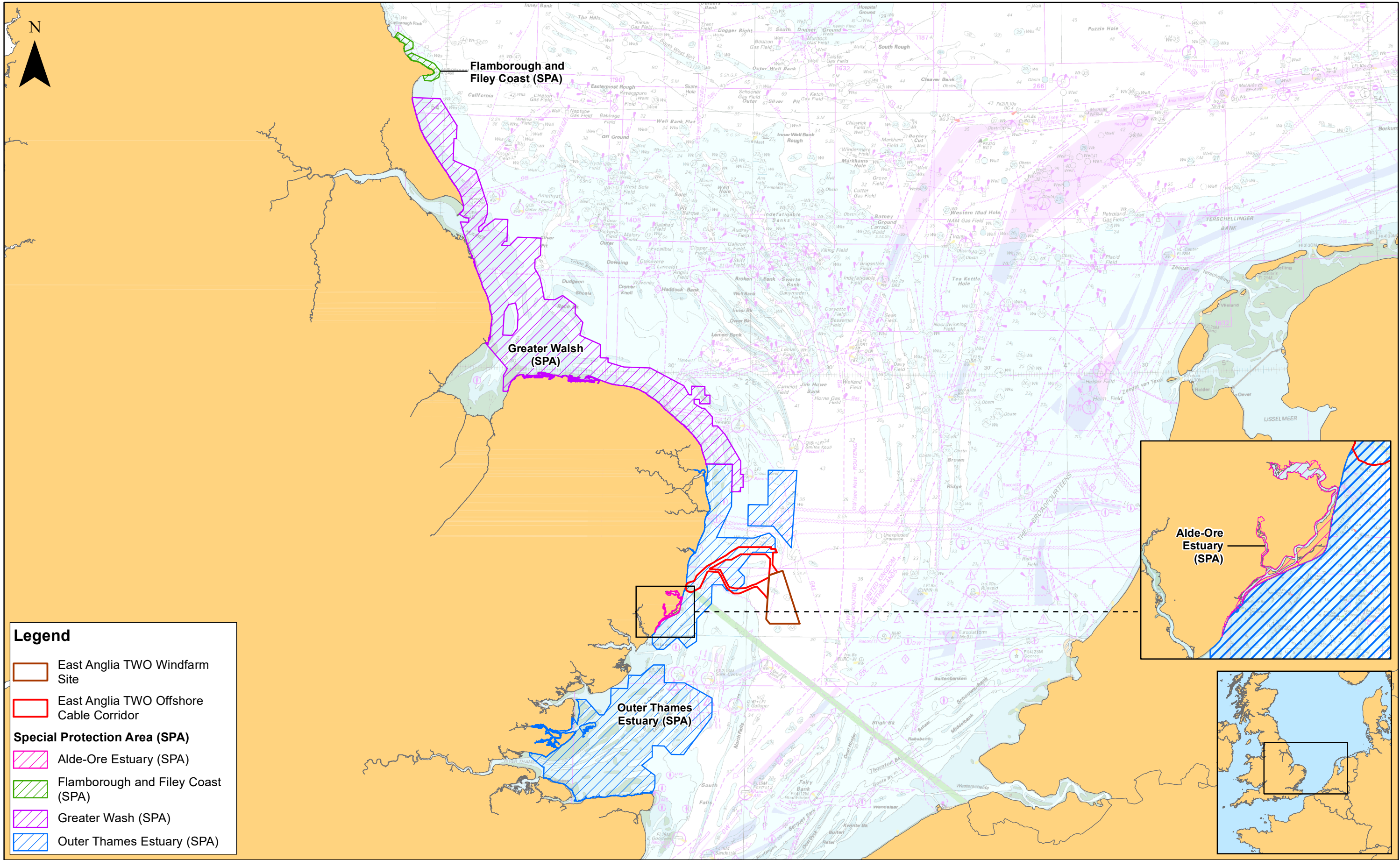
Annex 1: Supporting Figures



East Anglia TWO Onshore Development Area

Special Protection Area (SPA)

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	1	12/09/2019	FC	First Issue.	Checked:	RJ	Source: © Crown copyright and database rights 2019. Ordnance Survey 0100031673. This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Onshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.		Date	12/09/19	
	Rev	Date	By	Comment	Approved:	AH			Figure	1	



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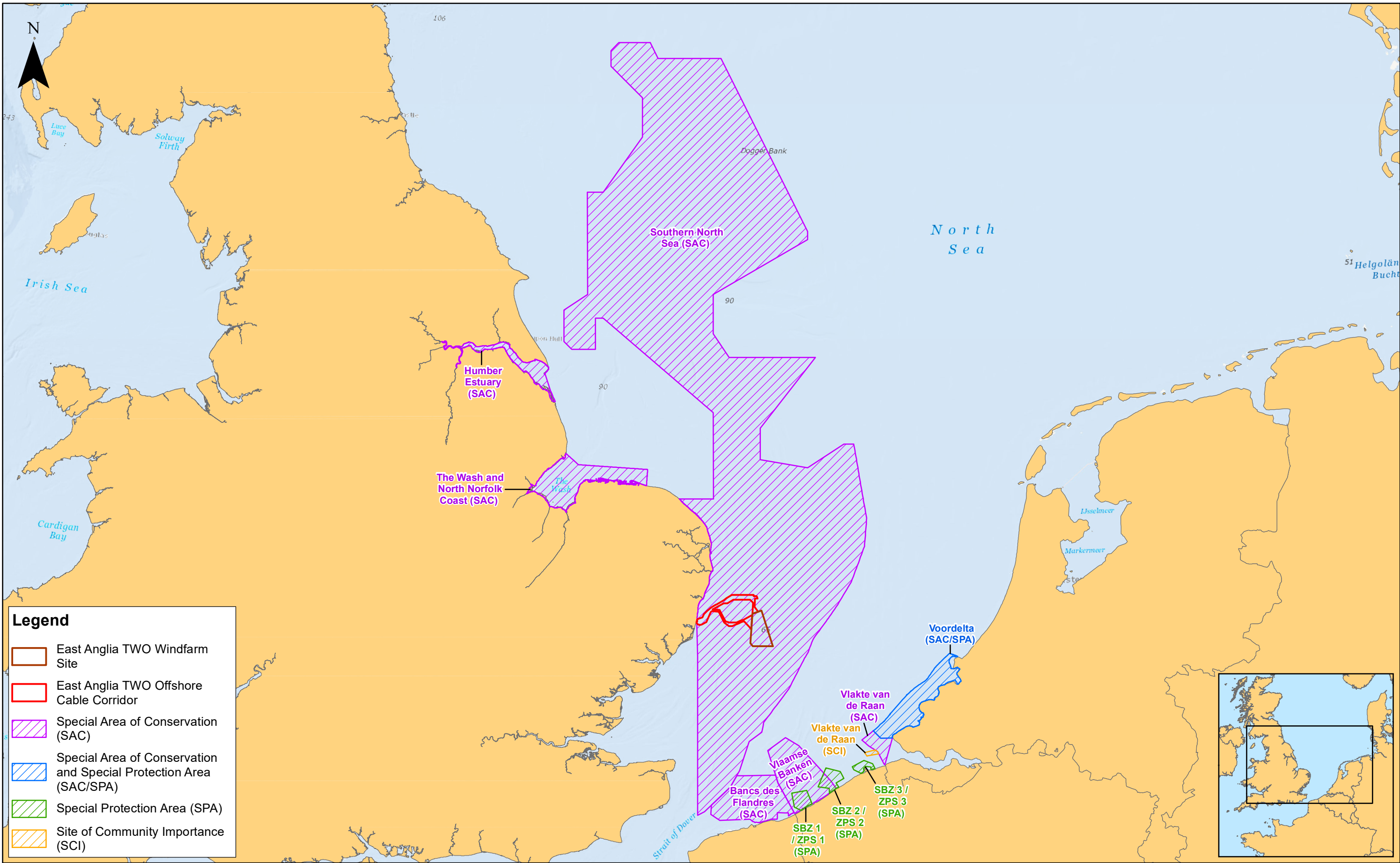
- East Anglia TWO Windfarm Site
- East Anglia TWO Offshore Cable Corridor
- Special Protection Area (SPA)**
 - Alde-Ore Estuary (SPA)
 - Flamborough and Filey Coast (SPA)
 - Greater Wash (SPA)
 - Outer Thames Estuary (SPA)

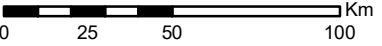


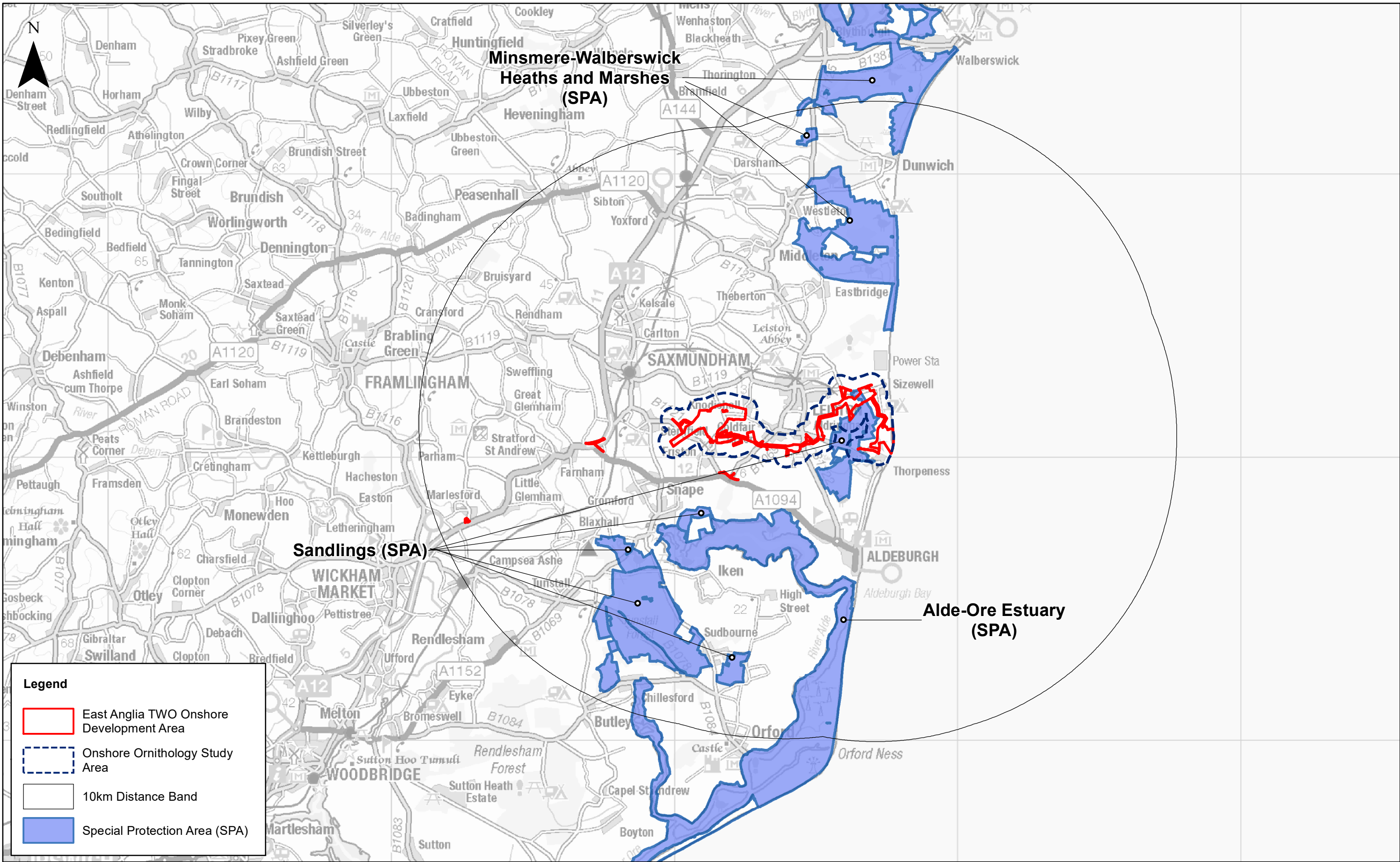
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Source: © JNCC, 2019. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. © British Crown and OceanWise, 2019. All rights reserved. License No. EMO-EX001-548160. Not to be used for navigation.	
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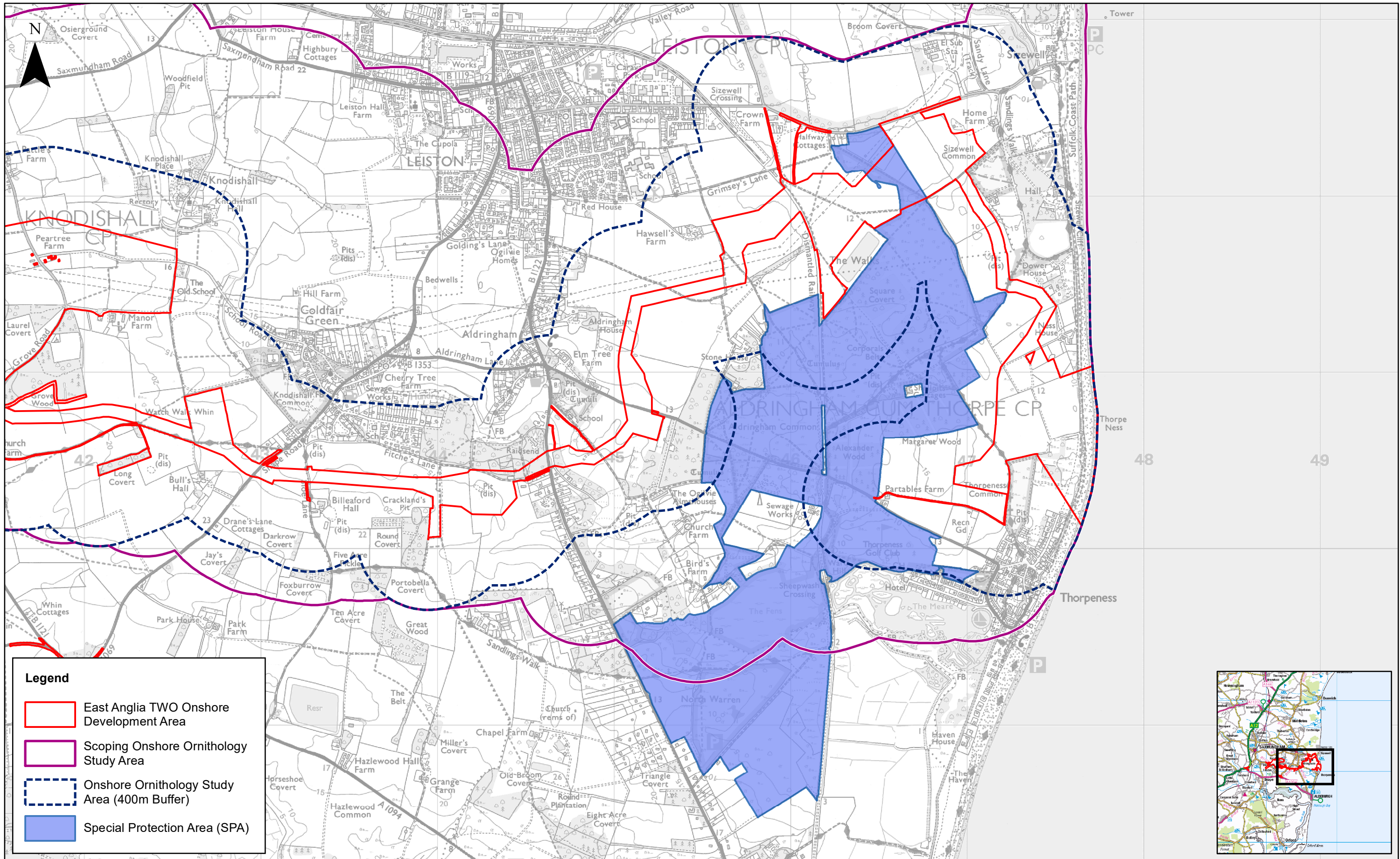
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Designated Sites Screened into the Assessment for Offshore Ornithology		Rev	1	Datum: WGS 1984 Projection: Zone 31N	
		Date	12/09/19		
		Figure	2		



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	1	12/09/2019	FC	First Issue.	Checked:	PM	Source: © JNCC, 2019. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org and other contributors. This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.			Date	12/09/19		
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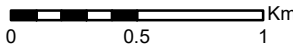


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	Rev	Date	By	Comment	Approved:	RD				Figure	4		



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	06	22/08/2019	KMS	Seventh Issue	Checked:	LNF	Scale @ A3			Rev	07	Coordinate System: BNG Datum: OSGB36	
	05	09/07/2019	BJF	Sixth Issue	Checked:	LNF				Date	30/08/19		
	Rev	Date	By	Comment	Approved:	RD				Figure	5		
	Source: © Crown copyright and database rights 2019. Ordnance Survey 0100031673. Contains public sector information licensed under the Open Government Licence v3.0 This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.												

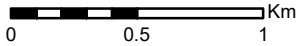
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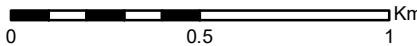
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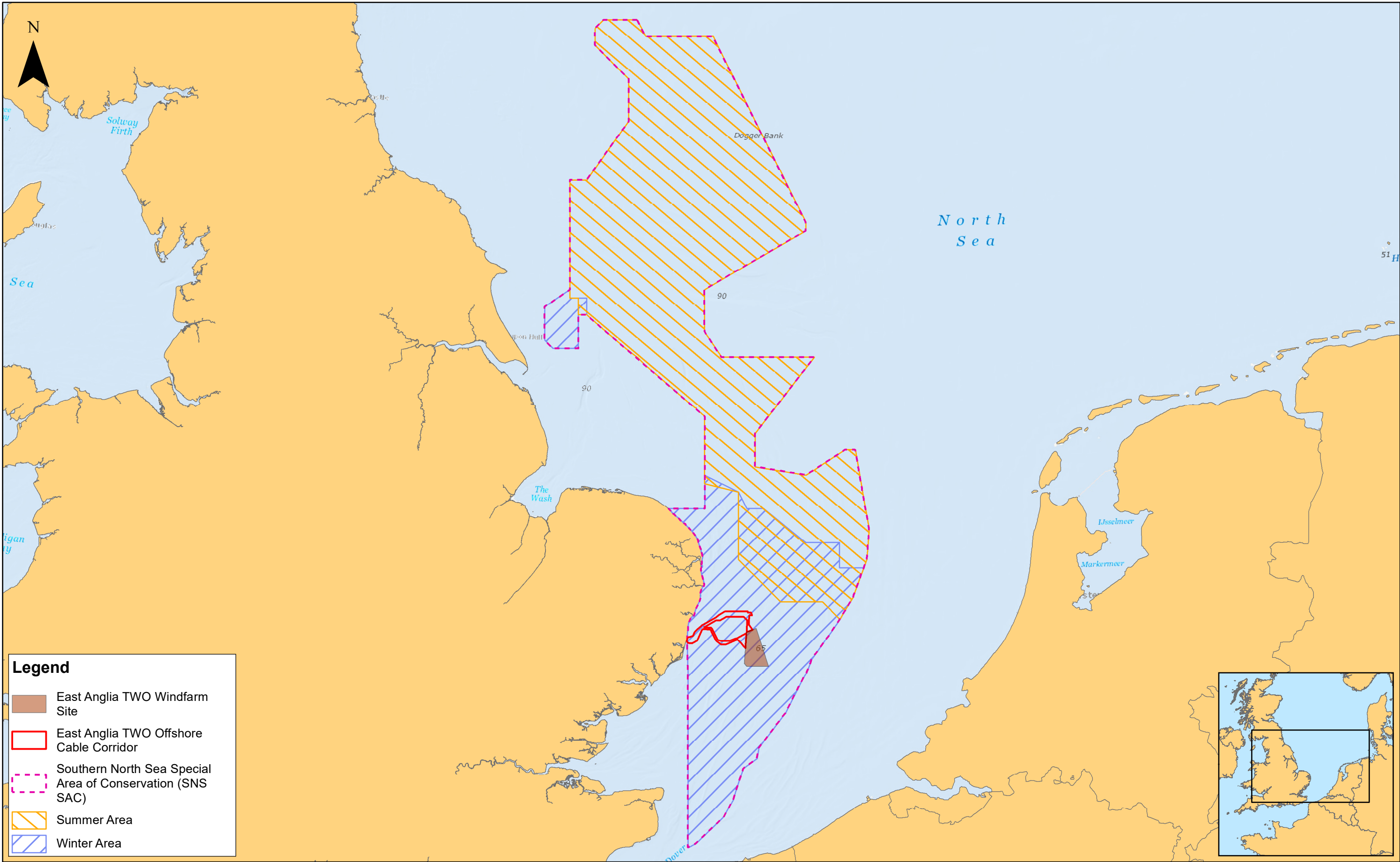
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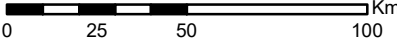
East Anglia TWO Windfarm Site

East Anglia TWO Offshore Cable Corridor

Southern North Sea Special Area of Conservation (SNS SAC)

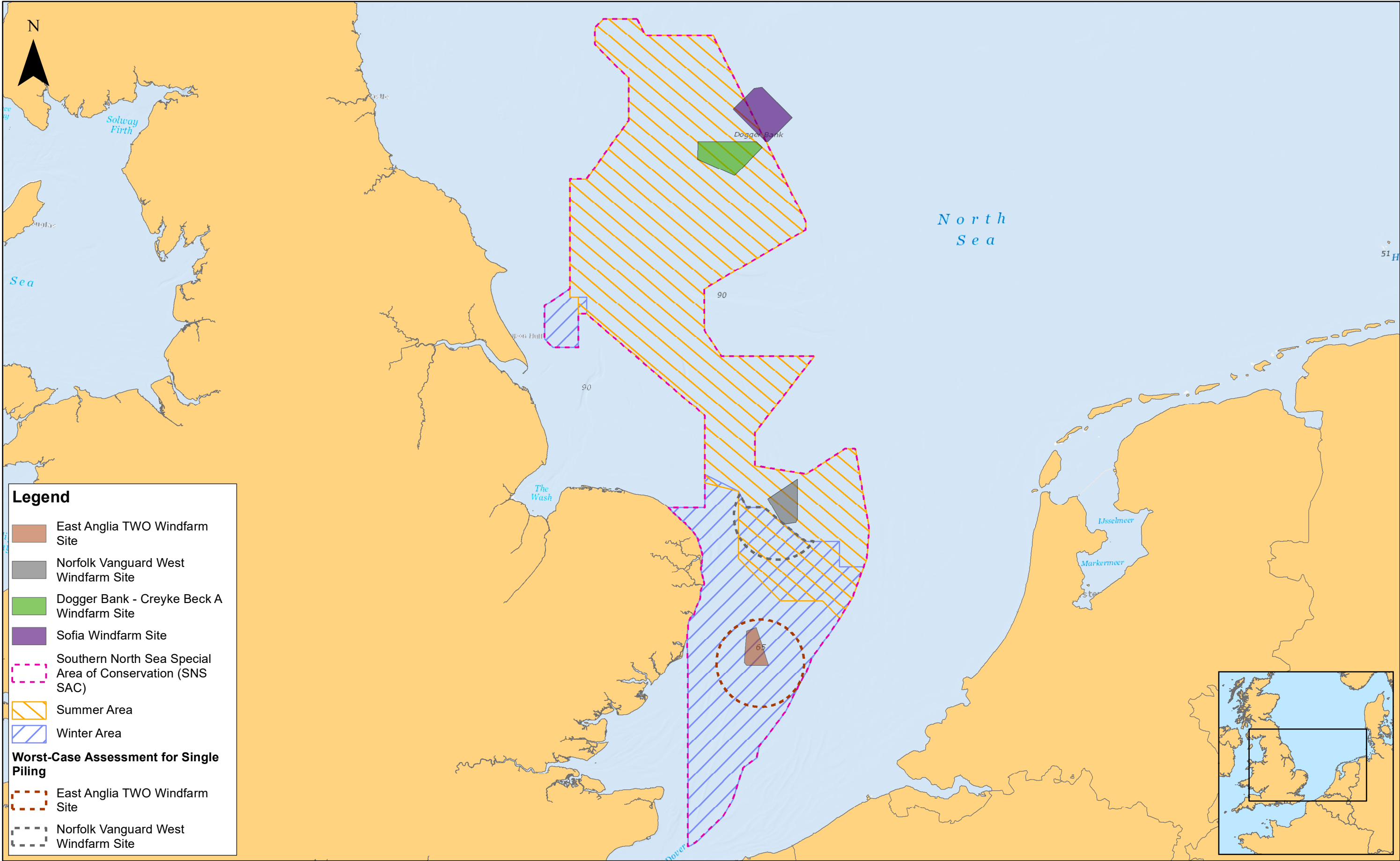
Summer Area

Winter Area

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Legend

East Anglia TWO Windfarm Site

Norfolk Vanguard West Windfarm Site

Dogger Bank - Creyke Beck A Windfarm Site

Sofia Windfarm Site

Southern North Sea Special Area of Conservation (SNS SAC)

Summer Area

Winter Area

Worst-Case Assessment for Single Piling

East Anglia TWO Windfarm Site

Norfolk Vanguard West Windfarm Site



2	13/09/2019	FC	Second Issue.	Prepared:	FC
1	22/07/2019	FC	First Issue.	Checked:	JL
Rev	Date	By	Comment	Approved:	PP

1:2,100,000

Scale @ A3

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25

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100

Km

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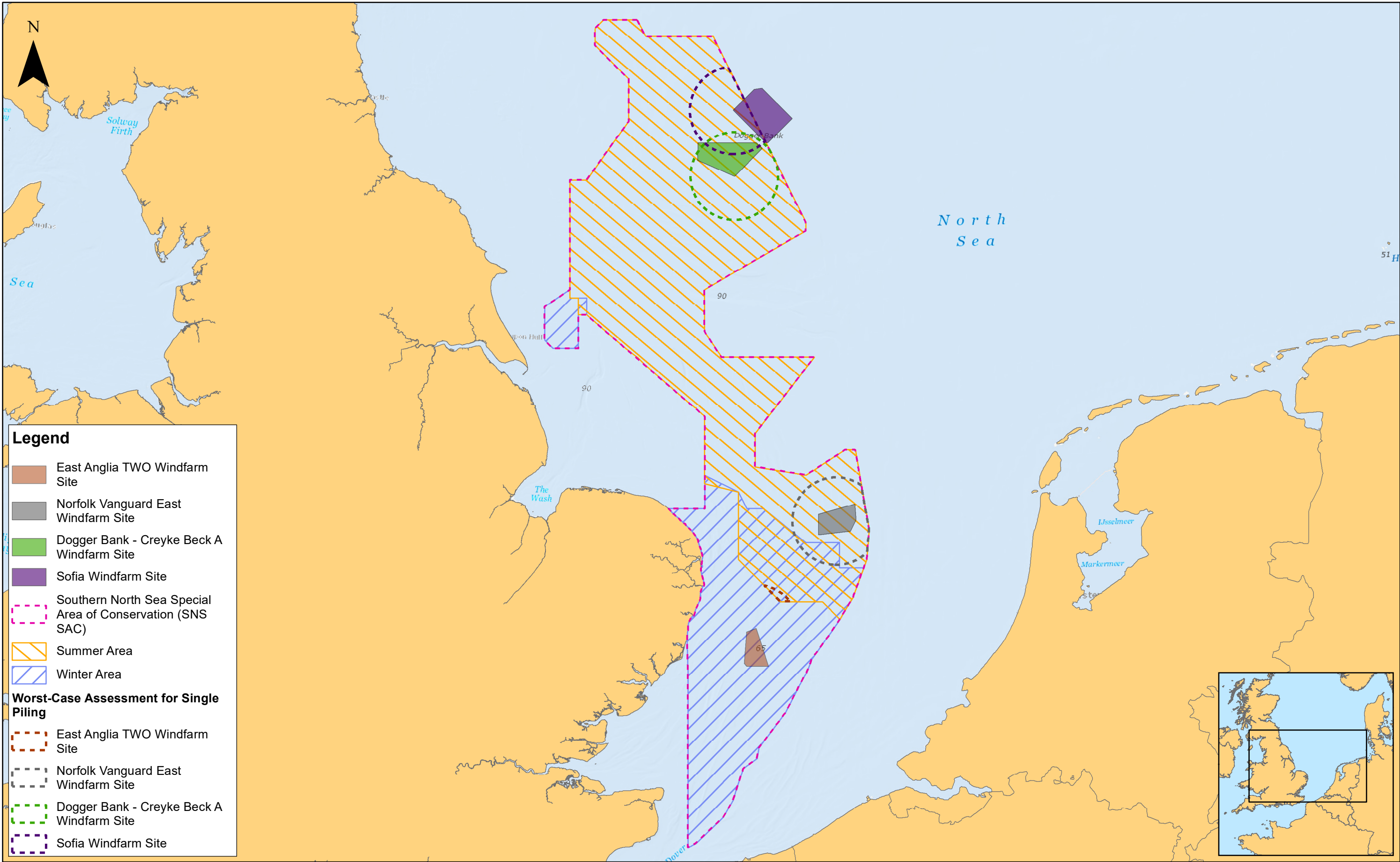
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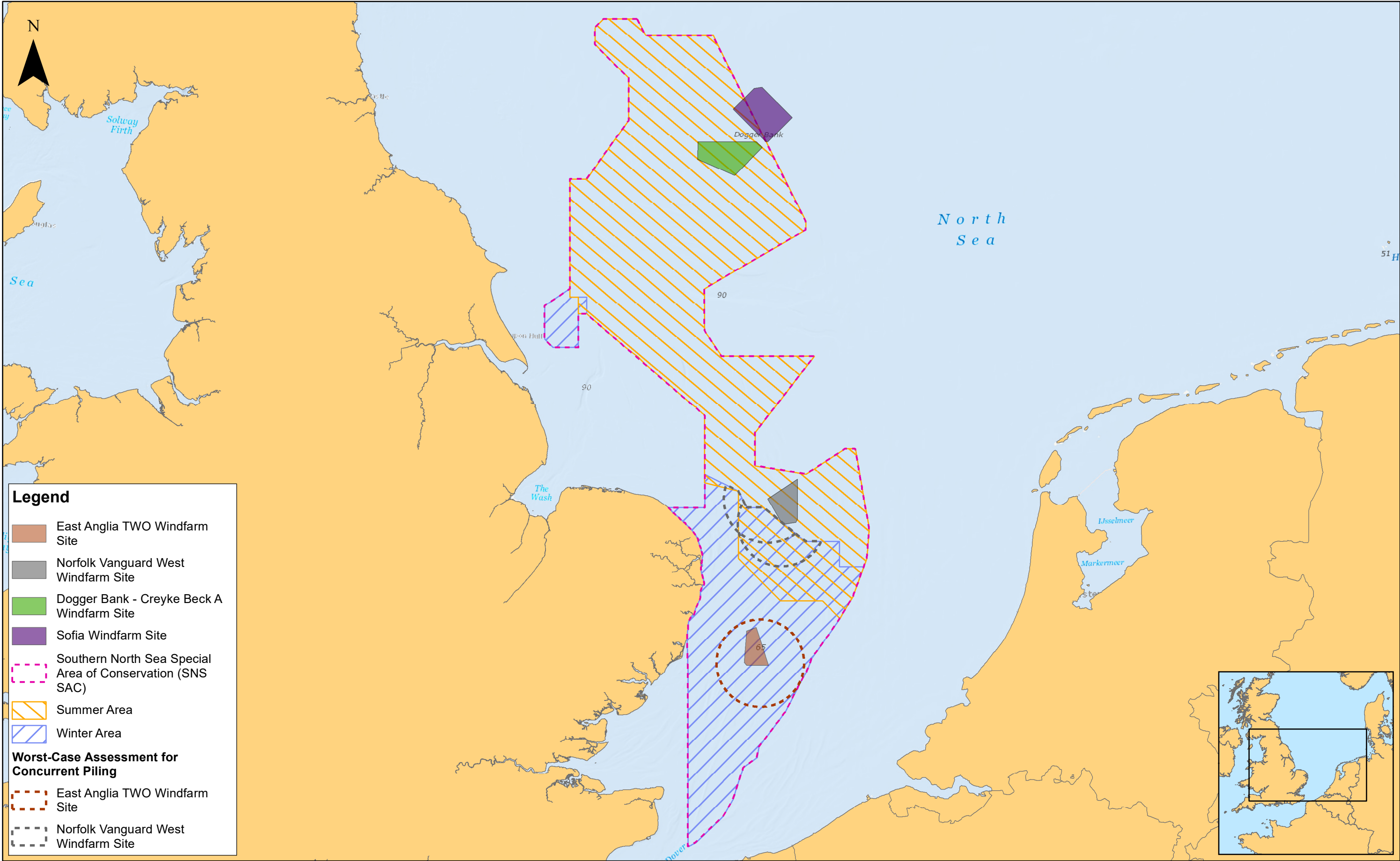
East Anglia TWO

Maximum Overlap with the SNS SAC Winter Area for In-Combination Effect of Single Piling

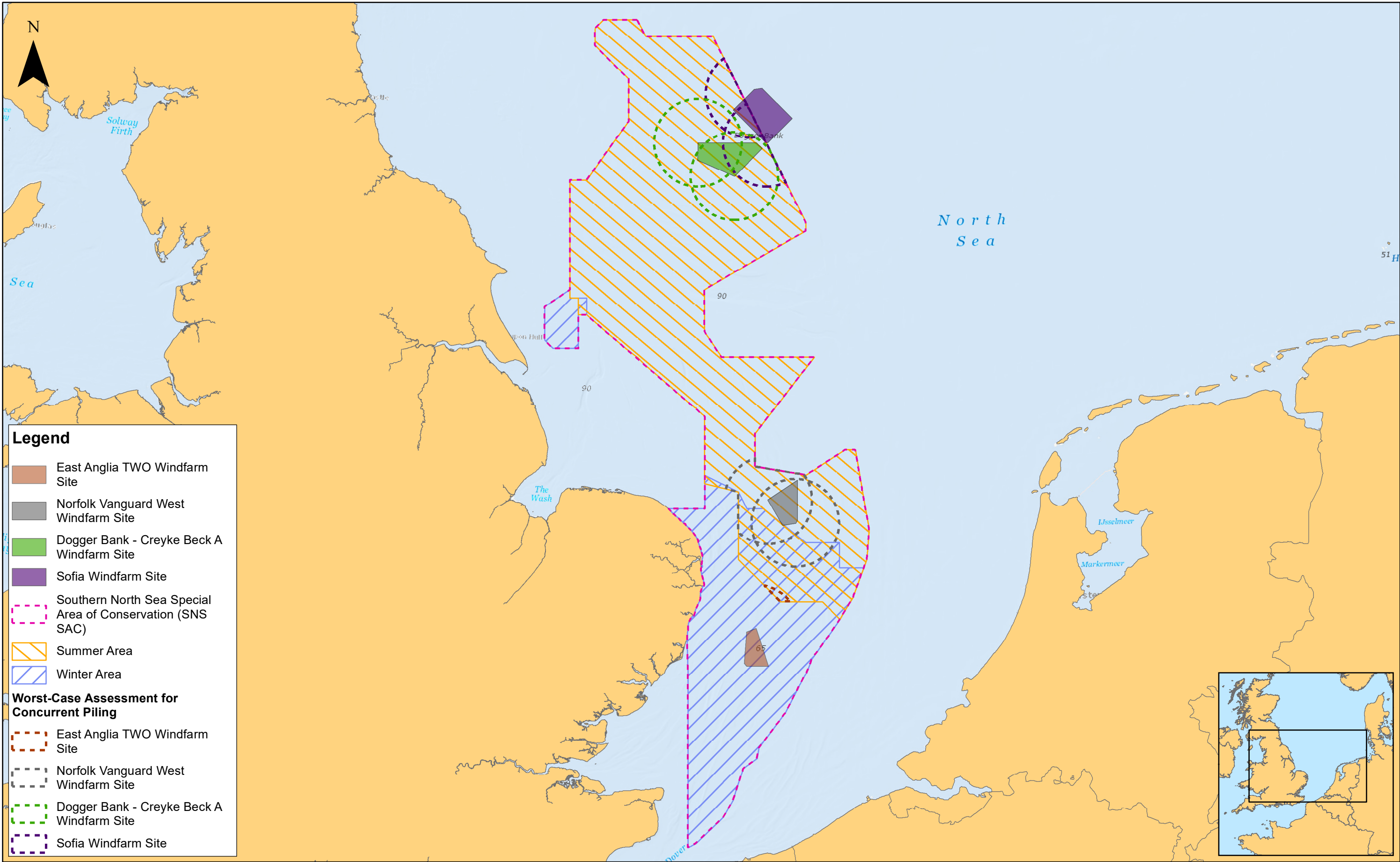
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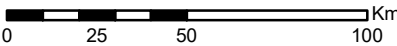


							1:2,100,000		East Anglia TWO Maximum Overlap with the SNS SAC Summer Area for In-Combination Effect of Single Piling	Drg No	EA2-DEV-DRG-IBR-000987	
	2	13/09/2019	FC	Second Issue.	Prepared:	FC	Scale @ A3			Rev	2	Datum: WGS 1984 Projection: Zone 31N
	1	22/07/2019	FC	First Issue.	Checked:	JL	Source: © JNCC, 2017 and 2019. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org and other contributors. This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.	Date		13/09/19		
	Rev	Date	By	Comment	Approved:	PP		Figure		13		



						1:2,100,000		East Anglia TWO Maximum Overlap with the SNS SAC Winter Area for In-Combination Effect of Concurrent Piling	Drg No	EA2-DEV-DRG-IBR-000988	
	2	13/09/2019	FC	Second Issue.	Prepared:	FC			Rev	2	Datum: WGS 1984 Projection: Zone 31N
	1	22/07/2019	FC	First Issue.	Checked:	JL	Source: © JNCC, 2017 and 2019. © The Crown Estate, 2019. Contains OS data © Crown copyright and database right, 2019. Service Layer Credits: Sources: Esri, GEBCO, NOAA, National Geographic, Garmin, HERE, Geonames.org and other contributors. This map has been produced to the latest known information at the time of issue, and has been produced for your information only. Please consult with the SPR Offshore GIS team to ensure the content is still current before using the information contained on this map. To the fullest extent permitted by law, we accept no responsibility or liability (whether in contract, tort (including negligence) or otherwise in respect of any errors or omissions in the information contained in the map and shall not be liable for any loss, damage or expense caused by such errors or omissions.		Date	13/09/19	
	Rev	Date	By	Comment	Approved:	PP	Figure		14		



						1:2,100,000		East Anglia TWO Maximum Overlap with the SNS SAC Summer Area for In-Combination Effect of Concurrent Piling		Drg No	EA2-DEV-DRG-IBR-000989	
	2	13/09/2019	FC	Second Issue.	Prepared:	FC				Rev	2	Datum: WGS 1984 Projection: Zone 31N
	1	22/07/2019	FC	First Issue.	Checked:	JL				Date	13/09/19	
	Rev	Date	By	Comment	Approved:	PP				Figure	15	

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