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, this 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	The proposed area for National Grid overhead line realignment works.
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 cable between offshore electrical platforms and landfall jointing bay.
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, this 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.
Proposed onshore development area	The area in which the landfall, onshore cable corridor, onshore substation, 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, this 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.

1 Introduction

1.1 Purpose of this document

1. The purpose of this Information to Support Habitats Regulations Assessment (HRA) 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 Appropriate Assessment (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 includingthe 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 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.

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 a detrimental effect on the integrity of the SPA, or SAC bearing in mind 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 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 require 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 require 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), and
- Flamborough and Filey Coast SPA, gannet and kittiwake (collision risk), razorbill, guillemot and puffin (displacement risk).

8. Razorbill, guillemot and puffin at Flamborough and Filey Coast SPA were included following advice from Natural England 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. However, 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 is more appropriate to assess auk displacement effects against appropriate BDMPS through the EIA process (as has been undertaken in the PEIR). Due to a combination of the large distance between the East Anglia TWO windfarm site and the Flamborough and Filey Coast SPA (which rules out breeding season connectivity) and the large number of birds from many colonies present in the North Sea during the nonbreeding period (which indicates very low levels of connectivity in the nonbreeding season) it is considered that the potential for an LSE can be excluded for these SPA features (i.e. razorbill, guillemot and puffin) and no further assessment is required.

11. This conclusion is consistent with those for the East Anglia ONE (DECC 2014) and for the 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).

2.2 SAC Sites and Features to be Considered

2.2.1 Marine Mammals

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

- Special Areas of Conservation (SACs);
- Possible SACs (pSACs);
    - A site which has been identified and approved to go out to formal consultation.
- Candidate SACs (cSACs);
    - 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);
    - Once the EC approves the site it becomes a SCI, before the national government then designates it as a SAC.

15. For marine mammals, the approach to HRA screening primarily 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.

16. 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. Therefore, the species assessed as part of the HRA process are:

- Harbour porpoise *Phocoena phocoena*;
- Grey seal *Halichoerus grypus*; and
- Harbour seal *Phoca vitulina*.

17. 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.

18. These potential effects were agreed as part of the consultation process.

2.2.2 Designated Sites for Harbour Porpoise

19. 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).

20. 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.

21. 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 though 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).

22. 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 candidate Special Area of Conservation / Site of Community Interest (SNS cSAC / SCI) was screened in for further assessment.

23. The East Anglia TWO offshore development area is located wholly within the SNS cSAC / SCI (***Figure 5***). Therefore, any harbour porpoise affected by the proposed East Anglia TWO project would be within or in close proximity to the SNS cSAC / SCI.

2.2.3 Designated Sites for Grey Seal

24. 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).

25. 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.

26. 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***).

27. In addition, although grey seal are not currently a qualifying feature at the Wash and North Norfolk SAC (which includes Blakeney Point) or Winterton-Horsey Dunes SAC, it is recognised that these sites are important for the population, as breeding, moulting and haul-out sites. Therefore, in the assessments for the HRA, consideration is given to grey seal as part of the Wash and North Norfolk SAC and Winterton-Horsey Dunes SAC (SPR 2018b).

28. Since the HRA screening the data has been reviewed and taking into account the consultation responses, 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.

2.2.4 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 ***Chapter 11 Marine Mammals***). 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 been considered further for any potential effects of changes to prey resources for foraging harbour seal. These additional sites include:

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

3 Onshore Ornithology Assessment of Effects

3.1 Project Details

3.1.1 Worst-Case Scenario

34. The worst-case scenario for each category of potential effect on onshore ornithology receptors has been determined (***Table 3.1***). The worst-case scenarios identified here also apply to the in-combination assessment.

Table 3.1 Realistic Worst Case Scenarios

Impact	Parameter	Notes
Construction		
Impacts related to the landfall	HDD temporary works area: 7,000m^2 (70m x 100m) Transition bay excavation footprint (for 2 transition bays): 1,554m^2 (37m x 42m) Landfall CCS: 18,400m^2 (160m x 115m) Landfall transition bays approximate quantity of spoil material (for 2 transition bays): 454m^3	Landfall to be achieved via HDD. No beach access required.
Impacts related to the onshore cable corridor	Onshore cable route: 287,360m^2 (8,980m x 32m) Jointing bay construction excavation footprint: 570m^2 (30.6m x 18.6m). Total for 36 jointing bays: 20,520m^2 (570m^2 x 36) HDD (retained as an option to cross SPA / SSSI): • Entrance pit CCS (x1): 7,000m^2 (100m x 70m) • Exit pit CCS (x1): 3,000m^2 (100m x 30m) Onshore cable route CCS: 18,400m^2 (160m x 115m). Total for 5 CCS: 92,000m^2 (18,400m^2 x 5) Temporary roads: • Onshore cable route haul road between landfall and Snape Road (4.5m wide with additional 4m for passing places at approximately 87m intervals): 41,376m^2 • Onshore cable route and substation	Onshore cable corridor construction footprint may be located anywhere within the proposed onshore development area. The location strategy for access routes, CCS and jointing bays will be to site them near to field boundaries or roads as far as practical. Two link boxes sit underground beside each jointing bay at a depth of approximately 1.2m. The construction footprint of these is included in the jointing bay construction excavation footprint.

Impact	Parameter	Notes
	access haul road (9m width): 18,675m^2 • Temporary access road: 23,495m^2 Onshore cable trench approximate quantity of spoil material: 13,321m^3	
Impacts related to the onshore substation	Onshore substation CCS: 17,100m^2 (190m x 90m) Permanent footprint (used as CCS during construction): 36,100m^2 (190m x 190m) Substation operational access road: 12,800m^2 (1,600m x 8m)	Construction access is included above as the onshore cable route and substation access haul road.
Impacts related to the National Grid Infrastructure	National Grid substation CCS: 78,750m^2 (250m x 315m) Permanent footprint (used as CCS during construction): 45,500m^2 (325m x 140m)	Design for the required overhead line (OHL) realignment work (including cable sealing end CCSs and pylon realignment CCS) is currently on going. As more detail is made available, this will be fully assessed and included in the Environmental Statement (ES) and DCO application. However, indicative locations for cable sealing end CCSs and pylon realignment CCS are shown in ***Figure 6.6*** of ***Chapter 6 Project Description***. Construction access is included above as the onshore cable route and substation access haul road. Operational access is included above as the substation operational access road,
Operation		
Impacts related to the landfall	Two transition bays will be installed underground, each with an operational volume of 227m^3	Transition bays will be buried approximately 1.2m underground – there will no above ground infrastructure.
Impacts related to the onshore cable corridor	36 jointing bays will be installed underground, each with an operational volume of 77m^3	Jointing bays will be buried approximately 1.2m underground – there will no above ground

Impact	Parameter	Notes
	72 link boxes will be installed underground (2 per jointing bay), each with an operational volume of $3m^3$	infrastructure. Link boxes will be located underground immediately adjacent to jointing bays – there will be no above ground infrastructure.
Impacts related to the onshore substation	Operational footprint: $36,100m^2$ (190m x 190m) Substation operational access road: $12,800m^2$ (1,600m x 8m)	The operational footprint does not include the additional landscaping footprint (which will be agreed post-PEIR).
Impacts related to the National Grid Infrastructure	National Grid operational substation: $45,500m^2$ (325m x 140m)	The operational footprint does not include the additional landscaping footprint (which will be agreed post-PEIR). Design for the required overhead line (OHL) realignment work (including cable sealing end CCSs and pylon realignment CCS) is currently on going. As more detail is made available, this will be fully assessed and included in the Environmental Statement (ES) and DCO application. However, indicative locations for cable sealing end CCSs and pylon realignment CCS are shown in ***Figure 6.6*** of ***Chapter 6 Project Description***.
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. However, the onshore substation will likely be removed and be reused or recycled. It is expected that the onshore cables will be removed and recycled, with the transition bays and cable ducts (where used) left *in situ*. 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. A decommissioning plan will be provided. 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 The Sandlings SPA (habitat loss and disturbance)

35. The Sandlings SPA 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 such as 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).

36. This site qualifies under Article 4.1 of the Directive (79/409/EEC) (the Birds Directive) by supporting populations of European importance of the following species listed on Annex I of the Directive:

- During the breeding season;
- 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).

37. After Screening (Stage 1), Stage 2 of the HRA process requires the consideration of identified impacts on the integrity of the SPA or SAC, either alone on 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.

38. With regard to the Sandlings SPA and the individual species 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:
  - The extent and distribution of the habitats of the qualifying features;
  - The structure and function of the habitats of the qualifying features;
  - The supporting processes on which the habitats of the qualifying features rely;
  - The population of each of the qualifying features; and,
  - The distribution of the qualifying features within the site.

39. Onshore ornithological designated sites within 10km of the proposed onshore development area are shown in ***Figure 1***. ***Figure 2*** shows the onshore

ornithology study area, comprising the indicative onshore development area (to which the proposed onshore development area is a more refined version of) plus a 400m buffer from the indicative onshore development area boundary, which is considered to be the uppermost spatial extent of potential disturbance-displacement impacts associated with any ornithological receptor likely to be present.

3.2.1 Nightjar

3.2.1.1 Status and Ecology

40. Nightjar is a migrant species, and is only present in Britain from May 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).

41. 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.

42. 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.

43. 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).

44. 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.

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

45. The key aspects of onshore infrastructure with respect to nightjar are the construction of the onshore substation, the excavation works (and supporting activities) associated with the onshore cable route and landfall during construction. There is the potential for direct impacts where the footprint of the proposed 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 would be both short-term (e.g. temporary compounds, excavation works) and long-term (e.g. substation). This could impact on breeding or foraging individuals. Further details of the worst case scenario can be found in ***PEIR Chapter 23 Onshore Ornithology.***

46. Displacement and disruption of breeding and foraging nightjars as a result of construction-related noise and general disturbance may occur over a short-term period (either the duration of a particular construction activity within working hours, or the duration of the whole construction period).

47. During the operational period routine maintenance, emergency repairs and lighting of permanent infrastructure may potentially affect breeding nightjar.

48. Details of survey observations are shown on ***Figures 1 to 4.*** For each species, expert professional judgement has been used to define the number of territories based on the survey observations. The number of territories for each species are then presented in this report.

3.2.1.3 Assessment of habitat loss to nightjar due to onshore cable infrastructure

3.2.1.3.1 During Construction

49. Baseline surveys in 2018 were recorded within the onshore ornithology study area, comprising the indicative onshore development area (to which the proposed onshore development area is a more refined version of) plus a 400m buffer from the indicative onshore development area boundary, which is considered to be the uppermost spatial extent of potential disturbance-displacement impacts associated with any ornithological receptor likely to be present (see ***Figure 2*** for details). Surveyors recorded six nightjar territories that were regularly distributed in dry heath habitats within the part of the Sandlings SPA that overlapped with the onshore ornithology study area.

50. Four territory centres within the SPA were within 200m of the proposed onshore development area (three of which were within 200m of the indicative onshore

development area – see ***Figure 3***). One further territory was within 500m of the indicative onshore development area, and two further territories were within 750m of the indicative onshore development area, suggesting that there may be some potential for individuals to forage outside of the SPA, within the indicative onshore development area (based on a mean maximum foraging range of 747m described by Sharps et al. (2015)). The results of the Phase 1 Habitat survey (conducted to inform ***Chapter 22 Onshore Ecology*** of the PEIR) show that there is a lack of suitable habitat (taken to be heath, coniferous woodland or scattered trees) surrounding the SPA, with land comprising improved grassland, arable fields, and only small, isolated patches of scrub and woodland. Nightjars are therefore likely to remain within the SPA when foraging, and therefore any potential impacts would be limited to where the onshore cable route overlaps with the SPA.

51. The proposed East Anglia TWO project design has minimised the overlap of the onshore cable route with the Sandlings SPA, choosing a crossing at the narrowest point. Within areas of overlap with the SPA, HDD and/or open cut crossing techniques may be employed. The HDD entry pits will be located outside the SPA to avoid any potential impacts.

52. If open cut trenching techniques are used across the SPA, the cable route working width within the Sandlings SPA would be reduced to 16.1m. This would represent a temporary loss of up to 0.483ha of the SPA designation, or 0.01% of the whole SPA (3,405ha).

53. This area of temporary habitat loss is therefore a very small extent of the overall SPA habitat available, and would occur within habitat where no nightjars were recorded in surveys undertaken in 2018, or in 2017 according to data provided by the RSPB (see ***PEIR Chapter 23 Onshore Ornithology*** for details), showing it is likely to be of limited value for the species.

54. Based on the information provided above, it is therefore considered unlikely that important habitat for nesting or foraging nightjars would be affected during the construction of 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 significant adverse effect on the integrity of the SPA due to habitat loss on nightjar.

3.2.1.3.2 During Operation

55. Following construction, all habitats will be fully re-instated meaning there will be no permanent SPA habitat loss.

56. 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 would not be compromised and that there would be no significant adverse effect (see section 2.1 of ***Appendix 1*** for a description of the HRA methodology) on the integrity of the SPA due to habitat loss on nightjar.

3.2.1.4 Assessment of disturbance to nightjar due to onshore infrastructure

3.2.1.4.1 During Construction

57. 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) specified an active disturbance upper limit of less than 10m for nightjars during incubation and 50–100m during chick rearing periods. Murison (2002) however found a significant negative effect on nightjar density within up to 500m of a path, and suggested that failures may have been 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.

58. 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.

59. During the construction period, any disturbance impacts on nightjar within the onshore ornithology study area at a greater distance than the previously prescribed 200m buffer 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 indicative onshore development area. The level of access to the public within and surrounding the Sandlings SPA is not anticipated to change as a result of construction of the proposed East Anglia ONE TWO project, suggesting no additional adverse disturbance impacts would occur beyond 200m from a disturbance source.

60. When considering the 200m potential disturbance buffer, as a worst-case, four nightjar SPA territories may potentially be affected by unmitigated construction activities within the indicative onshore development area during the construction period.

61. As outlined in ***section 3.2.1.3.1***, where the cable route would overlap with the SPA, measures would be taken to reduce the impacts on the SPA by

minimising the working route length and width should open cut trenching be used.

62. These embedded mitigation measures would reduce the likelihood that nightjars would be disturbed by construction activities. However, within the context of the cited Sandlings SPA population (109 pairs, count as at 1992), the possible loss of up to four territories (equivalent to four pairs) during the construction period would equate to 3.7% of the cited SPA population. Assuming a 66% decline in the SPA population since citation, this would represent 10.8% of the current population (c. 37 pairs) that may be affected.

63. With evidence suggesting that the nightjar SPA population has shown a significant decline since citation, the potential loss of 10.8% of the population would further reduce the likelihood of the population from attaining favourable conservation status, and may therefore compromise the SPA's Conservation Objectives. As such, an unmitigated significant effect on the integrity of the SPA due to construction disturbance to breeding nightjar cannot be ruled out.

3.2.1.4.2 During Operation

64. During the operational period, routine maintenance would require up to one visit per week which is understood to involve a single vehicle and staff visiting the sites during daylight hours (i.e. outside of the main periods of the day that nightjars are active). Emergency repairs are expected to be infrequent and short-term in duration. This would only briefly affect nightjar within the immediate vicinity of the area(s) being visited during the breeding season.

65. In addition, operational lighting will be required for operations and maintenance activities at the onshore substation and under normal conditions the substations would not be permanently lit. The substations are over 4km from the SPA and so no effects would result from lighting.

66. As such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.2.1.5 In-combination impacts

67. 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 agricultural landscape surrounding the SPA will remain largely unchanged over the medium term at least, with only two planned projects within a potential zone of influence for SPA nightjars identified: the proposed East Anglia ONE North

offshore windfarm project (the proposed East Anglia ONE North project), and the proposed Sizewell C New Nuclear Power Station.

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

68. The proposed East Anglia ONE North project is also in the pre-application stage. It will have a separate DCO application but is working to the same programme of submission as the proposed East Anglia TWO project. The two projects will share the same landfall and cable route and the two onshore substations will be co-located.

69. This in-combination assessment will therefore initially consider the cumulative impact with only the East Anglia ONE Northproject, under two construction scenarios:

- Scenario 1 - the proposed East Anglia TWO project and East Anglia ONE North are built simultaneously; and
- Scenario 2 - the proposed East Anglia TWO project and East Anglia ONE North are built sequentially. It is intended that the proposed East Anglia TWO project will be constructed first.

70. The worst case is then carried through to the wider in-combination assessment which considers other developments which are in close proximity to the proposed East Anglia TWO Project. The operational phase impacts will be the same irrespective of the construction scenario.

71. ***Appendix 23.27*** of ***PEIR Chapter 23 Onshore Ornithology*** presents the realistic worst-case parameters of both projects if it is assumed that they are built simultaneously (Scenario 1), and also presents the worst-case scenario in the eventuality that the proposed East Anglia TWO project and proposed East Anglia ONE North project are built sequentially (Scenario 2).

72. The following sections discuss which of the two scenarios detailed above will be the worst case in terms of construction impacts relating to nightjar.

3.2.1.5.1.1 Assessment of In-combination Habitat Loss to Nightjar

<u>During Construction</u>

73. The results from baseline surveys presented in ***Figure 3*** and ***section 23.5*** of ***PEIR Chapter 23 Onshore Ornithology*** show that the indicative onshore development area, which would be shared by the proposed East Anglia ONE North project and East Anglia TWO project, has little suitable habitat for nightjar, with nesting and foraging activity likely to take place within the confines of the SPA.

74. There does remain a possibility that a temporary loss of suitable habitat could occur where the cable route crosses the SPA. If open cut trenching techniques are used across the SPA for the construction of both the proposed East Anglia TWO and 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).

75. This area of temporary habitat loss is therefore a very small extent of the overall SPA habitat available, and would occur within habitat where no nightjars were recorded in surveys undertaken in 2018, or in 2017 according to data provided by the RSPB (see ***PEIR Chapter 23 Onshore Ornithology*** for details), showing it is likely to be of limited value for the species.

76. Based on the information provided above, it is therefore considered unlikely that important habitat for nesting or foraging nightjars would be affected during the construction of infrastructure associated with the proposed East Anglia TWO and proposed East Anglia ONE North project. As such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to habitat loss on nightjar.

77. The impacts of the increased duration of temporary habitat loss described under Scenario 2 would mean that breeding nightjar could be affected for up to six breeding seasons (and potentially more if habitats do not have time to be fully reinstated between projects), which would increase the possibility of territories being abandoned beyond the construction period and over the long-term.

78. Although the duration of impact is therefore extended under Scenario 2 from short-term to medium-term, the overall significance of effects on the SPA population is unchanged from that predicted in ***section 3.1*** for the proposed East Anglia TWO project alone, because in both cases it is assumed as a worst-case, that the same territories would be lost to the population.

79. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to construction effects on nightjar.

<u>During Operation</u>

80. Following construction of both projects, all habitats will be fully re-instated meaning there will be no permanent SPA habitat loss.

81. 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.

82. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.2.1.5.1.2 Assessment of in-combination disturbance to nightjar due to onshore infrastructure

During Construction

83. 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 a significant effect. It is considered that Scenario 2 would have a greater potential for an unmitigated significant 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 ***PEIR Chapter 23 Onshore Ornithology***) would mean that breeding nightjar may be affected for up to six breeding seasons, which would increase the possibility of territories being abandoned beyond the construction period and over the long-term.

84. Although the duration of impact is therefore extended under Scenario 2 from short-term to medium-term, the overall effect on the nightjar SPA population is unchanged from that predicted for the proposed East Anglia TWO project alone, because in both cases it is assumed as a worst-case, that the same territories would be lost to the population. As outlined in ***section 3.2.1.4.1***, similar embedded mitigation measures for both the proposed East Anglia ONE North project and East Angia TWO project would reduce the likelihood that nightjars would be disturbed by construction activities. However, within the context of the cited Sandlings SPA population (109 pairs, count as at 1992), the possible in-combination loss of up to four territories (equivalent to four pairs) during the construction period would equate to 3.7% of the cited SPA population. Assuming a 66% decline in the SPA population since citation, this would represent 10.8% of the current population (c. 37 pairs) that may be affected.

85. With evidence suggesting that the nightjar SPA population has shown a significant decline since citation, the potential in-combination loss of 10.8% of the population would further reduce the likelihood of the population from attaining favourable conservation status, and may therefore compromise the SPA's Conservation Objectives (***paragraph 38***). As such, an unmitigated

significant in-combination effect on the integrity of the SPA due to construction disturbance to breeding nightjar cannot be ruled out.

During Operation

86. Operational impacts on nightjar will be the same irrespective of construction scenario. See ***Table 23.21*** of ***PEIR Chapter 23 Onshore Ornithology*** for a summary of operational impacts. It is considered very unlikely that there would be any unmitigated significant 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.

87. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on nightjar

3.2.1.5.2 In-combination Impact with Sizewell C New Nuclear Power Station

3.2.1.5.2.1Assessment of in-combination habitat loss to nightjar

During Construction

88. The main development site for Sizewell C New Nuclear Power Station is located 0.7km north of the Sandlings SPA, mainly to the north of the existing Sizewell B power station, and comprises the nuclear power station, access road and temporary development required for construction. An area of land to the west/south-west of Sizewell B and close to the SPA will also be required during the construction phase. In addition, land may be required permanently or temporarily for associated development, such as a Visitor Centre, accommodation campus, and park and ride facilities.

89. The Sizewell C New Nuclear Power Station Pre-application Consultation Report (2016) identified that two options available for the creation of an accommodation campus would be located close to the Sandlings SPA. However, the Sizewell C New Nuclear Power Station Scoping Report (2014) noted that 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 nightjar territory is likely to be lost.

90. 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 38***) would not be compromised and that there would be no

significant adverse effect on the integrity of the SPA due to construction effects on nightjar.

<u>During Operation</u>

91. No cumulative 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 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.2.1.5.2.2 Assessment of in-combination disturbance to nightjar due to onshore infrastructure

<u>During Construction</u>

92. It has been identified in the Sizewell C New Nuclear Power Station 2014 and 2016 scoping and consultation documents, that although no nightjars have been recorded in proximity, it is possible that some suitable nightjar habitat close to the SPA may be subject to disturbance during construction. A number of mitigation measures are being 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.

93. Unmitigated, a significant in-combination effect may however exist on the Sandlings SPA nightjar population during the construction period of the proposed East Anglia TWO project, and proposed East Anglia ONE North project, should they overlap with that of Sizewell C New Nuclear Power Station.

<u>During Operation</u>

94. 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 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on nightjar.

3.2.1.6 Mitigation Measures

95. HDD techniques would be employed where practiable, where the indicative onshore development area overlaps with the Sandlings SPA. The HDD entry pits would (where possible) be located away from the SPA to avoid any potential impacts. Beyond the embedded design measures outlined in ***Table 23.3*** of ***PEIR Chapter 23 Onshore Ornithology***, the following Schedule of

Mitigation is planned for the duration of the construction period, which is designed to reduce the effects on breeding birds to a non-significant level.

3.2.1.6.1 Schedule of Mitigation

96. A detailed Method Statement would be developed for working within and / or in proximity to Sandlings SPA. As part of this, a Breeding Bird Protection Plan would be enforced to ensure compliance with the Wildlife & Countryside Act 1981, by ensuring no disturbance to breeding birds.

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

- Pre-construction bird surveys will be undertaken to establish the presence of breeding birds;
- A Breeding Bird Proection Plan will be produced for works within or within 200m of the SPA and SSSI boundary which will identify the risks to breeding birds and ensure the protection of their nests.
- Measures will be adopted to minimise noise, light and disturbance on identified breeding birds;
- Works would be subject to visual screening (e.g. opaque fencing) where practicable;
- 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 suspended until chicks have fledged.

3.2.1.7 Conclusion

98. 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 potential impacts on nightjar associated with the proposed East Anglia TWO project that were identified are habitat loss and disturbance during the construction phase, and disturbance and lighting during the operational phase.

99. No permanent SPA habitat loss will result from installation of the onshore cable, and any short-term habitat loss inside or outside the SPA during construction is considered to be of negligible significance to the SPA nightjar population.

100. To avoid the possible unmitigated loss of up to four nightjar territories and an adverse effect on the integrity of the SPA due to construction disturbance, a Method Statement with associated Breeding Bird Protection Plan will ensure that construction works within 200m of the SPA would not disturb breeding birds.

101. During the operational period, habitat loss, disturbance and lighting effects would be negligible.

102. 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.

103. 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.

104. Baseline surveys to date for Sizewell C New Nuclear Power Station suggest that the area around the Sizewell C New Nuclear Power Station is not used by nightjar, although habitat may be suitable for the species. Mitigation measures outlined for the proposed East Anglia TWO and East Anglia ONE North projects would minimise the risk of a significant in-combination effect on the SPA nightjar population occurring due to the additional effects of Sizewell C New Nuclear Power Station. This risk would be further reduced by the implementation of mitigation measures outlined for Sizewell C New Nuclear Power Station.

105. For the proposed East Anglia TWO (and East Anglia ONE North) project, the potential mitigation measures outlined in ***section 3.2.1.3.1*** would be required during the construction period only, after which the contribution of the proposed

East Anglia TWO project to in-combination effects during the operational periods would be negligible. The potential for the proposed East Anglia TWO project to contribute to an overall in-combination impact on the nightjar population of the Sandlings 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.

3.2.2 Woodlark

3.2.2.1 Status and Ecology

106. 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.

107. 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).

108. 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.

109. According to Natural England's (2015b) *Site Improvement Plan* for the Sandlings, the woodlark population on the Suffolk coast has declined by 65% 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).

110. 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.

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

111. The key aspects of onshore cable installation with respect to woodlark are the construction of the onshore substation, the excavation works (and supporting activities) associated with the onshore cable corridor and landfall during construction. There is the potential for direct impacts where the footprint of the proposed works 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 would be both short-term (e.g. temporary compounds, excavation works) and long-term (e.g. substations). This could impact on breeding or foraging individuals. Further details of the realistic worst case scenario can be found in ***PEIR Chapter 23 Onshore Ornithology.***

112. Displacement and disruption of breeding and foraging woodlarks as a result of construction-related noise and general disturbance may occur over a short-term period (either the duration of a particular construction activity within working hours, or the duration of the whole construction period).

113. During the operational period routine maintenance, emergency repairs and lighting of permanent infrastructure may potentially affect breeding woodlark.

3.2.2.3 Assessment of habitat loss to woodlark due to onshore cable installation

3.2.2.3.1 During Construction

114. Baseline surveys in 2018 (see ***PEIR Chapter 23 Onshore Ornithology*** and ***Figure 4*** for details) recorded approximately seven woodlark territories located within the onshore ornithology study area in 2018, all but one of these were located within suitable heath, scrub and forestry habitats within the Sandlings SPA. Of these territories, at least three may overlap in part with the indicative onshore development area, outside of the SPA.

115. The results of the Phase 1 Habitat survey (conducted to inform ***PEIR Chapter 22 Onshore Ecology***) show however 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 within the SPA when foraging.

116. No permanent SPA habitat loss will result from installation of the onshore cable, although as outlined in ***section 3.2.1.3.1*** for nightjar, temporary habitat loss may occur where the cable route construction would traverse the SPA (open cut trenching). This would represent a temporary loss of up to 0.483ha of the SPA designation, or 0.01% of the whole SPA (3,405ha).

117. This area of temporary habitat loss is therefore a very small extent of the overall SPA habitat available, and would occur within habitat where no woodlarks were recorded in surveys undertaken during 2018, or in 2017 according to data provided by the RSPB (see ***PEIR Chapter 23 Onshore Ornithology*** for details), showing it is likely to be of limited value for the species.

118. 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 would be negligible. As such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to habitat loss on woodlark.

3.2.2.3.2 During Operation

119. Following construction, all habitats will be fully re-instated meaning there will be no permanent SPA habitat loss.

120. 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 TWO project. As such it can be reasonably concluded that the SPA's Conservation Objectives (paragraph 35) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.2.2.4 Assessment of disturbance to woodlark due to onshore cable installation

3.2.2.4.1 During Construction

121. Breeding woodlark may be disturbed by construction activities while at their nest sites, or elsewhere within their territory when foraging. Approximately seven woodlark territories were located within the onshore ornithology study area in 2018, all but one of these were located within suitable heath, scrub and forestry habitats within the Sandlings SPA, with the other near Aldringham. Of these territories, at least three may overlap in part with the indicative onshore development area (***Figure 4***). The species was absent from the more intensive farmland to the west of Aldringham. It is possible that unmitigated, construction activities could disturb breeding or foraging birds. 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.

122. Activities associated with construction within the indicative onshore development area are likely to be more predictable and less intrusive than those associated with recreational access described in the above studies, taking place in a clearly defined zone outside of the SPA. As outlined above, where the cable route would overlap with the SPA, measures would be taken to reduce the impacts on the SPA by minimising the working route length and width should open cut trenching be used.

123. The embedded mitigation measures outlined in ***Table 23.3*** of ***PEIR Chapter 23 Onshore Ornithology*** would reduce the likelihood that woodlarks would be disturbed by construction activities. As such, although there may be some disturbance to foraging birds away from nest sites caused by construction activities, a loss of territories, or significant reduction in productivity is unlikely. However, in a worst-case scenario, the potential temporary loss of three territories due to unmitigated construction activities within the context of the cited Sandlings SPA population (154 pairs, count as at 1997) would equate to 1.9% of the population. Assuming a 65% decline in the SPA population since citation, this would represent 5.5% of the current population (c. 54 pairs) that may be affected.

124. Assuming a worst-case reduction in territories close to the SPA boundary, with evidence suggesting that the woodlark SPA population has shown a significant decline since citation, the potential loss of 5.5% of the population would further reduce the likelihood of the population from attaining favourable conservation status, and may therefore compromise the SPA's Conservation Objectives. As such, an unmitigated significant effect on the integrity of the SPA due to construction disturbance to breeding woodlark cannot be ruled out.

3.2.2.4.2 During Operation

125. During the operational period, routine maintenance would require up to one visit per week which is understood to involve a single vehicle and staff visiting the sites during daylight hours. Emergency repairs are expected to be infrequent and short-term in duration. This would only briefly affect woodlark within the immediate vicinity of the area(s) being visited during the breeding season, and so disturbance effects are unlikely to be significant.

126. In addition, operational lighting will be required for operations and maintenance activities at the onshore substation only, and under normal conditions the substations would not be permanently lit. The substations are over 4km from the SPA and so no effects would result from lighting.

127. As such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.2.2.5 In-combination impacts

128. 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 3.2.1.5***, the proposed East Anglia ONE North project and Sizewell C New Nuclear Power Station are likely to be the only other proposed developments with the potential for an in-combination effect with the proposed East Anglia TWO project.

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

129. The two scenarios for the construction of the proposed East Anglia ONE North and East Anglia TWO projects outlined in ***section 3.2.1.5.1*** for nightjar is also applicable for woodlark.

3.2.2.5.1.1Assessment of in-combination habitat loss to woodlark

<u>During Construction</u>

130. The results from baseline surveys presented in ***Figure 4*** and ***section 23.5*** of ***PEIR Chapter 23 Onshore Ornithology*** show that the indicative onshore development area, which would be shared by the proposed East Anglia TWO project and 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 SPA.

131. There does remain a possibility that a temporary loss of suitable habitat could occur where the cable route crosses the SPA. If open cut trenching techniques are used across the SPA for the construction of both the proposed East Anglia TWO and East Anglia ONE Northproject, 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).

132. This area of temporary habitat loss is therefore a very small extent of the overall SPA habitat available, and would occur within habitat where no woodlarks were recorded in surveys undertaken in 2018, or in 2017 according to data provided by the RSPB (see ***PEIR Chapter 23 Onshore Ornithology*** for details), showing it is likely to be of limited value for the species.

133. Based on the information provided above, it is therefore considered unlikely that important habitat for nesting or foraging woodlarks would be affected during the construction of infrastructure associated with the proposed East Anglia TWO and proposed East Anglia ONE North project. As such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to habitat loss on woodlark.

134. Scenario 2 (sequential construction of projects) would represent the worst-case. The impacts of the increased duration of temporary habitat loss would mean that breeding woodlark could be affected for up to six breeding seasons (and potentially more if habitats do not have time to be fully reinstated between projects), which would increase the possibility of territories being abandoned beyond the construction period and over the long-term.

135. Although the duration of impact is therefore extended under Scenario 2 from short-term to medium-term, the overall significance of effects on the SPA population is unchanged from that predicted for the proposed East Anglia TWO project alone, because in both cases it is assumed as a worst-case, that the same territories would be lost to the population.

136. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to habitat loss on woodlark.

<u>During Operation</u>

137. Following construction of both projects, all habitats will be fully re-instated meaning there will be no permanent SPA habitat loss.

138. 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.

139. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.2.2.5.1.2 Assessment of in-combination disturbance to woodlark due to onshore infrastructure

During Construction

140. As with nightjar, it is considered that Scenario 2 would have a greater potential for an unmitigated significant 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 ***PEIR Chapter 23 Onshore Ornithology***) would mean that breeding woodlark may be affected for up to six breeding seasons, which would increase the possibility of territories being abandoned beyond the construction period and over the long-term.

141. Although the duration of impact is therefore extended under Scenario 2 from short-term to medium-term, the overall effect on the woodlark SPA population is unchanged from that predicted for the proposed East Anglia ONE TWO project alone, because in both cases it is assumed as a worst-case, that the same territories would be lost to the population.

142. Assuming a worst-case loss of three territories close to the SPA boundary, with evidence suggesting that the woodlark SPA population has shown a significant decline since citation, the potential loss of 5.5% of the population would further reduce the likelihood of the population from attaining favourable conservation status, and may therefore compromise the SPA's Conservation Objectives. As such, an unmitigated significant in-combination effect on the integrity of the SPA due to construction disturbance to breeding woodlark cannot be ruled out.

During Operation

143. Operational impacts on woodlark will be the same irrespective of construction scenario. See ***Appendix 23.2*** of ***PEIR Chapter 23 Onshore Ornithology*** for a summary of operational impacts. As outlined above it is considered very unlikely that there would be any unmitigated significant 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.

144. No additional in-combination effects are therefore predicted and as such it can be reasonably concluded that the SPA's Conservation Objectives (***paragraph 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.2.2.5.2 In-combination Impact with Sizewell C New Nuclear Power Station

3.2.2.5.2.1 Assessment of in-combination habitat loss to woodlark

<u>During Construction</u>

145. The Sizewell C New Nuclear Power Station Scoping Report (2014) noted that there was no evidence to suggest that woodlark is currently breeding within the Sizewell C New Nuclear Power Station study area, within, or in proximity to the SPA.

146. Adjacent land to the SPA where the closest infrastructure would be located comprises unsuitable agricultural habitats, and so no woodlark territory is likely to be lost.

147. 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 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to habitat loss on woodlark.

<u>During Operation</u>

148. 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 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.2.2.5.2.2 Assessment of in-combination disturbance to woodlark due to onshore infrastructure

<u>During Construction</u>

149. It has been identified in the Sizewell C New Nuclear Power Station 2014 and 2016 scoping and consultation documents, that although no woodlarks have been recorded in proximity, it is possible that some suitable woodlark habitat close to the SPA may be subject to disturbance during construction. The mitigation measures being explored for Sizewell C New Nuclear Power Station, as outlined above for nightjar, would also be applicable for woodlark.

150. Unmitigated, a significant in-combination effect may however exist on the Sandlings SPA woodlark population during the construction period of the proposed East Anglia TWO project, and proposed East Anglia ONE North project, should they overlap with that of Sizewell C New Nuclear Power Station.

During Operation

151. 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 38***) would not be compromised and that there would be no significant adverse effect on the integrity of the SPA due to operational effects on woodlark.

3.2.2.6 Mitigation Measures

152. The Schedule of Mitigation outlined for nightjar in ***section 3.2.1.6.1*** is also applicable for woodlark.

3.2.2.7 Conclusion

153. 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 potential impacts on woodlark associated with the proposed East Anglia TWO project were identified as habitat loss and disturbance during the construction phase, and disturbance and lighting during the operational phase.

154. 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 of negligible significance to the SPA woodlark population, due to the habitat generally being unsuitable in the indicative onshore development area, both outside, and within the SPA.

155. To avoid the possible unmitigated loss of up to three woodlark territories and an adverse effect on the integrity of the SPA due to construction disturbance, a Method Statement with associated Breeding Bird Protection Plan will ensure that construction works within 200m of the SPA would not disturb breeding birds.

156. During the operational period, habitat loss, disturbance and lighting effects would be negligible and not significant.

157. 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.

158. 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.

159. Baseline surveys to date for Sizewell C New Nuclear Power Station suggest that the area around Sizewell C New Nuclear Power Station is not used by woodlark, although habitat may be suitable for the species. Mitigation measures outlined for the proposed East Anglia TWO and East Anglia ONE North projects would minimise the risk of a significant in-combination effect on the SPA woodlark population occurring due to the additional effects of Sizewell C New Nuclear Power Station. This risk would be further reduced by the implementation of mitigation measures outlined for Sizewell C New Nuclear Power Station.

160. For the proposed East Anglia TWO project (and the proposed East Anglia ONE North project), the potential mitigation measures set out in ***section 3.2.1.6*** would be required during the construction period only, after which the contribution of the proposed East Anglia TWO project to in-combination effects during the operational periods would be negligible. The potential for the proposed East Anglia TWO project to contribute to an overall in-combination impact on the woodlark population of the Sandlings 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 Offshore Ornithology Assessment of Effects

4.1 Project Details

4.1.1 Worst-Case Scenario

161. 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.

162. It should be noted that after collision risk modelling (CRM) was conducted for the proposed East Anglia TWO project, the design envelope was changed so that the maximum number of wind turbines increased from 67 to 75 for the 12MW (250m wind turbine model) scenario, and from 48 to 60 for the 15MW (300m wind turbine model) scenario. The collision risk modelling presented in this assessment is for the previous scenarios of 67 12MW, 48 15MW and 48 19MW turbines (see ***Appendix 12, Annex 3***). The collision risk model has not been re-run for the updated scenarios because of time constraints however an assessment of the updated parameters will be included within the ES.

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

Impact	Parameter	Rationale
Construction		
Impact 1 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	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.

Impact	Parameter	Rationale
	ploughing or jetting and 80m per hour if trenching (see ***Chapter 6 Project Description***.	
Impact 2 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.
	The maximum worst case area of disturbance to benthic habitats during construction would be 10,543,760m^2 across the offshore development area, equivalent to 2.79% 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 4,322,423m^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		
Impact 3 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 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	Maximum density of turbines and structures across the offshore project area, which maximises the potential for avoidance and displacement.

Impact	Parameter	Rationale
	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.	
Impact 4 Collision risk	Maximum of 75 250m (12MW) wind turbines, other scenarios are 60 300m (15MW) or 48 300m (19MW) wind turbines.	CRM has been carried out for all turbine scenarios based on the turbine specifications in ***Appendix 12.1, Annex 3, Table 5***. 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.
Impact 5 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: **Windfarm Site Infrastructure** 2,028,406m^2 which constitutes 0.80% of the windfarm site (75 turbine foundations, five offshore electrical and construction operation and maintenance platforms, one meteorological mast, cable protection for platform link cables and inter-array cables. **Export Cable** 176,800m^2, 0.14% of the northern offshore cable corridor which has been	The maximum possible above sea bed footprint of the project including scour or scour protection plus any cable protection. See ***Chapter 9 Benthic Ecology*** *and* ***Chapter 10 Fish and Shellfish Ecology.***

Impact	Parameter	Rationale
	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 2,205,206m^2 (0.58% of the offshore development area).	
Decommissioning		
Impact 6 Disturbance and Displacement from increased vessel activity	Assumed similar to construction and therefore a worst case would be as above in impact 1.	
Impact 7 Indirect effects as a result of displacement of prey species due to increased noise and disturbance to sea bed	There would be habitat disturbance effects over up to 2,677,414m^2 across the offshore development area (0.70% of maximum offshore development area). 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.***

4.2 Outer Thames Estuary SPA: Red-throated Diver (disturbance and displacement)

163. 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).

164. 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. Therefore, it is only the original feature (red-throated diver) that is considered here.

165. An estimated 6,466 red-throated divers wintered in the SPA from 1989-2006/07), but an aerial survey in February 2013 counted 14,161 red-throated divers within the SPA boundary, suggesting that numbers have increased (Goodship et al. 2015). 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.

166. 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).

167. 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).

168. 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).

4.2.1 Red-throated diver

4.2.1.1 Status and ecology

169. 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). Knowledge of red-throated diver distribution in the UK was transformed during the 2000s following the advent of aerial and boat surveys for offshore development (e.g. Percival et al. 2004; O'Brien et al. 2008). 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).

170. 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).

171. 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 study[1]), 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.

172. 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

[1] www.divertracking.com

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). A recent 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).

173. 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 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.

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

174. 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 ***PEIR 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).

175. Export cables from the east Anglia TWO Windfarm Site are planned to run through part of the Outer Thames Estuary SPA. 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 may represent more important habitat for red-throated divers. In this section, the offshore cable corridor width is between 2km and 4km, giving a total potential overlap between the export cable corridor and the SPA of approximately 132km^2 which represents an overlap with the SPA of approximately 3.5%, although this represents the area of search and 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.

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

176. 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).

177. 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).

178. 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.

179. The HRA conducted for the East Anglia THREE windfarm (EATL 2015) considered the same potential effect, and used available data to obtain two separate estimates of the red-throated diver density in the vicinity of the East Anglia THREE cable corridor, which passes a few kilometres to the south of that for East Anglia TWO. The two density estimates were 0.74 birds/km^2 (using JNCC/Natural England data, 2000/01-2009/10) and 0.91 birds/km^2 (using Natural England survey data collected in 2013; Goodship et al. 2015). These

compare with the overall density within the SPA which is estimated to be 1.7 birds per km^2 (designated population of 6,466 divided by the total SPA area of 3,792.7km^2).

180. 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 25.2km^2 (area round each vessel being 12.6km^2). If 100% displacement is assumed to occur within this area, then at densities of 0.74 and 0.91 per km^2, between 18.6 and 22.8 divers would be displaced at any given time. Assuming that displacement was local so that birds remained within the SPA, which seems likely, this would lead to a 0.6% increase in diver density in the remaining areas of the SPA. 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 (***PEIR 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. 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.

181. 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.

182. 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.

183. 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. However, the approach taken for the proposed East Anglia TWO project is to assume that a maximum mortality rate associated with the displacement of red-throated divers in the wintering period is 5% (i.e. 5% of displaced individuals die). At this level of mortality, a maximum of one bird would be expected to die across a single winter as a result of displacement effects from the export cable installation by two vessels operating simultaneously within the SPA for the entire winter period (5% of 18.6 to 22.8). The worst case scenario assumes export cable laying activity for the proposed East Anglia ONE North project (up to 152km) could be undertaken over two winter periods within the wider 27 month offshore construction period, though the likelihood of this is low (note that East Anglia ONE have installed 85km of export cable in a period of 20 days).. This precautionary estimate is considered to generate an effect of negligible magnitude in the context of an SPA population of over 6,400 red-throated divers, a species with a natural annual mortality ranging from about 16% of adults, up to about 28% of juveniles (Furness 2015). Since most of the annual mortality occurs during winter (Dierschke et al. 2017), these mortality rates would result in the natural death of about 1,000 to 2,000 red-throated divers per year from this population (depending on the proportions of juveniles in the population which is unknown but is likely to be around 30-40% based on Furness 2015). Therefore, one additional death as a consequence of displacement by cable laying vessel displacement in a maximum of two winters would add an extra 0.05 to 0.1% to the natural annual mortality during those two years. Changes in natural mortality of less than 1% are too small to be detectable, with the consequence that no significant effect can be concluded from an effect of this magnitude.

4.2.1.4 In-combination effects

184. 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. There is a possibility that extensions will be made to some of these windfarms, or that new windfarms will be consented. 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.

185. 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). 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.

186. Red-throated divers show strong avoidance of offshore windfarms, and so the construction of, or operation of, further offshore windfarms would also represent an in-combination effect on divers.

187. 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.

188. The contribution of the proposed East Anglia TWO project to in-combination effect is assessed as fewer than one death per year over a maximum of two successive winters. The extra 0.05 to 0.1% to the natural annual mortality in these two years would be too small to be detectable. Therefore, the contribution of East Anglia TWO to in-combination effect on the red-throated diver population can be assessed as negligible.

4.2.1.5 Conclusion

189. 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. Recent numbers appear to be remaining at least at a similar level, and probably have increased (e.g. Goodship et al. 2015 found 14,161 birds within the SPA in February 2013), suggesting that the population is 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.

190. At a predicted maximum mortality level of one, 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.

4.3 Greater Wash SPA: red-throated diver and little gull

191. 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 over-wintering 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.

192. 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.

193. The East Anglia TWO windfarm site does not overlap with the Greater Wash SPA and is approximately 35km away at its closest point.

194. 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:
  - The extent and distribution of the habitats of the qualifying features;
  - The structure and function of the habitats of the qualifying features;
  - The supporting processes on which the habitats of the qualifying features rely;
  - The populations of each of the qualifying features; and
  - The distribution of the qualifying features within the site.

195. 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).

4.3.1 Red-throated diver

4.3.1.1 Status and ecology

196. 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.

197. See ***section 4.3.1.1*** for details of red-throated diver ecology.

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

198. 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.

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

199. 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. Consequently, no significant effect can be concluded from effects of this magnitude.

4.3.1.4 In-combination effects

200. 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 10 kilometres in most cases. Furthermore, GPS tracking of red-throated divers[2] 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 Greater Wash SPA red-throated diver population.

4.3.1.5 Conclusion

201. 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.

[2] www.divertracking.com

202. 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.

4.3.2 Little gull

4.3.2.1 Status and ecology

203. 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.

204. 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 though on migration.

205. 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'.

206. 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).

207. 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).

208. 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***).

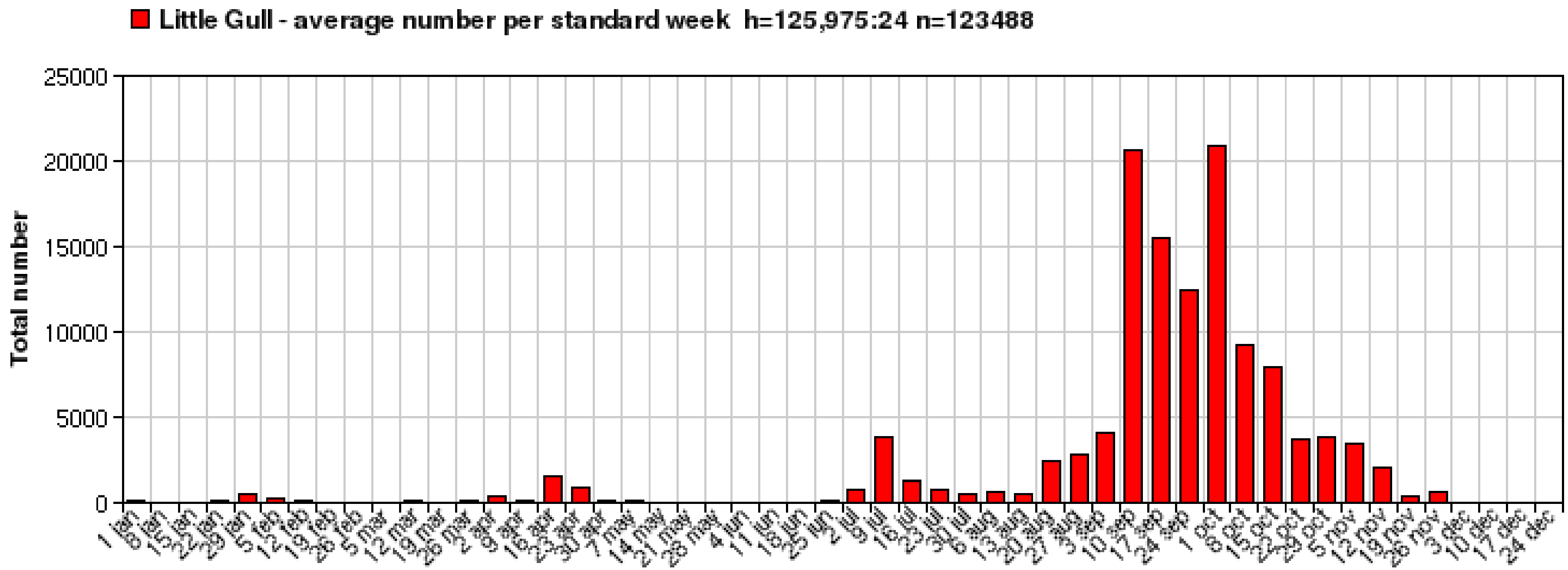

Plate 1 Counts of little gulls seen from sea watching vantage points on the east coast of England. Data from the Trektellen web page, summed for all years and sites

209. 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.

210. 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.

211. 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*".

212. 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.

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

213. 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.

214. 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%.

4.3.2.3 Assessment of collision risk to little gull

215. The little gull collision mortality for the proposed East Anglia TWO project was 0.5 birds per year, derived from option 2 of the Band model estimated with uncertainty in seabird density, avoidance rate and flight height. As described in ***section 4.3.2.1***, 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 0.5 birds represents an increase in mortality of between 0.0125% to 0.025%. 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.

216. 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 0.07 individuals from the Greater Wash SPA population of little gull could be killed by collisions (13% of 0.5), which would be even reduced further on the basis of the more realistic wider population (of 20,000).

217. 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.

218. 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.

4.3.2.4 In-combination effects

219. Given the extremely small potential project-only effect on little gull it is apparent that the proposed East Anglia TWO project will not contribute to an in-combination effect.

220. Thus, 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 projects.

4.3.2.5 Conclusion

221. 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.

222. 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.

4.4 Alde Ore Estuary SPA: lesser black-backed gull (collision risk)

223. 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.

224. 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.

225. 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.

226. 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).

227. 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.

4.4.1 Lesser black-backed gull

4.4.1.1 Status and ecology

228. 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).

229. 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 4.2***.

Table 4.2 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
2000	23000	400	2014	No data	2070
2001	5500	290	2015	No data	2399
2002	6500	338	2016	No data	1668
2003	6000	249			

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

230. 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.

231. 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.

232. 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. The JNCC's Seabird Monitoring Programme (SMP; http://jncc.defra.gov.uk/smp) includes the following lesser black-backed gull counts:

- Felixstowe Docks (2013) - 1,401 occupied territories,
- Ipswich (several sites; 2001) – 99 occupied nests, and
- Lowestoft (Town; 2000) – 750 occupied nests.

233. Counts have been undertaken in Norwich since 2008, although these have not been entered in the SMP, with a population estimate in the 2017 breeding season described as 'over 900 birds'[3].

234. Piotrowski (2012) reported on a survey of Suffolk breeding colonies undertaken in May 2012. Across all sites surveyed (within foraging range of East Anglia TWO), a total lesser black-backed gull breeding population of 4,694 pairs was estimated. However, the report noted that numbers were considered to be underestimated due to poor weather prior to and during the survey. This would appear to be borne out in the estimate for Felixstowe which was 675 pairs in 2012, but reported as 1,400 occupied territories a year later (SMP).

235. Using the SMP data, the urban adult lesser black-backed gull population in Norfolk and Suffolk with potential connectivity to the East Anglia TWO windfarm site can be conservatively estimated as 5,400 (= 2,800 + 200 + 1500 + 900), noting that the Lowestoft, Ipswich and Felixstowe estimates were from 2000, 2001 and 2013 respectively and would therefore almost certainly have increased substantially in the interim, as data from urban versus coastal colonies shows faster growth rates in general in urban sites. Although urban

[3] http://www.edp24.co.uk/news/environment/they-are-the-new-pigeon-seagull-numbers-triple-in-norwich-and-experts-warn-there-is-no-solution-1-5122565; quote attributed to Dr. Iain Barr from the University of East Anglia

nesting gulls may feed in urban areas so might spend less time at sea than coastal nesting gulls, tracking data from urban nests indicate that urban nesting lesser black-backed gulls also tend to switch to marine foraging when rearing chicks, presumably to provide chicks with higher quality food to sustain chick growth and development. So, the amount of marine foraging by urban gulls appears to be similar to the amount of marine foraging by coastal gulls (which also feed extensively inland early and late in the breeding season but tend to switch to marine foraging during chick-rearing).

236. Using the 2012 survey data (Piotrowski 2012), the Suffolk population excluding that at the Alde-Ore Estuary colonies was estimated at 2,900 pairs, yielding a Suffolk only estimate of the breeding adult population of 5,800.

237. In addition, some colonies of lesser black-backed gulls in the Netherlands are within 181km. However, extensive colour ringing and tracking of breeding lesser black-backed gulls from multiple colonies in the Netherlands has shown that there is negligible connectivity during the breeding season between birds breeding in those colonies and the UK, and indeed that there is remarkably little migration of birds from the colonies in the Netherlands through UK waters even after the breeding season in autumn, winter or spring (Camphuysen 2013). Not only do breeding adult lesser black-backed gulls from colonies in the Netherlands normally remain on the continental side of the North Sea while breeding, but 95% of their foraging trips in the 1990s and 2000s were less than 135km from those colonies (Camphuysen 1995, 2013), while tracking in 2008-2011 showed that 95% of foraging trips were within 60.5km of the colony (Camphuysen et al. 2015), so could not reach the East Anglia TWO windfarm site. Therefore, during the breeding season, it is likely that adult lesser black-backed gulls at the East Anglia TWO site will originate from Alde-Ore Estuary SPA and from non-SPA colonies in East Anglia. However, these birds may be mixed with nonbreeders from a variety of sources, so that any effect on lesser black-backed gulls due to the proposed East Anglia TWO project will be on a mixture of breeding birds from Alde-Ore Estuary, breeding birds from non-SPA colonies and immatures/nonbreeders from many different sources.

238. As discussed above, the non-SPA adult lesser black-backed gull population with potential for connectivity to the East Anglia TWO windfarm site is likely to be at least 5,400 and could easily be twice this figure when allowance is made for population increases since surveys were last conducted. Furthermore, this estimate is derived from partial coverage of urban locations at which gulls may breed (e.g. Norfolk appears to have had very limited coverage). Together with the fact that there is over 400km of coastline within foraging range of the East Anglia TWO windfarm site, also suggests the actual non-SPA lesser black-backed gull population within range of the East Anglia TWO windfarm site could

be twice the estimate of 5,400 (e.g. approx. 11,000 adults) which would represent an all age class population in excess of 19,000 individuals (on the basis that adults comprise approximately 58% of the population, Furness 2015).

239. The Alde-Ore SPA lesser black-backed gull breeding population has been about 2,000 pairs between 2007 and 2014 (minimum 1,580 pairs in 2011, maximum 2,769 pairs in 2008;***Table 4.2***) which suggests that the total population (all age classes) associated with the SPA is around 6,700 individuals (assuming adults comprise 60% of the population, Furness 2015).

240. Incorporating all of the above evidence, a worst case (precautionary) assumption has been made that 25% (~ 6,700 / (19000 + 6700)) of birds recorded on the East Anglia TWO windfarm site in the breeding season originate from the Alde-Ore SPA population.

241. 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. The Alde-Ore Estuary SPA population represents a very small fraction of the regional population 'at risk'. The lesser black-backed gull 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). 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 adult birds from the Alde-Ore SPA population. This percentage applies both for estimated mortality due to the proposed East Anglia TWO project alone, and in-combination within the region.

242. 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 somewhat higher proportion of the winter BDMPS than they do the migration seasons BDMPS populations because a higher proportion of the overwintering birds are likely to be adults (most immatures migrate further south). If it is assumed that all breeding adults remain in the region (a highly precautionary assumption), then the proportion of birds from the Alde-Ore SPA will be approximately 10% (Furness 2015), so no more than 10% of the estimated collision mortality on the lesser black-backed gull population during winter can 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 10%, but is likely to be greater than the 3.3% during migration seasons.

4.4.1.3 Assessment of collision risk to lesser black-backed gull

243. 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 4.3*** (data taken from ***PEIR Chapter 12 Ornithology***).

Table 4.3 Band Option 2 Predicted Monthly Numbers of Collision Mortalities of Lesser Black-Backed Gulls at the East Anglia TWO Site. Migration-Free Breeding Season Months (May-July) Shown in Bold

Month	Collisions
January	0 (0-0)
February	0 (0-1.63)
March	0 (0-2.12)
April	0 (0-2.49)
May	**0 (0-0)**
June	**0.48 (0-3.15)**
July	**0 (0-0)**
August	0 (0-0)
September	0 (0-3.26)
October	0 (0-0)
November	0 (0-0)
December	0 (0-0)
Total	0.48 (0-12.65)

244. 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 would be:

- Autumn (August-October): 0 x 3.3% = 0 (range 0-0.11)
- Winter (November-February): 0 x 10% = 0 (range 0-0.02)
- Spring (March-April): 0 x 3.3% = 0 (range 0-0.15)
- Migration-free breeding season (May-July): 0.48 x 25% = 0.12 (range 0-0.78)
- Total for Alde-Ore SPA = 0.12 (range 0-1.1)

245. Natural mortality for the SPA population (assuming approximately 6,666 birds of all ages) would be around 840 individuals, at an average mortality rate of 12.6% (using immature and adult survival rates from Horswill and Robinson 2015). A total additional mortality of 0.12 birds due to collisions at the East Anglia TWO windfarm site would increase this by 0.014%. 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.

246. 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.

4.4.1.4 In-combination assessment

247. The cumulative lesser black-backed gull collision risk prediction for the nonbreeding season has been calculated using a ‘tiered approach’ (***Table 4.4***). 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 440 to 442 birds (of all age classes), of which the proposed East Anglia TWO project contributes 0. Cumulative breeding season mortality was estimated as 126 to 142 (giving an annual total of 567 to 585). 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 and the proposed East Anglia TWO project. The total breeding season mortality for these windfarms is 84. 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, Galloper, London Array, the proposed East Anglia TWO project and the proposed East Anglia ONE North project) generate an estimate of 44.1 collisions.

Table 4.4 Lesser black-backed gull collision mortality for all windfarms (nonbreeding) and those with potential connectivity during the breeding season with the Alde-Ore SPA

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 Demonstrator	0.0	0.0	0	
1	Greater Gabbard	62.0	49.6	12.4	12.4
1	Gunfleet Sands	0.0	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	0.0	0	
1	Lynn and Inner Dowsing	0.0	0.0	0	
1	Scroby Sands	0.0	0.0	0	
1	Sheringham Shoal	8.3	6.6	1.7	1.7
1	Teesside	0.0	0.0	0	
1	Thanet	16.0	12.8	3.2	3.2
1	Humber Gateway	1.3	1.1	0.2	
1	Westermost Rough	0.3	0.3	0	
1	EOWDC (Aberdeen OWF)	0.0	0.0	0	
2	Beatrice	0.0	0.0	0	
2	Dudgeon	38.3	30.6	7.7	7.7
2	Galloper	138.8	111.0	27.8	27.8
2	Race Bank	54.0	10.8	43.2	
2	Rampion	7.9	6.3	1.6	
2	Hornsea Project 1	21.8	17.4	4.4	
2	East Anglia ONE	27.0	23.0	4.0	4.0
3	Blyth (NaREC Demonstration)	0.0	0.0	0	
3	Dogger Bank Creyke Beck A & B	13.0	10.4	2.6	
3	Firth of Forth Alpha and Bravo	10.5	8.4	2.1	
3	Inch Cape	0.0	0.0	0	
3	Moray Firth (EDA)	0.0	0.0	0	
3	Neart na Goithe	1.5	1.2	0.3	
3	Triton Knoll	37.0	29.6	7.4	

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
4	Dogger Bank Teesside A & B	12.0	9.6	2.4	
4	Hornsea Project 2	4.0	2.0	2.0	
4	East Anglia THREE	10.0	8.2	1.8	1.8
5	Hornsea Project 3	18	3	15	
5	Thanet Extension	2.3	0.8	1.5	1.5
5	Norfolk Vanguard (WCS)	27.4	4.1	23.3	23.3
5	East Anglia TWO	0.5	0	0.5	0.5
5	East Anglia ONE North	0.61	0	0.61	0.61
	Total	**522.6**	**354.9**	**167.7**	**84.8**

248. 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 population. Across all age classes the Alde-Ore Estuary SPA represents about 3.3% of the BDMPS autumn population, about 3.3% of the BDMPS spring population and a maximum of 10% of the BDMPS winter population. For windfarms which have presented a seasonal breakdown of predicted collisions, most mortality is predicted to occur during the migration seasons, so it is reasonable to assume that 3.3% of the in-combination mortality during the nonbreeding season could be apportioned to the Alde-Ore Estuary SPA lesser black-backed gull population. This would be about 12 birds (355 x 3.3%).

249. The estimated annual mortality of lesser black-backed gulls from the Alde-Ore SPA from collisions with offshore windfarms is therefore 12 during the winter and 44.1 during the breeding season, 56 in total (note that the proposed East Anglia TWO project contributes approximately 0.5 individuals to this annual total).

250. In-combination mortality of 56 birds attributable to the Alde-Ore SPA population of lesser black-backed gulls compares with estimated natural mortality of about 840 birds per year. Thus, the predicted additional in-combination collision mortality would increase the population mortality to 896 which represents an increase in mortality rate from 12.6% to 13.4%. This level of additional mortality would be expected to result in an adverse effect on the integrity of the SPA,

although notably approximately one third of this annual total is attributable to the estimated collisions at the Galloper Wind Farm alone.

251. 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 typically reduces predicted mortality by at least 40%, which would reduce the in-combination mortality prediction to around 20, equating to an increase in background mortality of 2% (although notably the reduction for the Galloper Wind Farm would be even greater at around 60%).

252. Population modelling conducted for the Galloper Wind Farm (GWF 2011) considered three sets of demographic rates, referred to as low, medium and high against which the effects on the population of additional mortality was considered. These indicated that for an additional mortality of 25 the reduction in population growth rate was between 0.1% and 1.1%, with the most likely reduction, from the medium scenario, being 0.3% (this set of demographic rates reflected the rates expected as a result of management measures which were being implemented at the SPA). It is also worth noting that the in-combination collision total predicted for the Galloper Wind Farm was 85 (at a 99.5% avoidance rate), compared with the precautionary estimate of 56 above, and more than four times the more likely prediction of 20.

4.4.1.5 Conclusion

253. 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 of about 14,000 pairs. The annual number of predicted lesser black-backed gull collisions at the East Anglia TWO windfarm site is very small (0.5 per year), and of that the proportion which can be attributed to the Alde Ore SPA is so small (0.12) 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.

254. The in-combination collision mortality attributable to the Alde-Ore SPA population is a precautionary 58 individuals, which represents an increase in mortality of 0.8% over natural mortality. While this increase in mortality would appear to be of concern, the comments made by the Secretary of State in relation to the East Anglia ONE assessment are relevant here. Despite the much lower avoidance rate applied at the time of that assessment (98%), it was concluded by the Secretary of State in relation to East Anglia ONE (DECC 2014), that the mortality from offshore windfarms is insignificant compared to other factors affecting the population of the lesser black-backed gull, and with

planned improvements to the SPA, immigration from other colonies is likely, and would boost numbers, should favourable breeding conditions be created.

255. Furthermore, since mortality of birds from the SPA at the East Anglia TWO windfarm site is estimated to be less than 1 individual, even if it is concluded that there will be an adverse effect on the integrity of the SPA due to in-combination collision mortality it is clear that the proposed East Anglia TWO project makes an extremely small contribution to this.

4.5 Flamborough and Filey Coast SPA: razorbill, guillemot and puffin (displacement risk) and gannet and kittiwake (collision risk)

256. Between 20 January 2014 and 14 April 2014, Natural England held a formal public consultation on the designation of what was formerly the Flamborough and Filey Coast pSPA. This pSPA, (now a fully designated SPA) represents a geographical extension to the former Flamborough Head and Bempton Cliffs SPA and adds several species to the citation list. The Flamborough and Filey coast SPA was formally designated on 31st July 2018.

257. While this HRA was being compiled, the site was still designated as a pSPA. It is Government policy to treat pSPAs as if they were a fully designated European site under the Habitats Regulations and therefore the assessment has considered the effects of the proposed project on features of now formally designated Flamborough and Filey Coast SPA, and has determined whether or not LSEs can be ruled out. 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.

258. 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).

259. 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.

260. 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]:
    - The extent and distribution of the habitats of the qualifying features;
    - The structure and function of the habitats of the qualifying features;
    - The supporting processes on which the habitats of the qualifying features rely;
    - The populations of the qualifying features; and

- The distribution of the qualifying features within the site.

4.5.1 Gannet

4.5.1.1 Status and ecology

261. 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).

262. 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).

263. 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. 2016).

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

264. 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).

265. 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.

266. 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 allocate all breeding season mortality of breeding adults to 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 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).

4.5.1.3 Assessment of collision risk to gannet

267. 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 18.6 birds per year, with approximately 50% occurring in autumn (***PEIR Chapter 12 Offshore Ornithology***).

268. Estimates of the proportion of birds present in the East Anglia TWO windfarm site which originate from Flamborough & 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 & Filey Coast SPA. During migration in autumn and spring, 4.2% and 5.6% (respectively) of the birds observed are predicted to originate from Flamborough & Filey Coast SPA, based on numbers at the SPA and in the BDMPS population estimate (following the same method applied above for lesser black-backed gull).

269. Applying these percentages to the collision estimates generates the following mortality estimates for the Flamborough & Filey Coast SPA population:

- Migration-free breeding season (April-August): 8.8 x 100% = 8.8 (range 2.15-35.8).
- Autumn migration (September-November): 8.6 x 4.2% = 0.4 (range 0.04-2.4).
- Spring migration (December-March): 1.1 x 5.6% = 0.06 (range 0-0.96).
- Total = 9.2 (range 2.5-39.2).

270. The SPA population is approximately 48,700 (derived from the 2017 population estimate of 13,391 pairs, multiplied by 2 and divided by the adult proportion of 0.55 to estimate the total population size). At an average natural mortality rate of 0.191 (derived as a weighted average across all age classes), the natural annual mortality of the population is 9,300. The addition of 9 individuals would therefore increase the mortality rate by 0.1%.

271. 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.

272. 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.

4.5.1.4 In-combination assessment

273. 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 4.5***. All windfarm estimates have been updated to reflect the evidence based nocturnal flight activity rates reported in Furness et al. (2018). Furness et al. (2018) recommended precautionary nocturnal activity rates for gannet in the breeding and nonbreeding seasons of 8% and 4% respectively. However, the actual average rates from their study were 7.1% and 2.3% respectively. Furthermore, the breeding season value was very heavily influenced by the results from the smallest study in the review, which was based on only three tagged birds in Shetland (Garthe et al., 1999). This study yielded a nocturnal activity rate of 20.9% (compared to daytime) but the total duration of flight activity recorded was only 215 hours, which was less than 3% of the > 8,000 hours covered by the remaining studies. If the average rate is calculated without this study a breeding season rate of 4.3% (SE 2.7%) is obtained. This is considered to be more robust and has been used in the current assessment. Similarly, the actual nonbreeding season rate of 2.3% (SE 0.4%) has been used here in preference to the rounded-up value of 4% reported in Furness et al. (2018).

Table 4.5 Gannet collision mortality for all windfarms with potential connectivity to the Flamborough and Filey Coast SPA. Note that the mortality for each windfarm has been adjusted to correspond to the revised nocturnal flight activity rates (see text for details)

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 Demonstrator	0.6	0.0	0.9	0.0	0.7	0.0
1	Greater Gabbard	0.0	0.0	0.0	0.0	0.0	0.0
1	Gunfleet Sands	0.0	0.0	0.0	0.0	0.0	0.0

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	Kentish Flats	0.2	0.0	0.0	0.0	0.0	0.0
1	Lincs	4.3	4.3	0.0	0.0	0.0	0.0
1	London Array (Phase 1)	0.0	0.0	0.0	0.0	0.0	0.0
1	Lynn and Inner Dowsing	0.0	0.0	0.0	0.0	0.0	0.0
1	Scroby Sands	0.0	0.0	0.0	0.0	0.0	0.0
1	Sheringham Shoal	10.3	10.3	4.7	0.2	0.0	0.0
1	Teesside	5.6	2.8	0.0	0.0	0.0	0.0
1	Thanet	0.8	0.0	0.0	0.0	0.0	0.0
1	Humber Gateway	2.9	2.9	0.0	0.0	0.0	0.0
1	Westermost Rough	0.2	0.2	0.0	0.0	0.0	0.0
1	EOWDC (Aberdeen OWF)	2.9	0.0	2.2	0.0	0.0	0.0
2	Beatrice	20.0	0.0	48.2	0.9	10.0	0.3
2	Dudgeon	20.1	20.1	30.3	1.3	15.4	0.9
2	Galloper	9.4	0.0	24.9	1.0	13.5	0.8
2	Race Bank	29.6	29.6	6.9	0.3	3.1	0.2
2	Rampion	36.4	0.0	50.1	2.1	1.1	0.1
2	Hornsea Project 1	10.3	10.3	23.6	1.0	17.5	1.0
2	East Anglia ONE	1.8	1.8	66.0	2.8	3.6	0.2
3	Blyth (NaREC Demonstration)	0.0	0.0	0.0	0.0	0.0	0.0
3	Dogger Bank Creyke Beck A & B	10.0	5.0	10.3	0.2	6.7	0.4
3	Firth of Forth Alpha and Bravo	742.5	0.0	111.1	2.0	83.8	2.8
3	Inch Cape	337.5	0.0	30.3	0.5	7.2	0.2
3	Moray Firth (EDA)	48.3	0.0	50.4	1.0	30.2	1.0
3	Neart na Goithe	130.6	0.0	38.6	0.7	18.5	0.6
3	Dogger Bank Teesside A & B	13.6	6.8	8.1	0.1	8.7	0.5

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	Triton Knoll	24.4	24.4	64.6	2.7	40.8	2.3
3	Hornsea Project 2	7.9	7.9	10.2	0.4	4.0	0.2
3	East Anglia THREE	5.2	5.2	24.7	1.0	7.1	0.4
5	Hornsea Project 3	18.3	18.3	12.1	0.5	8.1	0.5
5	Thanet Extension	0.0	0.0	2.9	0.1	7.1	0.4
5	Norfolk Vanguard (WCS)	18.3	18.3	62.3	2.6	29.9	1.7
5	East Anglia TWO	8.8	8.8	8.6	0.4	1.2	0.1
5	East Anglia ONE North	8.8	8.8	5.5	0.2	1.3	0.1
	Total	1529.6	185.8	697.5	22.1	319.5	14.5

274. In autumn, the cumulative gannet collisions were estimated to be 621, in spring 320 and in the breeding season 1,530. Using the Flamborough & Filey Coast SPA proportions for all the windfarms with potential connectivity to the Flamborough and Filey Coast SPA (MacArthur Green 2015a), the proportions of the mortality attributed to the Flamborough and Filey Coast SPA population were 22 (autumn), 15 (spring) and 186 (breeding). Of these totals, the proposed East Anglia TWO project contributed a maximum of 0.4, 0.1 and 9 individuals within each period respectively. Therefore, as discussed above, irrespective of the potential total effect on the Flamborough and Filey Coast SPA gannet population, the contribution from the proposed East Anglia TWO project is very small and would have an undetectable effect on the population. The annual increase in background mortality from the in-combination total of 223 is 2.4% (from 0.191 to 0.195).

275. Population modelling of the Flamborough and Filey Coast SPA gannet population conducted for the Hornsea Project Two Offshore Windfarm (MacArthur Green 2014) indicated that an annual mortality of 125 adults would reduce the median population growth rate by approximately 0.5% from the current rate (using the more precautionary density independent model). Since adults comprise an estimated 55% of the population, this level of mortality (125) is equivalent to a total mortality of 227 distributed across all ages (i.e. approximately the same as the predicted 223). However, if an extremely

precautionary assumption is made that all of the mortality is confined to adults, this would indicate a reduction in the growth rate of 1%. The gannet population has grown at a much higher rate than this over the last 25 years (at least 10% per year). Therefore, a maximum reduction of 1% would generate a negligible risk to the population's status, and continued population growth would be predicted on the basis of this modelling.

276. An individual-based modelling approach used by Warwick-Evans et al. (2017) may be useful for assessing effects of offshore windfarms on gannet populations, but that approach depends on knowledge of a large number of parameters for which there is, at present, a shortage of evidence.

277. Natural England's assessment for East Anglia ONE included consideration of the level of annual mortality which the Flamborough and Filey Coast SPA population could sustain, which was reported as between 286 and 361 (Natural England 2013a). This was derived using Potential Biological Removal (PBR), a method which Natural England no longer recommend is used for assessing seabird effects. However, it is informative to note that when the increase in population size (7,859 AON to 13,391 AON between 2008 and 2017) is taken into account, a revised threshold of between 487 and 615 individuals is obtained. Thus, while the in-combination total estimated for this SPA has increased by only a small amount since the East Anglia ONE assessment (202 at 98.9%, Natural England 2013b) the population is now 1.7 times larger.

278. The in-combination mortality of up to 223 individuals predicted for the proposed East Anglia TWO project (all age classes) apportioned to the Flamborough and Filey Coast SPA is clearly well below both the previously accepted threshold for collisions (286-361) and also the revised thresholds (487-615). It is also important to note that the threshold figures quoted above relate only to the breeding adult component of the population. Of the total current predicted in-combination mortality of 223, breeding adults would be estimated to be 124 (55% of the population, Furness 2015). Thus, the threshold of 286 to 361 applies only to the adult total and this is between two and three times higher than the predicted in-combination adult mortality of 124.

279. 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.

280. 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 effects compared to other UK seabirds. For example, at Sula Sgeir SPA, where breeding gannet is an SPA feature, numbers continued to increase at a rate of 2.2% per annum from 2004 to 2013 (Murray et al. 2015), increasing from 9,225 pairs to 11,230 pairs, 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 effect of harvesting fledglings is less than the effect of harvesting adults because survival rates of adults are higher, this example clearly shows how robust populations of gannets can be to human effects.

4.5.1.5 Conclusion

281. 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.

282. 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.

283. The number of predicted in-combination gannet collisions attributed to the Flamborough & 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 & 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.

4.5.2 Kittiwake

4.5.2.1 Status and ecology

284. 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). 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).

285. 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).

286. 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).

287. 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).

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

288. 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).

289. 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. Furthermore, study birds tend to be those most readily caught at the periphery of colonies or the base of cliffs. This typically means tagged individuals are of lower quality and are more likely to suffer breeding failure which will result in longer duration trips due to the absence of a need to return to the colony to feed chicks (although it should be noted that since not all of the FAME and STAR data are yet to be published it can be difficult to fully understand the methods used and which areas of the colony are sufficiently accessible to permit catching).

290. The FAME and STAR tracking studies (and many others) have deployed loggers on kittiwakes that weigh about 4 to 5% of body weight (Wakefield et al. 2017). 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 3 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).

291. There is evidence therefore, that some of 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.

292. Long trips can also be a consequence of breeding failure, which is particularly likely among the tracked birds. 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.

293. 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 effects on behaviour of equipped birds.

294. RSPB tracking data from the Flamborough & Filey Coast SPA colony conducted between 2010 and 2013 (and subject to the probable biases described above) have been made available to Natural England, although not made public. According to Natural England (2015a) the data indicate that breeding birds from the colony were foraging up to a maximum of 219km from the colony. The mean maximum foraging range varied considerably between years, ranging from 58km in 2011 to 156km in 2012 (Natural England 2015a). On the basis of these data, Natural England suggest that kittiwakes from Flamborough & Filey Coast SPA colony should be assumed to forage within 156km of the colony for impact assessments for offshore windfarms (Natural England 2015a). Since Flamborough & Filey Coast SPA is 247km from the East Anglia TWO windfarm site, following Natural England guidance it is reasonable to assume that only a very small percentage of breeding adults from Flamborough & Filey Coast SPA colony will be at risk of collision mortality at the East Anglia TWO windfarm site during the breeding season.

295. An analysis of the relationship between kittiwake breeding success and the North Sea sandeel fishery (Carroll et al. 2017) presents foraging areas for birds tagged at both Filey (2012-2015, 50 birds) and Flamborough (2010-2015, 104

birds) as 95% Kernel Density Estimates (KDE). A figure presenting the results of this analysis does not indicate any overlap with either the former East Anglia Zone nor the East Anglia TWO windfarm site (Figure 1b, Carroll et al. 2017). Therefore, while breeding season connectivity between the East Anglia TWO windfarm site and the colony cannot be ruled out, the weight of evidence available indicates that this is both highly unlikely and, if it does occur, very infrequent.

296. Kittiwakes from the Flamborough & 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 & 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.

297. 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).

298. 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).

299. 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 & Filey Coast SPA colony. For example, a 2nd year or 3rd year bird at the average distance of 600km north of Flamborough & 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*’.

300. 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).

301. 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 & 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 & Filey Coast SPA will breed in a different ‘population’ and not at Flamborough & Filey Coast SPA colony. Apportioning immature birds at risk of collision mortality at the East Anglia TWO windfarm site to the Flamborough & 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.

302. A proportion of the birds at the East Anglia TWO windfarm site in summer will be immatures from higher latitude colonies. Since there are very large populations of kittiwakes at higher latitudes, the proportion of kittiwakes at the East Anglia TWO windfarm site during summer that originate from high latitude colonies may be quite high, but cannot accurately be quantified based on current knowledge. It is therefore difficult to apportion assessed effects during the breeding season to immatures and nonbreeders ‘associated with’ Flamborough & Filey Coast SPA colony, as the numbers from elsewhere are uncertain, and any ‘association’ of immature birds with the Flamborough & Filey Coast SPA colony is at best tenuous, at least until they obtain a site within the colony and so are in the process of recruiting into that population. Wakefield et al. (2017) point out that immature kittiwakes are very likely to be dispersed widely at sea, and perhaps particularly in areas beyond the foraging range of

adults from breeding colonies because immature birds are likely to be less competitive so would likely avoid competing for food with adults in areas close to colonies. This suggests that there is likely to be an increasing proportion of immature and nonbreeding birds over marine areas further from breeding sites.

4.5.2.3 Assessment of collision risk to kittiwake

303. Collision mortality of kittiwakes at the East Anglia TWO windfarm site was estimated as 9.3 in spring, 13.6 in summer and 2.9 in autumn, giving an annual total of 25.8 birds (***PEIR 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).

304. Estimates of the proportion of birds present on windfarms in the North Sea which originate from Flamborough & 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 & 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 & Filey Coast SPA.

305. Applying these percentages to the collision estimates stated above generates the following mortality estimates for the Flamborough & Filey Coast SPA population:

- Migration-free breeding season (May-July): 13.6 x 16.8% = 2.3 (range 0.4-8.9).
- Autumn migration (August-December): 2.9 x 5.4% = 0.16 (range 0-0.8).
- Spring migration (January-April) 9.3 x 7.2% = 0.7 (range 0.08-3.1).
- Total = 3.2 (range 0.5-12.8).

306. These sum to an annual total maximum collision mortality of 3 individuals, from a population of approximately 141,000 (37,618 pairs multiplied by 2 and divided by the adult proportion of 0.532 to estimate the total population size). It should also be noted that the population of kittiwakes 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 population to approximately 191,700.

307. At an average natural mortality rate of 0.156 (derived as a weighted average across all age classes, ***PEIR Chapter 12 Offshore Ornithology*** for details), the natural mortality of the population is 22,000 (based on the designated

population size). The addition of a maximum of 3 individuals to this would increase the mortality rate by 0.01%.

308. 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, demonstrates that no significant effect can be attributed to this level of effect arising from the proposed East Anglia TWO project alone.

309. It is, therefore, concluded 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.

4.5.2.4 In-combination assessment

310. In-combination collision risk 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 4.6***. All windfarm collision estimates have been updated to reflect the evidence based nocturnal flight activity rates estimated in Furness et al. (in prep) for kittiwake. In the breeding and nonbreeding seasons, these updated rates are respectively 20% (SE 5%) and 17% (SE 1.5%).

Table 4.6 Kittiwake collision mortality for all windfarms with potential connectivity to the Flamborough and Filey Coast SPA. Note that the mortality for each windfarm has been adjusted to correspond to the revised nocturnal flight activity rates (see text for details)

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 Demonstrator	0.0	0.0	2.1	0.1	1.7	0.1
1	Greater Gabbard	1.1	0.2	15.0	0.8	11.4	0.8
1	Gunfleet Sands	0.0	0.0	0.0	0.0	0.0	0.0
1	Kentish Flats	2.4	0.4	0.0	0.0	0.0	0.0
1	Lincs	0.0	0.0	0.0	0.0	0.0	0.0
1	London Array (Phase 1)	0.0	0.0	0.0	0.0	0.0	0.0
1	Lynn and Inner Dowsing	0.0	0.0	0.0	0.0	0.0	0.0
1	Scroby Sands	0.0	0.0	0.0	0.0	0.0	0.0

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	Sheringham Shoal	0.0	0.0	0.0	0.0	0.0	0.0
1	Teesside	14.0	2.4	0.0	0.0	0.0	0.0
1	Thanet	0.8	0.1	0.0	0.0	0.0	0.0
1	Humber Gateway	5.7	5.7	0.0	0.0	0.0	0.0
1	Westermost Rough	0.4	0.4	0.0	0.0	0.0	0.0
2	Beatrice	62.1	10.4	11.2	0.6	48.4	3.5
2	Dudgeon	0.0	0.0	0.0	0.0	0.0	0.0
2	Galloper	8.6	1.4	37.2	2.0	12.9	0.9
2	Race Bank	1.3	0.2	17.1	0.9	4.4	0.3
2	Rampion	62.6	10.5	31.3	1.7	21.9	1.6
2	Hornsea Project 1	39.3	6.6	41.8	2.3	18.9	1.4
3	Blyth (NaREC Demonstration)	0.0	0.0	0.0	0.0	0.0	0.0
3	Dogger Bank Creyke Beck A & B	197.0	33.1	100.1	5.4	277.6	20.0
3	East Anglia ONE	0.9	0.2	73.7	4.0	23.4	1.7
3	EOWDC (Aberdeen OWF)	14.7	2.5	5.7	0.3	1.0	0.1
3	Firth of Forth Alpha and Bravo	356.7	59.9	229.8	12.4	255.6	18.4
3	Inch Cape	10.3	1.7	193.1	10.4	25.0	1.8
3	Moray Firth (EDA)	36.6	6.1	8.1	0.4	25.1	1.8
3	Neart na Goithe	9.1	1.5	17.9	1.0	2.2	0.2
3	Dogger Bank Teesside A & B	86.7	14.6	65.6	3.5	197.6	14.2
3	Triton Knoll	12.4	2.1	93.3	5.0	53.4	3.8
3	Hornsea Project 2	11.0	1.8	7.8	0.4	3.7	0.3
3	East Anglia THREE	5.2	0.9	46.5	2.5	27.1	2.0
5	Hornsea Project Three	86.0	14.4	70.3	3.8	71.0	5.1
5	Thanet Extension	1.8	0.3	2.1	0.1	7.3	0.5

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
	Norfolk Vanguard (WCS)	20.8	3.5	61.3	3.3	76.2	5.5
	East Anglia TWO	13.6	2.3	2.9	0.2	9.3	0.7
	East Anglia ONE North	6.0	1.0	4.3	0.2	17.4	1.3
	Total	**1067.1**	**184.3**	**1138.2**	**61.5**	**1192.5**	**85.9**

311. The cumulative total kittiwake collisions in autumn were estimated to be 1,138, in spring 1,192, and in the breeding season 1,067. Using the Flamborough & Filey Coast SPA proportions for all the windfarms with potential connectivity to the Flamborough and Filey Coast SPA (MacArthur Green 2015b), the mortality attributed to the Flamborough and Filey Coast SPA population was 61 (autumn), 86 (spring) and 184 (breeding) respectively (annual mortality of 332 birds).

312. Of these, the proposed East Anglia TWO project contributed a maximum of 0.2, 0.7 and 2.3 individuals, respectively. Therefore, irrespective of the potential total effect on the Flamborough and Filey Coast SPA kittiwake population, the contribution from the proposed East Anglia TWO project is extremely small (<=1% annually) and (as discussed above) would have an undetectable effect on total mortality. However, addition of the in-combination total of 332 individuals to the background mortality of 22,000 would increase the mortality rate by 1.5% from 0.156 to 0.158.

313. Population modelling of the Flamborough and Filey Coast SPA kittiwake population conducted for the Hornsea Project One windfarm (MacArthur Green 2014) indicated that an annual mortality of 200 adults would reduce the median population growth rate by a maximum of approximately 0.2% (derived from density independent simulations using the worst case suite of demographic rates). Since adults comprise an estimated 53% of the population, this level of adult mortality (200) is equivalent to a total mortality of 377 distributed across all ages (i.e. in excess of the predicted 332). However, if an extremely precautionary assumption is made that all of the mortality is confined to adults, this would indicate a reduction in the growth rate of 0.4%. Thus, even at the maximum predicted decline in growth rate (0.4%) this level of mortality represents a very small risk to the population's conservation status.

314. Natural England's assessment for the Hornsea Project One development included consideration of the level of annual mortality which the Flamborough and Filey Coast SPA population could sustain. Natural England advised that the outputs from a precautionary PBR calculation (using a recovery factor of 0.1) indicated that the mortality threshold for the Flamborough and Filey Coast SPA population should be 512 (Planning Inspectorate 2014). Although Natural England no longer advocate the use of PBR for windfarm assessments, the results remain informative in terms of the relative predicted effects.

315. The in-combination mortality of 347 individuals (all age classes) apportioned to the Flamborough and Filey Coast SPA is clearly well below this threshold. Note also that the PBR figure of 512 related only to the breeding adult component of the population. Of the total predicted mortality of 332, the breeding adults would be estimated to comprise 176 (53% of the population, Furness 2015). Thus, the adult threshold of 512 is more than two and a half times the equivalent in-combination adult mortality of 176.

316. It is, therefore, concluded 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.

4.5.2.5 Conclusion

317. The decline in the kittiwake population observed since the population was designated for Flamborough Head & 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.

318. 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.

319. The number of predicted in-combination kittiwake collisions attributed to the Flamborough & Filey Coast SPA remains below the sustainable levels estimated using PBR and this level would not trigger a risk of population decline based on population viability analysis modelling and despite the precautionary nature of collision risk assessments. Furthermore, the effect on the Flamborough and Filey Coast SPA kittiwake population resulting from in-combination collisions is below the thresholds of concern as proposed for recently consented developments. Therefore, 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 in-combination with other projects.

5 Marine Mammals Assessment of Effects

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

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

5.1 Project Details

5.1.1 Worst-Case Scenario

321. 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 700g (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 piling (represents worst case scenario for underwater noise, alternative foundation types are also considered)	Number of wind turbines	Up to 75 (250m wind turbines) or 60 (300m wind turbines)	
	Number of offshore platforms	4 x Electrical 1 x Met mast 1 x Construction, operation and maintenance = 6	
	Wind turbine foundation options	Monopile = piled Quadropod (4-leg) jacket = pin-piles	Hammer piled platforms 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	

Potential Effect	Parameter	Maximum worst-case	Notes
	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 foundation	Wind turbines = 1 monopile or 4 pin-piles Electrical platforms = 8 pin-piles per platform Met mast = 1 monopile or 4 pin-piles Construction, OandM 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 Construction, operation and maintenance platform = 8 pin-piles	Maximum number of pin-piles for all platform foundations is 44.
	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 -	Maximum hammer energy = 4,000kJ for 300m wind	This is the worst-case scenario with potential

Potential Effect	Parameter	Maximum worst-case	Notes
	monopiles	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.	underwater noise impacts greater than 3,000kJ for 250m wind turbine monopile.
	Hammer energy – pin-piles	Maximum hammer energy = 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.	This is the worst-case scenario with potential underwater noise impacts greater than 1,800kJ for 250m wind turbine pin-piles.
	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).	4.6m diameter is the worst-case scenario for pin-piles, with potential underwater noise impacts greater than 4m diameter for 250m wind turbines and 2.5m diameter pin-piles for met mast (confirmed with INSPIRE light assessment).
	Total piling time – per wind	325 minutes (5.42hrs) x 60 (300m wind turbines)	The maximum hammer piling

Potential Effect	Parameter	Maximum worst-case	Notes
	turbine foundation for monopiles (including soft-start and ramp-up and providing allowance for issues such as low blow rate, refusal, etc.)	monopiles = 2325 hours (13.5 days)	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 minutes, including soft-start and ramp-up x 75 x 4).

Potential Effect	Parameter	Maximum worst-case	Notes
	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)	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	Cable installation methods	Trenching (potential noisiest cable installation method)	

Potential Effect	Parameter	Maximum worst-case	Notes
such as seabed 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 Tugs and storage barges	

Potential Effect	Parameter	Maximum worst-case	Notes
		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 0.01km^2 Increased suspended sediments and sediment re-deposition = approximately 0.004km^3 Underwater noise during piling = parameters as outlined above.	See ***PEIR 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

Potential Effect	Parameter	Maximum worst-case	Notes
		Underwater noise from activities, including UXO clearance = parameters as outlined above.	turbines and platform foundation installation, cable installation, footprint of jack up barges and boulder clearance. The worst case suspended sediment and deposition is modelled in ***PEIR 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 activities such as seabed preparations, cable installation 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.		
	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	

Potential Effect	Parameter	Maximum worst-case	Notes
	Annual number of maintenance activities requiring the use of a cable laying vessel (inter-array, platform link and export cable)	5	
	Annual number of geophysical surveys required for non-intrusive inspection (for example, of cable burial/scour).	4	
Underwater noise from operational wind turbines	Number of wind turbines	Up to 75 (250m wind turbines) or 60 (300m wind turbines)	
	Wind turbine size	250-300m blade tip height	
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 = $0.002km^2$. Increased suspended sediments and sediment re-deposition = $0.000335km^3$ Underwater noise = parameters as outlined above Electromagnetic fields (EMF) = 435km maximum cable length (as outlined above).	See ***PEIR Chapter 10 Fish and Shellfish Ecology*** The overall total footprint which could be subject to permanent habitat loss from gravity based foundations, platform foundations, scour

Potential Effect	Parameter	Maximum worst-case	Notes
			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.
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 *in situ* while unburied sections would be cut at the ends and removed. Scour and cable protection would also be left *in situ.*		
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 Southern North Sea cSAC / SCI

322. In January 2017, the SNS cSAC was submitted to the European Commission to become designated as a SAC. As a cSAC it is legally afforded the same protection as a SAC. Harbour porpoise is the primary and only listed feature of the site. The SNS cSAC was adopted as a SCI by the European Commission and therefore is referred throughout as the SNS cSAC / SCI.

323. The majority of the site 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 cSAC / SCI, Margate and Long Sands SAC, Haisborough, Hammond and Winterton cSAC / SCI and North Norfolk Sandbanks and Saturn Reef cSAC / SCI, all of which have important sandbank and gravel beds.

324. The SNS cSAC / SCI has been recognised as an area with persistent high densities of harbour porpoise (JNCC 2017b). The SNS cSAC / SCI has a surface area of 36,715km^2 and covers both winter and summer habitats of importance to harbour porpoise, with approximately 27,018km^2 of the site being important in the summer and 12,697km^2 of the site being important in the winter period (***Figure 5***; JNCC 2017b).

325. The SNS cSAC Site Selection Report (JNCC 2017b) identifies that the SNS cSAC 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).

326. The Statutory Nature Conservation Bodies (SNCBs) current advice on the assessment of impacts on the SNS harbour porpoise cSAC / SCI 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 cSAC / SCI 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 cSAC / SCI at any one time and or on average

exceed 10% of the seasonal component of the SNS cSAC / SCI over the duration of that season.

- The effect of the project should be considered in the context of the seasonal components of the SNS cSAC / SCI, rather than the SNS cSAC / SCI as a whole.
- A buffer of 10km around seismic operations and 26km around UXO detonations should be used to assess the area of cSAC / SCI habitat from which harbour porpoise may be disturbed.

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

- Inclusion of seismic surveys within 10km of the SNS cSAC / SCI;
- Inclusion of projects undertaking percussive piling within 26km from the SNS cSAC / SCI boundary (or relevant seasonal component); and
- Inclusion of UXO detonation within 26km of the SNS cSAC / SCI.

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

5.2.1 Conservation Objectives

329. The draft Conservation Objectives for the SNS cSAC / SCI 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.

330. The draft Conservation Objectives for the site are (JNCC and Natural England 2016):

To avoid deterioration of the habitats of the harbour porpoise or significant disturbance to the harbour porpoise, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to maintaining Favourable Conservation Status (FCS) for the UK harbour porpoise.

To ensure for harbour porpoise that, subject to natural change, the following attributes are maintained or restored in the long term:

1. *The species is a viable component of the site;*
2. *There is no significant disturbance of the species; and*

3. *The supporting habitats and processes relevant to harbour porpoises and their prey are maintained*.

331. These draft Conservation Objectives *'are based on considerations of the ecological requirements of the species within the site, yet their interpretation is contextualised in their contribution to maintaining[4] FCS at a wider scale. With regard the Southern North Sea site, harbour porpoise need to be maintained rather than restored'* (JNCC and Natural England 2016).

1. The Species is a Viable Component of the Site

332. This Conservation Objective is designed to minimise risk posed to harbour porpoise viability by activities within the site, such as activities that could kill, injure or significantly disturb harbour porpoise.

333. Harbour porpoise are considered to a *viable component of the site* if they are able to live successfully within it. As this site has been selected for its long term preferential use by harbour porpoise within the North Sea, it is assumed that it provides optimal habitat for breeding, calving and foraging (JNCC and Natural England 2016).

334. 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.

335. 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*'.

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[4] Maintain implies that, based on our existing understanding, the feature is regarded as being in favourable condition and will, subject to natural change, remain in this condition after designation (JNCC and Natural England 2016).

2. There is no significant disturbance of the species

336. The aim of this Conservation Objective is to ensure that the site contributes, as best as it can, to maintaining the FCS of the wider harbour porpoise population in the North Sea. Therefore, JNCC and Natural England (2016) state that '*it is how the impacts within the site translate into effects on the North Sea MU population that are of greatest concern*'.

337. As outlined above, JNCC and Natural England (2016) note that due the mobile nature of this species the concept of a 'site population' may not be appropriate for this species. JNCC (2017a) therefore advise that assessments of effects of plans or projects (i.e. HRA) need to take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals.

338. Disturbance of harbour porpoise may lead to displacement from an area, and the temporary loss of habitat. As such, JNCC and Natural England (2016) suggest that activities within the SNS cSAC / SCI should be managed to ensure access to the site; and any disturbance should not lead to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time.

3. The supporting habitats and processes relevant to harbour porpoise and their prey are maintained.

339. 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.

340. 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 cSAC / SCI will not affect this.

5.2.2 Management Measures

341. Specific management measures are yet to be developed for the SNS cSAC / SCI, 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*'.

342. 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*'.

5.2.3 Advice on Activities

343. JNCC and Natural England (2016) have provided draft advice on activities that specifically occur within or near to the SNS cSAC / SCI site that could be expected to impact on the site's integrity. The key impacts and activities that JNCC and Natural England (2016) consider to have the greatest impact on the population of UK harbour porpoise and therefore the SNS cSAC / SCI 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.

344. 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 2016).

345. For the purposes of this assessment, the potential effects are considered in relation to the SNS cSAC / SCI draft Conservation Objectives; as outlined in ***Table 5.2***.

Table 5.2 Potential effects of East Anglia TWO in relation to the draft Conservation Objectives for the Southern North Sea cSAC / SCI

Draft Conservation Objective	Potential Effect
The species 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

Draft Conservation Objective	Potential Effect
	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 supporting habitats and processes relevant to harbour porpoises and their prey are maintained.	Changes in prey availability have potential to affect the site and will be considered further.

5.2.4 Harbour Porpoise Status and Ecology

346. 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***), Preliminary Environmental Information Report (PEIR) ***Chapter 11 Marine Mammals*** and PEIR ***Appendix 11.1***.

5.2.4.1 Density Estimates

5.2.4.1.1 SCANS-III

347. 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/km^2 (CV = 0.38; Hammond et al. 2017).

5.2.4.1.2 East Anglia TWO Site Specific Surveys

348. 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 11.1*** of the PEIR 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 11.1*** of the PEIR.

349. The information included in this assessment is based on 21 months of survey for the proposed East Anglia TWO project (November 2015 to April 2016, September 2016 to October 2017, and May 2018). The complete 24 months of survey data (adding June to August 2018) will be included in the final HRA for submission with the Development Consent Order (DCO) application.

350. The annual mean density estimate when using the seasonal correction factors is 0.71/km^2 for the East Anglia TWO windfarm site. The density estimate during

summer (April to September) is 0.41/km^2 and during the winter (October to March) the estimated density is 1.01/km^2 using the corrected densities.

351. The East Anglia TWO windfarm site density estimate of 0.71/km^2, 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.

5.2.4.2 Reference Population

352. 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.

5.2.4.3 Conservation Status

353. 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).

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	0.71/km^2 for the East Anglia TWO windfarm site*	Site specific surveys (see PEIR ***Appendix 11.1***)
	0.607/km^2	SCANS-III survey block L (Hammond et al. 2017)

5.2.5 Assessment of Potential Effects on Southern North Sea cSAC / SCI

354. 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 cSAC / SCI have been agreed in consultation with the marine mammal ETG as part of the EPP.

355. The assessment has been based on the current SNCB advice outlined in ***section 5.2***.

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

356. 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.

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

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

358. There is the likley requirement for UXO clearance prior to construction. Whilst any underwater UXO that are identified would preferentially be avoided or removed from the seabed and disposed of onshore in a suitable area, 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.

359. 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 24 hour period.

360. A number of UXOs with a range of charge weights could be located within the East Anglia TWO 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 within the 24 hour period.

361. 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.

362. 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.

363. The impact criteria use thresholds and weightings based on the National Oceanic and Atmospheric Administration (NOAA) (National Marine Fisheries Services (NMFS) 2018) criteria. 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.

5.2.5.1.1.1 Risk of permanent auditory injury during UXO clearance

364. Underwater noise modelling (***Appendix 11.3*** of the PEIR) 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***).

365. 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***).

366. 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. As outlined in ***Appendix 11.3*** of the PEIR, 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.

367. 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 porpoise (***Table 5.5***).

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* (km²)			
Permanent auditory injury (PTS) – without mitigation	SPL_{peak} unweighted (NMFS 2018) 202 dB re 1 µPa Impulsive criteria	7.8km (191km²)	8.8km (243km²)	10.2km (327km²)	11.1km (387km²)
	SEL weighted (NMFS 2018) 155 dB re 1 µPa²s Impulsive criteria	2.1km (14km²)	2.5km (20km²)	3.1km (30km²)	3.6km (41km²)
	SEL weighted (NMFS 2018) 173 dB re 1 µPa²s Non-impulsive criteria	0.093km (0.03km²)	0.11km (0.04km²)	0.14km (0.06km²)	0.17km (0.09km²)

<table>
<tr><th rowspan="3">Potential effect</th><th rowspan="3">Criteria threshold</th><th colspan="4">Possible maximum charge weight</th></tr>
<tr><th>200kg</th><th>300kg</th><th>500kg</th><th>700kg</th></tr>
<tr><th colspan="4">Maximum predicted impact range (km) and area* (km^2)</th></tr>
<tr><td colspan="2">Maximum number of harbour porpoise and % of reference population based on maximum impact area* (387km^2) for PTS unweighted SPL_{peak}</td><td colspan="4">235 harbour porpoise (0.07% of NS MU) based on SCANS-III survey density (0.607/km^2).
275 harbour porpoise (0.08% of NS MU) based on site specific survey density (0.71/km^2) at EA2.</td></tr>
<tr><td colspan="2">Number of harbour porpoise and % of reference population based on maximum impact area* (0.09-41km^2) for PTS weighted SEL impulsive and non-impulsive criteria</td><td colspan="4">0.06-25 harbour porpoise (0.00002-0.007% of NS MU) based on SCANS-III survey density (0.607/km^2).
0.06-29 harbour porpoise (0.00002-0.008% of NS MU) based on site specific survey density (0.71/km^2) at EA2.</td></tr>
</table>

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

Mitigation

368. A detailed Marine Mammal Mitigation Protocol (MMMP) will be prepared for UXO clearance. 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.

369. 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).

370. 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 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.
- 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.

371. The PTS SPL_{peak} criteria and maximum impact range is the most appropriate to use for the MMMP. As outlined in ***Appendix 11.3*** of the PEIR, 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 SELs.

372. It is important to note that an impulsive wave tends to be smoothed (i.e. the pulse becomes longer) over distance (see ***Appendix 11.3*** of the PEIR) 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.

373. 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.

374. The effective implementation of the UXO MMMP will reduce the risk of permanent auditory injury (PTS) to harbour porpoise during any underwater detonations at East Anglia TWO (alone), therefore, there would be **no potential**

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

375. An EPS licence application, if required, will be submitted post-consent. At this time, pre-construction UXO surveys will have been conducted and full consideration will have been given to any necessary mitigation measures that may be required following the development of the MMMP for UXO clearance.

5.2.5.1.1.2 Potential disturbance during UXO clearance

376. 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

377. The current SNCBs recommendation is that an EDR of 26km (approximate area of 2,124km^2) around UXO detonations is used to assess the area that harbour porpoise could be disturbed in the SNS cSAC / SCI. 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 cSAC / SCI seasonal areas, based on the worst-case scenario for UXO clearance at East Anglia TWO (***Table 5.6***).

378. Only one UXO at a time would be detonated during UXO clearance operation at East Anglia TWO offshore development area; there would be no concurrent UXO detonations.

379. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.6 Estimated Area of SNS cSAC / SCI 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 cSAC / SCI	Minimum potential overlap with SNS cSAC / SCI	Average potential overlap with SNS cSAC / SCI	Potential adverse effect on site integrity
UXO detonation in East Anglia TWO offshore development area	2,124km^2 (approximately 16%) in the winter area 160km^2 (approximately 0.6%) 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 80km^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 cSAC / SCI area at any one time during any UXO clearance at East Anglia TWO (alone), based on the worst-case scenario.

Seasonal averages

380. 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.

381. 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 cSAC / SCI 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).

382. The assessment indicates, less than 10% (approximately 7%) of the seasonal component of the SNS North Sea cSAC / SCI 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 (2,124km^2) (***Table 5.7***). Therefore, under these circumstances, there would be **no significant**

disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.

383. 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 cSAC / SCI 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 (2,124km^2) (***Table 5.7***). Therefore, under these circumstances, there would be **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

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

UXO clearance	Number of UXO clearance days per season	Average area within SNS cSAC / SCI seasonal areas	Estimated seasonal area average	Potential adverse effect on site integrity
UXO detonations in the offshore development area	**One detonation per day**			**No** Temporary effect. Disturbance of harbour porpoise would not exceed 10% of the seasonal component of the SNS cSAC / SCI over the duration of that season during any UXO clearance at East Anglia TWO (alone)
	80 days	Winter area = 16% Summer area = 0.6%	Winter area = 7% Summer area = 0.3%	
	Two detonations per day			
	40 days	Winter area = 16% Summer area = 0.6%	Winter area = 3.5% Summer area = 0.1%	

Assessment in relation to the North Sea Management Unit

384. 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***.

385. As outlined above, only one UXO would be detonated at a time during UXO clearance operations in the offshore development area.

386. The assessment indicates that without mitigation, 0.4% 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 anticipated adverse effect on the integrity of the SNS cSAC / SCI 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 (2,124km²) during underwater UXO clearance - based on 26km	1,289 harbour porpoise based on SCANS-III density (0.607/km²). 1,508 harbour porpoise based on site specific survey density (0.71/km²).	0.4% of NS MU (345,373 harbour porpoise) 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 any UXO clearance at East Anglia TWO (alone), based on the worst-case scenario.

387. In addition, the number of harbour porpoise that could be displaced during underwater UXO clearance at East Anglia TWO has been estimated based on the maximum potential Temporary Threshold Shift (TTS) / fleeing response range (***Table 5.9***). The TTS onset thresholds based on the NOAA (NMFS 2018) SEL weighted criteria is the point at which there is an increase in risk of temporary hearing impairment in an underwater receptor. 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.

388. As outlined in ***section 5.2.5.1.1.1***, modelling was conducted using both the impulsive and non-impulsive criteria to give an indication of the difference between maximum potential impact ranges.

389. The assessment indicates that, without mitigation, 0.4% of the North Sea MU reference population could be temporarily displaced (maximum TTS / fleeing range) during UXO clearance at East Anglia TWO (alone), based on the worst-case scenario (***Table 5.9***). Therefore, under these circumstances, **there is no**

anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.

Table 5.9 Potential Effects of Temporary Auditory Injury (TTS) / Fleeing Response on Harbour Porpoise during UXO Clearance without Mitigation

Potential effect	Criteria threshold	Possible maximum charge weight 200kg Maximum predicted impact range (km) and area* (km²)	300kg	500kg	700kg
Temporary auditory injury (TTS) / fleeing response – without mitigation	SPL_{peak} unweighted (NMFS 2018) 196 dB re 1 µPa Impulsive criteria	13km (531km²)	15km (707km²)	17km (908km²)	18km (1,018km²)
	SEL weighted (NMFS 2018) 140 dB re 1 µPa²s Impulsive criteria	17km (908km²)	20km (1,257km²)	23km (1,662km²)	25km (1,964km²)
	SEL weighted (NMFS 2018) 153 dB re 1 µPa²s Non-impulsive criteria	2.9km (26km²)	3.4km (36km²)	4.3km (58km²)	5km (79km²)
Maximum number of harbour porpoise and % of reference population based on maximum impact area* (1,018km²) for TTS unweighted SPL_{peak}		618 harbour porpoise (0.18% of NS MU) based on SCANS-III survey density (0.607/km²). 723 harbour porpoise (0.2% of NS MU) based on site specific survey density (0.71/km²).			
Number of harbour porpoise and % of reference population based on maximum impact area* (79-1,964km²) for TTS weighted SEL impulsive and non-impulsive criteria		48-1,192 harbour porpoise (0.01-0.35% of NS MU) based on SCANS-III survey density (0.607/km²). 56-1,394 harbour porpoise (0.02-0.4% of NS MU) based on site specific survey density (0.71/km²).			

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

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

390. 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 and pile diameter for the maximum potential duration to install (***Table 5.1***).

5.2.5.1.2.1 Risk of permanent auditory injury during piling

391. 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 11.3*** of the PEIR) 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 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 of 2,400kJ and starting hammer energy of 10% maximum hammer energy (240kJ).

392. 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 5.10***.

393. Without any mitigation, the estimated maximum number of harbour porpoise that could potentially be at risk of PTS as a result of a single strike of the maximum monopile hammer energy of 4,000kJ is 3.3 individuals (0.00096% of the North Sea MU reference population), based on the site specific density for East Anglia TWO (0.71 harbour porpoise per km^2).

394. 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 of 4,000kJ, including the soft-start and ramp-up is up to 68.2 individuals (0.02% of the North Sea MU reference population). As a result of the maximum pin-pile hammer energy of 2,400kJ, the estimated maximum number of harbour porpoise that could potentially be at risk of PTS from cumulative SEL is up to 689 harbour porpoise (up to 0.2% of the North Sea MU reference population), based on the site specific density for East Anglia TWO (***Table 5.10***).

Table 5.10 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). 3.3 harbour porpoise (0.00096% of NS MU) based on site specific survey density (0.71/km^2).			
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). 0.355 harbour porpoise (0.0001% of NS MU) based on site specific survey density (0.71/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). 689 harbour porpoise (0.2% of NS MU) based on site specific survey density (0.71/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

395. 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.

396. 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.

397. 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).

398. 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.

399. The activation of ADDs 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 5.10***).

400. The proposed mitigation of 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 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 for monopiles of 4,000kJ, based on the unweighted SPL_{peak} NOAA (NMFS 2018) criteria (***Table 5.10***).

401. 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 (see ***Appendix 11.3*** of the PEIR) 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. Where possible, this will be considered when determining the required mitigation zone.

402. 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), therefore, there would be **no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

403. Although the proposed mitigation will increase the distance of harbour porpoise from the piling location, it cannot mitigate the potential disturbance to harbour porpoise.

5.2.5.1.2.2 Potential disturbance during proposed mitigation

404. 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 2.54km^2. This is approximately 0.02% of the winter SNS cSAC / SCI area (12,697km^2), where the East Anglia TWO windfarm site is located (***Figure 5***). Therefore, disturbance of harbour porpoise would not exceed 20% of the seasonal component of the cSAC / SCI 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 cSAC / SCI over the duration of that season as a result of the proposed 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

405. 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 1.8 individuals (0.00052% of the NS MU reference population), based on the site specific density for East Anglia TWO (0.71 harbour porpoise per km^2). The assessment indicates that up to 0.00052% of the NS MU reference population could be temporarily affected as a result of the proposed ADD activation before piling at East Anglia TWO (alone). Therefore, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

406. 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.

407. It should be noted that the disturbance of harbour porpoise as a result of the proposed 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 proposed ADD activation prior to piling has been taken into account, as a worst-case scenario, in the assessment of the duration of potential disturbance for piling.

5.2.5.1.2.3 Potential disturbance during piling

Spatial assessment

408. The current SNCBs recommendation is that an EDR of 26km (approximate area of 2,124km^2) around pile locations is used to assess the area that harbour porpoise could be disturbed in the SNS cSAC / SCI. 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 cSAC / SCI seasonal areas, based on the worst-case scenario for underwater noise during piling at East Anglia TWO (***Table 5.11***).

409. There will be no concurrent piling at the East Anglia TWO windfarm site, therefore, the potential effects have been assessed for single pile installation only.

410. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI area at any one time during piling at East Anglia TWO (alone), based on the worst-case scenario (***Table 5.11***). Therefore, under these circumstances, **there is no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.11 Estimated Area of SNS cSAC / SCI Winter and Summer Areas that Harbour Porpoise Could Potentially be Disturbed from During Piling at East Anglia TWO

Piling	Maximum potential overlap with SNS cSAC / SCI	Minimum potential overlap with SNS cSAC / SCI	Average potential overlap with SNS cSAC / SCI	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 160km^2 (approximately 0.6%) 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 80km^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 cSAC / SCI area at any one time during piling at East Anglia TWO (alone), based on the worst-case scenario.

Seasonal averages

411. 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 potential 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.

412. 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, would be up to 41.6 days.

413. 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 cSAC / SCI 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).

414. 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.

415. 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 cSAC / SCI 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 5.12***). Therefore, under these circumstances, there would be **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.12 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 0.3% average overlap) = 0.07%	**No** Temporary effect. Disturbance of harbour porpoise would not on average exceed 10% of the seasonal component of the cSAC area over the duration of that season.

416. Based on maximum potential overlap with the SNS cSAC / SCI 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.

417. 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.

418. 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.

Assessment in relation to the North Sea Management Unit

419. 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 5.13***. As outlined above, there would be no concurrent piling at East Anglia TWO.

420. 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 5.13***). Therefore, under these circumstances, **there is no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

421. 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.

422. The assessment indicates that, without mitigation, 0.8% 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 5.13***). Therefore, under these circumstances, **there is no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

423. The assessment indicates that, without mitigation, 0.5% 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 5.13***). Therefore, under these circumstances, **there is no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.13 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 ($0.607/km^2$). 1,508 harbour porpoise based on site specific survey density ($0.71/km^2$).	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^2s 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 ($0.71/km^2$).	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) 42.5 harbour porpoise based on SCANS-III density ($0.607/km^2$). 49.7 harbour porpoise based on site specific survey density ($0.71/km^2$).	0.012% of NS MU based on SCANS-III density. 0.014% of NS MU based on the site specific survey density.	**No** Temporary effect. 0.014% 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^2s impulsive criteria; NMFS 2018).	Up to $1,500km^2$ for monopiles (4,000kJ) 910.5 harbour porpoise based on SCANS-III density ($0.607/km^2$). 1,065 harbour porpoise based on site specific survey density ($0.71/km^2$).	0.26% of NS MU based on SCANS-III density. 0.3% of NS MU based on the site specific survey density.	**No** Temporary effect. 0.3% 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 ($0.607/km^2$). 2,840 harbour porpoise	0.7% of NS MU based on SCANS-III density. 0.8% of NS MU based on	**No** Temporary effect. 0.8% 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
	based on site specific survey density (0.71/km²).	the site specific survey density.	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 µPa²s criteria	Up to 4,600km² for monopiles (4,000kJ) 2,094 harbour porpoise based on SCANS-III density (0.607/km²). 2,499.5 harbour porpoise based on site specific survey density (0.71/km²).	0.6% of NS MU based on SCANS-III density. 0.7% of NS MU based on the site specific survey density.	**No** Temporary effect. 0.7% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
	Up to 4,500km² for pin-piles (2,400kJ) 2,049 harbour porpoise based on SCANS-III density (0.607/km²). 2,395 harbour porpoise based on site specific survey density (0.71/km²).	0.6% of NS MU based on SCANS-III density. 0.7% of NS MU based on the site specific survey density.	**No** Temporary effect. 0.7% or less of the reference population could be temporarily disturbed during single pile installation at East Anglia TWO (alone).
50% disturbed in maximum range for a possible behavioural response – based on Lucke et al. (2009) SEL unweighted 145 dB re 1 µPa²s criteria	Up to 4,600km2 for monopiles (4,000kJ) 1,396 harbour porpoise based on SCANS-III density (0.607/km²). 1,633 harbour porpoise based on site specific survey density (0.71/km²).	0.4% of NS MU 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 single pile installation at East Anglia TWO (alone).
	Up to 4,500km² for pin-piles (2,400kJ) 1,366 harbour porpoise based on SCANS-III density (0.607/km²). 1,597.5 harbour porpoise based on site specific survey density (0.71/km²).	0.4% of NS MU based on SCANS-III density. 0.5% of NS MU based on the site specific survey density.	

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

424. Possible sources of underwater noise during non-piling construction activities, include seabed preparation, rock dumping and cable installation. The results of the underwater noise modelling (***Table 5.14***) 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.

425. 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.

Table 5.14 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 µPa^{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 µPa^{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 µPa	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.*

<u>Spatial assessment</u>

426. 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 activites 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 5.14)***.

427. The offshore development area (436km^2) is approximately 3% of the SNS cSAC / SCI winter area (12,697km^2).

428. Disturbance of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

429. 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 5.15***). The offshore development area is located entirely within the SNS cSAC / SCI winter area (***Figure 5***), therefore the potential effects of non-piling construction activities would only affect the winter area during the winter period.

430. Disturbance of harbour porpoise would not on average exceed 10% (approximately 3%) of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.15 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

Potential effect area	Duration based on worst-case scenario	Maximum seasonal area average	Potential adverse effect on site integrity
			average exceed 10% of the seasonal component of the cSAC / SCI area over the duration of that season.

Assessment in relation to the North Sea Management Unit

431. 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 5.16***. The assessment indicates that up to 0.09% 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 anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.16 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 ($436km^2$)	265 harbour porpoise based on SCANS-III survey density ($0.607/km^2$). 310 harbour porpoise based on site specific survey densities ($0.71/km^2$).	0.08% of NS MU based on SCANS-III density. 0.09% of NS MU based on site specific survey density	**No** Temporary effect. Maximum of 0.09% of the reference population could be temporarily displaced from the total offshore development area.

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

432. 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.

433. The results of the underwater noise modelling (***Table 5.17***) 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.

434. 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.

435. 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 (0.07km^2). Therefore for 74 large vessels the potential area of possible behavioural response for harbour porpoise is up to 5.2km^2 (1.2% of the 436km^2 total offshore development area).

Table 5.17 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.*

436. 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 5km^2 area).

437. 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 (436km^2) there would be approximately 0.85 vessels per 5km^2, therefore this would not exceed the Heinänen and Skov (2015) threshold.

438. The marine traffic baseline survey (see PEIR ***Chapter 14 Shipping and Navigation***), indicates that during the summer survey, an average of 74

vessels per day passed within the East Anglia TWO study area, recorded on AIS and Radar. During winter, an average of 71 vessels per day passed within the East Anglia TWO study area.

439. 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 (approximately 78.5 vessels per day) and approximately 6.3% increase in the number of vessels during the winter periods (approximately 75.5 vessels per day), 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 5km^2 area.

440. A study on the effects of the construction of offshore windfarms within the German North Sea between 2009 and 2013 on harbour porpoise (Brandt et al. 2016), indicated significant decreases in porpoise detections prior to piling at distances of up to 10km, which is thought to relate to increased shipping activity during preparation works.

441. 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 5.17***).

Spatial assessment

442. As outlined above, the East Anglia TWO total offshore development area (436km^2) is approximately 3% of the SNS cSAC / SCI winter area.

443. Disturbance of harbour porpoise would not exceed 20% (approximately 3%) of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

444. 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 5.15***).

445. Disturbance of harbour porpoise would not on average exceed 10% (approximately 3%) of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

446. The estimated number of harbour porpoise that could be disturbed as a result of construction vessels at East Anglia TWO is presented in ***Table 5.16***. The assessment indicates that approximately 0.09% 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 anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

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

447. 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.

448. 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.

449. The spatial worst-case is the maximum area over which potential disturbance could occur at any one time based on single foundation installation (2,124km^2) and UXO clearance (2,124km^2).

450. As outlined in ***section 5.2.5.1.9***, 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.

451. As outlined in ***section 5.2.5.1.9***, the duration of potential disturbance, based on the worst-case scenario could be up to 80 days.

452. 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.

453. To reduce the potential for any adverse effect on the integrity of the winter area of SNS cSAC / SCI 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.

454. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

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

455. During the construction of East Anglia TWO there will be an increase in vessel traffic, with an estimated average of 136 trips per month. 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.

456. 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.

457. 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).

458. 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).

459. 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 5.18***).

460. 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.

461. 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.

462. 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.

463. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

Table 5.18 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 (436km^2)	13-26.5 harbour porpoise based on SCANS-III survey density. 15.5-31 harbour porpoise based on site specific survey density at EA2.	0.004-0.008% of NS MU based on SCANS-III density. 0.005-0.01% of NS MU based on site specific survey density.	**No** Maximum of 0.01% of the reference population at potential increased risk.

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

464. 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.

465. 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 11.3*** of the PEIR) 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 of 4,000kJ) and up to 6km for recoverable injury (based on maximum potential ranges for SEL cumulative exposure for pin-piles with maximum hammer energy). TTS and behavioural impacts could occur up to 29km (based on maximum potential ranges for SEL cumulative exposure).

466. The maximum potential area of temporary physical disturbance and/or temporary loss of habitat to fish during construction could be approximately $9.97km^2$ in total, approximately 2.29% of the total offshore development area (see PEIR ***Chapter 10 Fish and Shellfish Ecology***).

467. 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 PEIR ***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 $0.008km^3$ (see PEIR ***Chapter 9 Benthic Ecology***).

468. 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 5.16***). 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.

469. 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

470. As outlined above, the East Anglia TWO total offshore development area (436km^2) is approximately 3% of the SNS cSAC / SCI winter area.

471. 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 cSAC / SCI at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

Seasonal averages

472. 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 5.15***).

473. 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 cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

474. 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 0.09% of the NS MU reference population, based on the worst-case scenario (***Table 5.16***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

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

475. 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 PEIR ***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.

476. 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. Therefore, the potential for pollutants to be released into the environment is not considered further in this assessment.

477. 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 PEIR ***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.

478. 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 PEIR ***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.

479. As outlined above and in PEIR ***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.

480. 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

481. As outlined above, the East Anglia TWO total offshore development area (436km^2) is approximately 3% of the SNS cSAC / SCI winter area.

482. 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 cSAC /SCI at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

Seasonal averages

483. 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 5.15***).

484. 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 cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

Assessment in relation to the North Sea Management Unit

485. 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 0.09% of the NS MU reference population,

based on the worst-case scenario (***Table 5.16***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

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

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

486. 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.

487. Only one UXO would be detonated at a time during UXO clearance operations at East Anglia TWO. There would also be no concurrent piling at East Anglia TWO.

<u>Spatial assessment</u>

488. ***Table 5.19*** outlines the potential maximum, minimum and average overlap with the seasonal areas of the SNS cSAC / SCI, 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 anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.

489. To reduce the potential for any adverse effect on the integrity of the winter area of SNS cSAC / SCI 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 on the same day at the East Anglia TWO site during the winter period. Therefore, under these circumstance, there would be **no potential for an anticipated adverse effect on the integrity of the SNS cSAC / SCI winter area in relation to the conservation objectives for harbour porpoise**.

490. 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 anticipated adverse effect on the integrity of the SNS cSAC / SCI summer area in relation to the conservation objectives for harbour porpoise**.

Table 5.19 Estimated Area of SNS cSAC / SCI 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 cSAC / SCI	Minimum potential overlap with SNS cSAC / SCI	Average potential overlap with SNS cSAC / SCI	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** The Applicant, if required, would ensure UXO detonation and piling would not occur on the same day at the East Anglia TWO windfarm site during the winter period.
UXO detonation in cable corridor and piling at windfarm site - summer area	186km^2 (approximately 0.7%) in the summer area	0km^2 (approximately 0%) in the summer area	93km^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 cSAC / SCI area at any one time during any UXO clearance and piling at East Anglia TWO (alone), based on the worst-case scenario.

Seasonal averages

491. 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.

492. 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).

493. This assessment is also based on the precautionary approach that the total duration for active piling and ADD activation could occur in one season.

494. The assessment indicates, 10% or less of the seasonal component of the SNS North Sea cSAC / SCI over the duration of that season could be affected during any UXO clearance and piling at East Anglia TWO (alone), based on the worst-case scenario of 41.6 days piling and ADD activation (see ***section 5.2.5.1.2.3***) or 80 days of UXO clearance per season (see ***section 375***) and average area overlap (***Table 5.20***). Therefore, under these circumstances, there would be **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.20 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 5.2.5.1.2.3***)	Winter area (based on average 23% overlap) = 5.26% Summer area (based on average 0.3% overlap) = 0.07%	**No** Temporary effect. Disturbance of harbour porpoise would not on average exceed 10% of the seasonal component of the cSAC area over the duration of that season.
	80 days of UXO clearance per season (see ***section 375***)	Winter area (based on average 23% overlap) = 10% Summer area (based on average 0.3% overlap) = 0.13%	

Assessment in relation to the North Sea Management Unit

495. The maximum potential area of disturbance is 4,248km^2, based on 26km disturbance range around each piling location and UXO location, and assuming no overlap in the potential impact areas.

496. 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 5.21***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.21 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). 3,016 harbour porpoise based on site specific survey density (0.71/km^2).	0.75% of NS MU (345,373 harbour porpoise) based on SCANS-III density. 0.87% of NS MU based on the site specific survey density at EA2.	**No** Temporary effect. Less than 0.9% 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.

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

497. 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 vessels, in the offshore cable corridor.

Spatial assessment

498. Disturbance of harbour porpoise during piling and other construction activities, including vessels would not exceed 20% (up to 17.8%) of the seasonal component of the SNS cSAC / SCI during any construction at East Anglia TWO (alone), based on the worst-case scenario (***Table 5.22***). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.22 Estimated Area of SNS cSAC / SCI 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 cSAC / SCI	Minimum potential overlap with SNS cSAC / SCI	Average potential overlap with SNS cSAC / SCI	Potential adverse effect on site integrity
Piling at windfarm site and other construction activities and vessels in cable corridor	2,264km² (approximately 17.8%) in the winter area (with up to 2,124km² from piling and 140.4km² of cable corridor) 160km² (approximately 0.6%) in the summer area (with up to 160km² from piling and 0km² of cable corridor)	2,166.5km² (approximately 17%) in the winter area (with up to 2,124km² from piling and 42.8km² of cable corridor) 0km² (approximately 0%) in the summer area (with up to 0km² from piling and 0km² of cable corridor)	2,215km² (approximately 17.4%) in the winter area (with up to 2,1247km² from piling and 91.6km² of cable corridor) 80km² (approximately 0.3%) in the summer area (with up to 0km² from piling and 0km² of cable corridor)	**No** Temporary effect. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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

499. 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 5.22***) and worst-case scenarios of 41.6 days of piling and ADD activation (see ***section 5.2.5.1.2.3***) and all 182 days in winter period for other construction activities and vessels.

500. 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 7.8%) of the seasonal component of the SNS cSAC / SCI area over the duration of that season (***Table 5.23***). Therefore, under these circumstances, there **is no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.23 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 and vessels in offshore cable corridor	41.6 days of piling per season (see ***section 5.2.5.1.2.3***)	Winter area (based on average 17.8% overlap) = 4.07% Summer area (based on average 0.6% overlap) = 0.14%	**No** Temporary effect. Disturbance of harbour porpoise would not on average exceed 10% of the seasonal component of the cSAC area over the duration of that season.
	182 days of other construction activities and vessels	Winter area (based on average 17.8% overlap) = 7.8% Summer area (based on average 0.6% overlap) = 0.3%	

Assessment in relation to the North Sea Management Unit

501. 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 5.24***).

502. 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 5.24***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.24 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 2,264km^2 area of disturbance during pile installation (2,124km^2) at windfarm site and disturbance from other	1,374 harbour porpoise based on SCANS-III density (0.607/km^2). 1,607 harbour porpoise based on site specific survey density (0.71/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-

Potential effect	Estimate number in area	% of reference population	Potential adverse effect on site integrity
construction activities and vessels in the cable corridor (140km^2)			combination with construction and vessels at East Anglia TWO (alone), based on the worst-case scenario.

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

503. 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.

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

504. 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 cSAC / SCI 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); and
- Changes to prey resource.

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

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

506. 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.

507. The Marine Management Organisation (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.

508. 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).

509. 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 11.3*** of the PEIR for further information).

510. 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 5.25***).

511. 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 (0.02km^2). Therefore for 60 300m wind turbines the potential area of possible behavioural response for harbour porpoise is up to 1.2km^2 (0.47% of the 255km^2 East Anglia TWO windfarm site).

Table 5.25 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 µPa^{2}s non-impulsive criteria	<0.1km (0.031km^2)

Potential Impact	Criteria and threshold	Operational wind turbines (300m) modelled impact ranges (km) (and areas* (km^2))
	HF SEL_{cum}	
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 153 dB re 1 µPa²s non-impulsive criteria HF SEL_{cum}	<0.1km (0.031km²)
Possible behavioural response	Lucke et al. (2009) Unweighted SEL 145 dB re 1 µPa	0.08km (0.02km²)

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

Spatial Assessment

512. The East Anglia TWO windfarm site (255km²) is approximately 2% of the winter SNS cSAC / SCI.

513. The maximum area of potential PTS or TTS from cumulative exposure for 60 300m wind turbines is 1.86km², based on the underwater noise modelling (***Table 5.25***), is approximately 0.015% of the winter SNS cSAC / SCI (12,697km²).

514. The maximum area of possible behavioural response (1.2km²), based on the underwater noise modelling (***Table 5.25***), is approximately 0.0095% of the winter SNS cSAC / SCI.

515. 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 cSAC / SCI at any one time. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

516. 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 5.26***).

Table 5.26 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 cSAC / SCI)	Throughout the winter period (182 days).	2% of the SNS cSAC / SCI winter area.	**No** Displacement of harbour porpoise would not on average exceed 10% of the seasonal component of the SNS cSAC / SCI area over the duration of that season.
Maximum potential area for PTS or TTS from cumulative exposure (0.015% of the winter area)	Throughout the winter period (182 days).	0.015% of the SNS cSAC / SCI winter area.	
Maximum area of possible behavioural response (0.0095% of the winter SNS cSAC / SCI)	Throughout the winter period (182 days).	0.01% of the SNS cSAC / SCI winter area	

517. 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 cSAC / SCI, based on the worst-case scenario (***Table 5.26***). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

518. 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 0.05% or less of the NS MU reference population, based on the worst-case scenario of disturbance from the entire windfarm site (***Table 5.27***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.27 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(255km²)	155 harbour porpoise based on SCANS-III density (0.607/km²). 181 harbour porpoise based on site specific survey density	0.05% of NS MU based on SCANS-III density. 0.05% of NS MU based on site specific	**No** Long-term (not permanent) effect. Maximum of 0.05% of the

Potential effect	Estimate number in area	% of reference population[1]	Potential adverse effect on site integrity
	(0.71/km²).	survey density.	reference population could be disturbed.
Maximum potential area for PTS or TTS from cumulative exposure (1.86km²)	1.13 harbour porpoise based on SCANS-III density (0.607/km²). 1.32 harbour porpoise based on site specific survey density (0.71/km²).	0.0003% of NS MU based on SCANS-III density. 0.0004% 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 area of possible behavioural response (1.2km²)	0.73 harbour porpoise based on SCANS-III density (0.607/km²). 0.85 harbour porpoise based on site specific survey density (0.71/km²).	0.0002% of NS MU based on SCANS-III density. 0.00025% of NS MU based on site specific survey density.	**No** Long-term (not permanent) effect. Maximum of 0.00025% of the reference population could have a possible behavioural response.

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

519. 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.

520. 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 5.14***).

521. 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

522. The East Anglia TWO offshore development area (436km²) is approximately 3% of the SNS cSAC / SCI winter area (12,697km²).

523. Disturbance of harbour porpoise would not exceed 20% (up to 3%) of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

524. 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 5.15***).

525. 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 cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

Assessment in relation to the North Sea Management Unit

526. The estimated maximum number of harbour porpoise that could potentially be disturbed during maintenance activities at East Anglia TWO (alone) is less than 0.09% of the NS MU reference population, based on the worst-case scenario of 100% disturbance from the entire offshore development area (***Table 5.16***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

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

527. 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***).

528. As outlined in ***section 5.2.5.1.4***, the results of the underwater noise modelling (***Table 5.17***) 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.

529. 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.

530. 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 ($0.071km^2$). Therefore, for two large vessels per day the potential maximum area of possible behavioural response for harbour porpoise is $0.142km^2$ (0.033% of the $436km^2$ total offshore development area).

531. 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.

532. 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 $5km^2$ (approximately 16 vessels per km^2). 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

533. The East Anglia TWO offshore development area ($436km^2$) is approximately 3% of the winter SNS cSAC / SCI.

534. The maximum area of possible behavioural response to vessels during operation and maintenance ($0.142km^2$), based on the underwater noise modelling (***Table 5.17***), is approximately 0.0011% of the winter SNS cSAC / SCI.

535. 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 cSAC / SCI at any one time. Therefore, under these circumstances, there is no **significant**

disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.

Seasonal average

536. 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 5.15***).

537. 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 cSAC / SCI. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

538. 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 0.09% of the NS MU reference population, based on the worst-case scenario (***Table 5.16***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

539. For the two large vessels per day during operation and maintenance the number of harbour porpoise that could potentially be disturbed is 0.09 (0.00002% of NS MU). Therefore, under these circumstances, there is no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.

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

540. 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***).

541. 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.

542. Following the precautionary worst-case scenario approach in ***section 5.2.5.1.6***, 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 5.18***).

543. 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.

544. 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.

545. 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.

546. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.**

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

547. 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).

548. 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 2.025km^2 in total at East Anglia TWO, up to 0.5% of the East Anglia TWO offshore development area (***Table 5.1***).

549. 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 PEIR ***Appendix 11.3***).

550. 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). In addition, EMFs are expected to attenuate rapidly in both horizontal and vertical plains with distance from the source. Therefore, any potential effect of EMF on fish species would not be expected to be significant.

Spatial assessment

551. 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 (436km^2), approximately 3% of the winter SNS cSAC / SCI. 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 2km^2), up to 0.02% of the SNS cSAC / SCI winter area.

552. 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 cSAC / SCI. Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

553. 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 5.15***).

554. 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 cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Assessment in relation to the North Sea Management Unit

555. 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 0.09% of the NS MU reference population, based on the worst-case scenario (***Table 5.16***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

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

556. 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.

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

557. 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); and
- Changes to prey resource.

558. 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.

5.2.5.3.1 Potential disturbance from the underwater noise associated with foundation removal

559. 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.

560. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise).

561. 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.

562. 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 anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

5.2.5.3.2 Potential disturbance from vessels

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

5.2.5.3.3 Possible vessel interaction (collision risk)

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

5.2.5.3.4 Potential changes to prey resource

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

5.2.5.3.5 Potential changes to water quality

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

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

567. 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.

5.2.5.4 Summary of potential effects of East Anglia TWO Alone

568. ***Table 5.28*** summarises the potential effects of East Anglia TWO alone.

Table 5.28 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 cSAC / SCI 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.	0.4% 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 cSAC / SCI area (up to 16% of the winter area; up to 0.6% of summer area) at any one time and on average would not exceed 10% (up to 7%) of the seasonal component of the SNS cSAC / SCI 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	Without mitigation, up to 0.2% of the NS MU	N/A Assessment based on number of	**No (with the implementation**

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
underwater noise during piling.	reference population could be at increased risk.	individuals at potential risk.	**of MMMP for piling)**
Potential disturbance from underwater noise during proposed mitigation (e.g. 10 minute ADD activation)	0.00052% 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 cSAC / SCI area (up to 0.02% of the winter area) at any one time and on average would not exceed 10% (up to 0.02%) of the seasonal component of the SNS cSAC / SCI area over the duration of that season.	**No**
Potential disturbance from underwater noise during piling.	0.8% 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 cSAC / SCI area (up to 16% of the winter area; up to 0.6% of summer area) at any one time and on average would not exceed 10% (up to 3.66%) of the seasonal component of the SNS cSAC / SCI 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 0.09% 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 cSAC / SCI 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 cSAC / SCI 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 0.09% of the NS MU reference population could be	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of	**No**

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
	temporarily disturbed.	the SNS cSAC / SCI 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 cSAC / SCI area over the duration of that season.	
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 0.01% 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 0.09% 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 cSAC / SCI 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 cSAC / SCI 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 0.09% 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 cSAC / SCI 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 cSAC / SCI area over the duration of that	**No**

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
		season.	
Potential overall effects during UXO clearance and piling at East Anglia TWO (alone)			
UXO detonation in cable corridor and piling at windfarm site – winter	Up to 0.9% of the reference population could be temporarily disturbed.	Temporary displacement of harbour porpoise could exceed 20% of the seasonal component of the SNS cSAC / SCI area (up to 29.5% of winter area) at any one time, but would not on average exceed 10% of the seasonal component of the SNS cSAC / SCI area over the duration of that season.	**No** The Applicant, if required, would ensure UXO detonation and piling would not occur on the same day at the East Anglia TWO windfarm site during the winter period.
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 cSAC / SCI area (up to 0.7% 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 cSAC / SCI 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 cSAC / SCI area (up to 17.8% of winter area; up to 0.6% of summer area) at any one time and on average would not exceed 10% (up to 7.8%) of the seasonal component of the SNS cSAC / SCI area over the duration of that season.	**No**
Operation and maintenance at East Anglia TWO (alone)			
Potential disturbance from the underwater noise associated with operational turbines at 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 cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
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 cSAC / SCI 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 cSAC / SCI 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 0.09% 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 cSAC / SCI 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 cSAC / SCI 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 0.09% 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 cSAC / SCI 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 cSAC / SCI area over the duration of that season.	**No**
Possible vessel interaction (collision risk) during operation and maintenance at East Anglia TWO (alone)			
Possible vessel interaction (collision risk).	Up to 0.01% of the NS MU reference population could be at increased risk.	N/A	**No**

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
Potential changes to prey resource during operation and maintenance at East Anglia TWO (alone)			
Potential changes to prey resource.	Up to 0.09% of the NS MU reference population could be displaced.	Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI 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 0.09% of the NS MU reference population could be displaced.	Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI area over the duration of that season.	**No**
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 0.09% 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 cSAC / SCI 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 cSAC / SCI area over the duration of that season.	**No**
Potential disturbance from vessels			
Potential disturbance from underwater noise and disturbance from	Up to 0.09% of the NS MU reference population could be	Temporary displacement of harbour porpoise would not exceed 20% of the seasonal component of	**No**

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
vessels.	temporarily disturbed.	the SNS cSAC / SCI 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 cSAC / SCI area over the duration of that season.	
Possible vessel interaction (collision risk)			
Possible vessel interaction (collision risk).	Up to 0.01% of the NS MU reference population could be at increased risk.	N/A	**No**
Potential changes to prey resource			
Potential changes to prey resource.	Up to 0.09% 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 cSAC / SCI 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 cSAC / SCI area over the duration of that season.	**No**
Potential changes to water quality			
Potential changes to water quality.	Up to 0.09% 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 cSAC / SCI 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 cSAC / SCI area over the duration of that season.	**No**
Potential overall effects during decommissioning			
Potential overall effects during decommissioning.	Up to 0.09% 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 cSAC / SCI area (up to 3% of winter area) at any one time	**No**

Potential effect	Assessment in relation to the North Sea MU population	Spatial assessment and seasonal averages in relation to the SNS cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
		and on average would not exceed 10% (up to 3%) of the seasonal component of the SNS cSAC / SCI area over the duration of that season.	

5.2.5.5 Potential in-combination effects

569. 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.

570. 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.

571. 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.

572. The assessment is based on the in-combination effects of projects using the tiered approach as outlined in ***Table 5.29*** 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 5.29 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 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	High uncertainty and limited data or

Tier	Consenting or Construction Phase	Certainty and Data Availability
	relevant strategic plans or programmes	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.

573. 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 cSAC / SCI or within 26km of the SNS cSAC / SCI boundary.

574. 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.

575. Therefore, the assessment will be based on the most realistic worst-case scenario. To help reduce any uncertainty and highly unrealistic worst-case scenarios while still providing a conservative assessment. Careful consideration has been undertaken to determine the most realistic worst-case scenario for the in-combination assessment.

576. The level of uncertainty in completing an in-combination assessment further supports the need for strategic assessment rather than developer or project led assessment. Population models, such as the Disturbance Effects on the Harbour Porpoise Population in the North Sea (DEPONS) and the interim Population Consequences of Disturbance (iPCoD) used at a strategic level would allow consideration of the biological fitness consequences of disturbance from underwater noise, and the conclusions of a quantitative assessment to be put into a population level context (e.g. Nabe-Nielsen et al. 2018). The Applicant is supportive of these strategic initiatives, and will continue to work alongside other developers, Regulators and SNCBs in order to further

understand the potential for significant in-combination effects, and how to reduce these effects, where appropriate.

5.2.5.5.1 Potential disturbance from underwater noise during offshore windfarm piling

577. 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.

578. The commitment to the MMMP for UXO clearance (see ***section 5.2.5.1.1.1***) and the MMMP for piling (see ***section 5.2.5.1.2.1***) 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.

579. 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 cSAC / SCI (as outlined in ***section 5.2***).

580. 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 adius of 26km from each piling location (2,124km^2 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 (4,248km^2 per project).

581. 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 5.30***).

582. 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.

583. 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.

584. 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.

585. As outlined in ***section 5.2.5.1.2.3***, 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.

586. 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 relativelylow (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.

Table 5.30 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 (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	Up to 900	Up to 75	2020 (2020-2027)	2025 - 2027	Yes
Tier 3: consented						
Creyke Beck A, UK	261	500-600	200	Feb-15 (2015-2022)	2021-2027	Yes[2]
Creyke Beck B, UK	283	500-600	200	Feb-15 (2015-2022)	2021-2028	No[2]
Teesside A, UK	295	1,200	200	Aug-15 (2015-2022)	2021-2028	No[2]
Sophia (formerly Teesside B), UK	281	1,200	200	Aug-15 (2015-2022)	2020-2028	Yes[2]
East Anglia THREE, UK	47	1,200	172	Aug-17 (2017-2024)	Piling: 2020 – 2022	No
Hornsea Project Two, UK	158	1,800	225	Aug-16 (2016-2023)	2018-2021 Piling: 2018-2020	No

Name and country of project	Distance from East Anglia TWO (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
Triton Knoll phase 1-3, UK	143	1,200	288	Jul-13 (2013-2020)	2018-2021	No
Kincardine (floating turbines)	588	49.6	8	2017 (2017-2024)	2018-2019	No
Mermaid (Belgium)	44	366-288	24-48	2015 (2015-2022)	2017-2019	No
Northwester 2 (Belgium)	44	224	22-38	2015 (2015-2022)	Unknown	No
Vesterhav Nord/Syd (Denmark)	604	344	41	2016 (2016-2023)	Unknown	No
Eoliennes du Calvados (France)	334	450	75	2016 (2016-2023)	Unknown	No
Parc éolien en mer de Fécamp (France)	262	498	83	2016 (2016-2023)	Unknown	No
Borkum Riffgrund West II (Germany)	333	240	16-18	2017 (2017-2024)	Unknown	No
Gode Wind 03 (Germany)	387	110	7-8	2016	2020	No

Name and country of project	Distance from East Anglia TWO (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
				(2016-2023)		
Gode Wind 04 (Germany)	385	131.75	9-10	2009 (2009-2016)	2023	No
Kaskasi (Germany)	446	235	34	2018 (2018-2025)	2018-2022	No
Delta Nordsee 1 (Germany)	358	210	35	2005	2023	No
Delta Nordsee 2 (Germany)	358	192	32	2009	2023	No
Hollandse Kust Zuid Holland I and II – Chinook (Netherlands)	115	580	91	2018 (2018-2025)	2023	No
Borssele I and II (Netherlands)	56	350+350	95+95	May-16 (2016-2023)	2019	No
Borssele III and IV (Netherlands)	56	360+340	95+95	May-16 (2016-2023)	2020	No
Borssele Site V - Leeghwater - Innovation Plot (Netherlands)	57	20	2	May-16 (2016-2023)	2020	No

Name and country of project	Distance from East Anglia TWO (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
Windpark Fryslan (Netherlands)	217	382.7	89	2018 (2018-2025)	2019-2021	No
Tier 4: application submitted or project on-hold						
Norfolk Vanguard	57	1,800	90-200	2019 (2019-2026)	Construction and piling: 2024 – 2028	Yes[3]
Thanet Extension	69	340	34	2019 (2019-2026)	2024-2028	No[3]
Hornsea Project Three	172	2,400	319	2019 TBC (2019-2026)	Construction: 2022-2029 Piling: 2022-2023 and 2027-2028	No
Firth of Forth Phase 1 Seagreen Alpha and Bravo, UK	525	1,050	150	Oct-14 original consent	Unknown – on-hold	No
Inch Cape, UK	534	784	110	Oct-14 original consent	Unknown – on-hold	No
Neart na Gaoithe, UK	516	448	75	Oct-14 original consent	Unknown – on-hold	No
Moray Firth West	716	750	90	2018	Unknown – on-hold	No
Dounreay Tri	129	10	2	2017	Unknown – project postponed	No

Name and country of project	Distance from East Anglia TWO (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
				(2017-2024)		
Tier 5: application in preparation						
Norfolk Boreas	73	1,800	90-200	2020 (2020-2027)	Construction and piling: 2025 – 2029	No[3]
East Anglia ONE North	10	Up to 800	Up to 67		2026 - 2028	No[4]
Hornsea Project Four	175	Up to 1,000	Up to 180	Unknown	Unknown	No

[1]Piling and offshore construction dates are based on the latest dates and information available.
[2]It 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.
[3]Based 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.
[4]Based on the most efficient and most likely build scenario, the Applicant would conduct piling at only one site at a time, with East Anglia ONE North following East Anglia TWO.

Spatial assessment

587. For each project, the area of potential disturbance for single and concurrent piling that overlaps the SNS cSAC / SCI winter and summer areas has been estimated, based on the worst-case scenarios for the maximum, minimum and average overlap.

588. The offshore windfarms included in the assessment are located within the SNS cSAC / SCI or less than 26km from the boundary of the SNS cSAC / SCI (***Table 5.30***).

589. The potential 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.

590. This highly conservative potential 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 5.30***):

- Creyke Beck A;
- Sofia (formerly Teesside B); and
- Norfolk Vanguard.

591. 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.

592. The estimated maximum, minimum and average overlap with the SNS cSAC / SCI winter and summer areas if all four offshore windfarms were single piling at exactly the same time is outlined in ***Table 5.31***, taking into account the overlap in disturbance areas (***Figures 6*** and ***7***). The assessment indicates that less than 20% of the SNS cSAC / SCI 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 cSAC / SCI winter area based on the maximum potential overlap for single piling at the four offshore windfarms (***Table 5.31***).

593. For the potential worst-case scenario, with single piling at East Anglia TWO and concurrent piling at Creyke Beck A, Sofia and Norfolk Vanguard (***Figures 8*** and ***9***), the assessment indicates that less than 20% of the SNS cSAC / SCI winter and summer areas would be affected based on the minimum potential overlap.

However, there is the potential to exceed 20% of the SNS cSAC / SCI winter and summer areas based on the maximum and average potential overlap (***Table 5.31***).

594. The scenarios presented in this assessment are indicative of what the actual in-combination scenarios 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.

595. The approach to the in-combination assessment, based on the four UK 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 be concurrently piling at exactly the same time or even on the same day as piling at East Anglia TWO.

596. 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 5.31 Estimated Maximum, Minimum and Average Overlap with SNS cSAC / SCI 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 cSAC / SCI	Minimum overlap with SNS cSAC / SCI	Average overlap with SNS cSAC / SCI
Potential worst-case scenario (4 offshore windfarms) – single piling	Maximum overlap with winter area* = 3,058km^2 (22.9%) Maximum overlap with summer area[1] = 5,376km^2 (19.8%)	Minimum overlap with winter area[1] = 2,128km^2 (15.9%) Minimum overlap with summer area[1] = 3,500km^2 (12.9%)	Average overlap with winter area = 2,593km^2 (19.4%) Average overlap with summer area = 4,438km^2 (16.4%)
Potential worst-case scenario (4 OWFs) – EA2 single piling and others concurrent piling	Maximum overlap with winter area* = 3,364km^2 (25.2%) Maximum overlap with summer area* = 7,241km^2 (26.7%)	Minimum overlap with winter area[1] = 2,129km^2 (15.9%) Minimum overlap with summer area[1] = 3,593km^2 (13.3%)	Average overlap with winter area = 2,746km^2 (20.5%) Average overlap with summer area = 5,417km^2 (20%)

[1]using Norfolk Vanguard East as the worst-case scenario
**using Norfolk Vanguard West as the worst-case scenario*

597. 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.

598. In the absence of current site management measures for the Southern North Sea cSAC / SCI, it is difficult to state with any certainty what the potential impact on site integrity will be for in-combination effects. 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.

599. With the use of appropriate mitigation and management measures across projects and managed by the MMO, it is considered that there could be **no significant disturbance and no adverse effect on the integrity of the SNS cSAC / SCI 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

600. 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 cSAC / SCI and number of days piling per season).

601. 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.

602. The assessment indicates that on average, more than 10% of the SNS cSAC / SCI over the duration of that season could be affected (***Table 5.32***), based on the average potential overlap of the winter and summer areas for piling at the four offshore windfarms occurring at the same time.

603. 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.

604. The assumptions outlined above are highly conservative and with management from the MMO, 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise as a result of in-combination effects from underwater noise during offshore windfarm piling**.

Table 5.32 Estimated Seasonal Averages based on Average Overlap with SNS cSAC / SCI 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 cSAC / SCI area	Number of potential piling days per season	Average overlap with SNS cSAC / SCI	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 = 16.4% Single piling at EA2 and concurrent piling at other sites = 20%	Single piling = 15.5% Single piling at EA2 and concurrent piling at other sites = 18.9%

Assessment in relation to the North Sea Management Unit

605. 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.

606. The OWFs that were considered in this assessment were those located within the North Sea MU, not just in the SNS cSAC or within 26km of the SNS cSAC (***Table 5.30***).

607. This highly conservative potential 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 5.30***):

- Creyke Beck A;
- Sofia (formerly Teesside B); and
- Norfolk Vanguard.

608. 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.

609. 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 14,868km^2, 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 5.33***).

610. Based on a single pile installation at each of the four offshore windfarms, the estimated maximum area of potential disturbance is 8,496km^2, 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 5.33***).

Table 5.33 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

Name of Project	SCANS-III survey block	SCANS-III density estimate (No/km²)	Potential number of harbour porpoise disturbed during single piling (2,124km²)	Potential number of harbour porpoise disturbed during concurrent piling with no overlap (4,248km²)
Sofia	O[2]	0.837	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%**	**4%**

[1]Norfolk Vanguard East is located in SCANS-III survey block L, [1]Norfolk 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.
[2]Sofia overlaps SCANS-III survey block O and N, but majority of site is in block O.

611. 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 concurrently piling at exactly the same time is overly precautionary.

612. 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 5% of the estimated construction period).

613. 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%.

614. With 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise as a result of in-**

combination effects from underwater noise during offshore windfarm piling.

615. 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.

5.2.5.5.2 Potential disturbance from other noise sources

616. 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;
- Offshore windfarm construction activities and vessels (excluding piling); and
- Offshore windfarm operation and maintenance, including vessels.

617. 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.

5.2.5.5.2.1 Unexploded ordnance

618. The commitment to the MMMP for UXO clearance at East Anglia TWO, as outlined in ***section 5.2.5.1.1.1***, 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.

619. 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 cSAC / SCI, as outlined in ***section 5.2***, 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.

620. This assessment has been based on the potential for disturbance from one UXO detonation in the North Sea area.

621. 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).

622. It is also 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 (2,124km^2) in this assessment is considered a worst-case scenario.

Spatial assessment

623. If one UXO detonation was undertaken, the potential area of disturbance could be (2,124km^2) which would be approximately 16% of the winter area or 8% of summer area.

624. Displacement of harbour porpoise would not exceed 20% of the seasonal components of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

625. It is currently not possible to determine the number of days per season that UXO clearance, if undertaken, could be in the SNS cSAC / SCI 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.

626. 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.

627. The assessment indicates on average less than 10% of the seasonal component of the SNS cSAC / SCI over the duration of that season could be affected, if there was one UXO operation in the summer or winter area (***Table 5.34***). Therefore, under these circumstances, there would be **no significant disturbance and no adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.34 Estimated Maximum Seasonal Averages for In-Combination Effects of UXO Clearance Operations in the SNS cSAC / SCI Winter and Summer Areas

SNS cSAC / SCI area	Number of UXO clearance days per season	Maximum area within SNS cSAC / SCI	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

628. The potential disturbance area during a single UXO detonation, based on a radius of 26km from each location is 2,124km^2.

629. The SCANS-III harbour porpoise density estimate for the North Sea MU is 0.52/km^2 (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 5.35***).

630. The number of harbour porpoise that could potentially be disturbed during one UXO clearance operation would be up to 1,105 harbour porpoise (0.3% of the North Sea MU reference population). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.35 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 (0.3%)

5.2.5.5.2.2 Seismic surveys

631. 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 cSAC / SCI, as outlined in ***section 5.2***, and has been based on the following parameter:

- A distance of 10km around seismic operations has been used to assess the area that harbour porpoise could potentially be disturbed.

632. 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).

Spatial assessment

633. It is currently not possible to estimate the number of potential seismic surveys that could be undertaken in the SNS cSAC / SCI. It has therefore been assumed as a very worst-case scenario that there could potentially be up to two seismic surveys, one in the summer area and one in the winter area at any one time. Based on a potential range of 10km, the area of disturbance could be up to 314km^2, approximately 2.5% of the winter area and approximately 1.2% of the summer area.

634. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Seasonal averages

635. It is currently not possible to determine the number of days per season that seismic surveys, if undertaken, would be in the SNS cSAC / SCI summer and winter areas. Therefore, it has been assumed, as worst-case that each seismic survey could be up to 10 days. For example, seismic surveys 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 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).

636. The assessment indicates on average less than 10% of the seasonal component of the SNS cSAC / SCI over the duration of that season could be affected (***Table 5.36***). Therefore, under these circumstances, there is **no significant disturbance and no adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.36 Estimated Maximum Seasonal Averages for In-Combination Effects of Seismic Surveys in the SNS cSAC / SCI Winter and Summer Areas

SNS cSAC / SCI area	Number of potential seismic survey days per season	Maximum overlap with SNS cSAC / SCI area	Estimated seasonal average overlap with SNS cSAC / SCI 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

637. The potential disturbance area during a single seismic survey, based on a radius of 10km from each location is 314km^2.

638. The SCANS-III harbour porpoise density estimate for the North Sea MU is 0.52/km^2 (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 5.37***).

639. The number of harbour porpoise that could potentially be disturbed during one seismic survey would be up to 163 harbour porpoise (0.05% of the North Sea MU reference population).

640. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.37 Quantified In-Combination Assessment for the Potential Disturbance of Harbour Porpoise during Seismic Surveys 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%)

5.2.5.5.2.3Offshore windfarm construction, other than piling

641. 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.

642. 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 5.14***).

643. As a precautionary approach, the in-combination assessment considered all UK and European offshore windfarms in the southern North Sea which could potentially have construction activities, other than piling, during the East Anglia TWO construction period (***Table 5.30***). 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.

644. 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.

645. 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

646. For each project within (wholly or partly) the SNS cSAC / SCI, the area of the offshore windfarm site that overlaps the winter and summer areas has been estimated (***Table 5.38***).

647. The in-combination assessment indicates that if the six offshore windfarms were conducting construction activities, other than piling, the estimated maximum in-combination area of disturbance, based on the worst-case scenario of the entire offshore windfarm area, is 2,779km^2 (***Table 5.38***).

648. 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 237km^2, which represents approximately 1.9% of the winter SNS cSAC / SCI area (***Table 5.38***).

649. 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 1,347km^2, which represents approximately 5% of the summer SNS cSAC / SCI area (***Table 5.38***).

650. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI area at any one time. Therefore, under these circumstances, there is **no significant disturbance and no adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.38 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 cSAC / SCI area (km^2)	Area in summer cSAC / SCI 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	206	206	46
Total area	**2,779**	**237**	**1,347**
% of SNS cSAC / SCI area		1.9%	5%

Seasonal averages

651. 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).

652. The assessment indicates on average less than 10% of the seasonal component of the SNS cSAC / SCI over the duration of that season could be affected, based on 100% disturbance from the offshore windfarm areas (***Table 5.39***). Therefore, under these circumstances, there is **no significant disturbance and no adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.39 Estimated Maximum Seasonal Averages for In-Combination Effects of Construction Activities, other than Piling, in the SNS cSAC / SCI Winter and Summer Areas

SNS cSAC / SCI area	Number of days per season	Maximum overlap with SNS cSAC / SCI area	Estimated maximum seasonal average
Winter area	182 days	1.9%	1.9%
Summer area	183 days	3%	3%

Assessment in relation to the North Sea Management Unit

653. 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.

654. The in-combination assessment indicates that if all six of these offshore windfarms in the southern North Sea were conducting construction activities, other than piling, at the same time, the estimated maximum in-combination area of disturbance is 2,862km^2 and the maximum number of harbour porpoise that could potentially be disturbed is 2,434 individuals, which represents approximately 0.7% of the North Sea MU reference population (***Table 5.40***). Therefore, under these circumstances there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.40 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	206	125
Total			**2,862**	**2,434**
% of North Sea MU reference population (345,373 harbour porpoise)				0.7%

**Source: http://www.4coffshore.com/*
[1]Norfolk Boreas overlaps SCANS-III survey block O and L; therefore, higher density estimate from survey block O is used.

5.2.5.5.2.4 Offshore windfarm operation and maintenance

655. 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.

656. 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 5.14*** and ***Table 5.17***).

657. 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

658. For operational UK and European offshore windfarms within (wholly or partly) the SNS cSAC / SCI 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.

659. The in-combination assessment indicates that, based on the potential worst-case scenario, six UK offshore windfarms located in the SNS cSAC / SCI 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 915km^2 (***Table 5.41***).

660. Three of these windfarms is located in or overlaps with the summer area and the estimated maximum area of disturbance is 649km^2, which represents approximately 2.4% of the summer area (***Table 5.41***).

661. Three of these windfarms are located in the winter area and the estimated maximum in-combination area is 521km^2, which represents approximately 4.1% of the winter area (***Table 5.41***).

662. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS cSAC / SCI 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.41 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 cSAC / SCI area (km^2)	Area in summer cSAC / SCI 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 cSAC / SCI area		4.1%	2.4%

Seasonal averages

663. 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).

664. The assessment indicates on average less than 10% of the seasonal component of the SNS cSAC / SCI over the duration of that season could be affected, based on 100% disturbance from the offshore windfarm areas (***Table 5.42***). Therefore, under these circumstances, there is **no significant disturbance and no potential adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.42 Estimated Maximum Seasonal Averages for In-Combination Effects of Operational and Maintenance Activities at other Offshore Windfarms in the SNS cSAC / SCI Winter and Summer Areas

SNS cSAC / SCI area	Number of days per season	Average overlap with SNS cSAC / SCI 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

665. 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 3,860km^2 (based on disturbance from entire offshore windfarm area) and the maximum number of harbour porpoise that could be temporarily disturbed would be up to 2,345 individuals which represents approximately 0.7% of the North Sea MU reference population (***Table 5.43***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.43 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

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
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
Borssele III and IV	N	0.837	122	102
Borssele Site V	N	0.837	1	1
Deutsche Bucht (DeBu)	N	0.837	18	15
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
Eoliennes du Calvados	C	0.213	78	17
European Offshore Wind Deployment Centre EOWDC (Aberdeen Demonstration)	R	0.599	20	12
Galloper[1]	L	0.607	113	69

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
Gemini[1]	N	0.837	70	59
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
Hywind – Pilot Park[1]	R	0.599	15	9
Karmoy Marine Energy Test Centre (Metcentre)	V	0.137	1	0.137
Kaskasi[2]	M	0.277	17	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
Mermaid	N	0.837	16	13
Moray Firth East	S	0.152	295	45
Nissum Bredning Vind	P	0.823	5	4
Nobelwind	N	0.837	22	18

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
Nordergrunde[1]	M	0.277	3	1
Nordsee One (Innogy Nordsee I)	M	0.277	31	9
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 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
RennesØy Wind Turbine Demonstration Area[2]	V	0.137	1	0
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
Veja Mate[1]	N	0.837	51	43
Vesterhav Nord/Syd	P	0.823	10	8

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
Windpark Fryslan	N	0.837	35	29
Total			**3,860m^2**	**2,345**
% of North Sea MU reference population (345,373 harbour porpoise)				0.7%

**Source: http://www.4coffshore.com/*
[1]Operational after the start of the East Anglia TWO site specific surveys, but before the submission of the PEI
[2]Unknown date of project operation, but assumed to be before the construction of East Anglia TWO

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

666. The potential in-combination effects from all noise sources including offshore windfarm piling during construction at East Anglia TWO is summarised in ***Table 5.44***.

667. The maximum number of harbour porpoise that could potentially be temporarily disturbed is 12,964 individuals, which represents approximately 4% of the North Sea MU reference population (***Table 5.44***).

668. Based on the worst-case scenarios, there is the potential for up to 45% of the winter area, with a seasonal average of 38% or up to 31% of the summer area, with a seasonal average of 29%, to be affected.

669. 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.44 Quantified In-Combination Assessment for the Maximum Potential Disturbance of Harbour Porpoise in the North Sea MU and SNS cSAC / SCI 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 cSAC / SCI area (km^2) (% of seasonal area)	Area in summer cSAC / SCI area (km^2) (% of seasonal area)	Seasonal average for winter cSAC / SCI area	Seasonal average for summer cSAC / SCI 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%)	4,438km^2 (16.4%)	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	237km^2 (1.9%)	1,347km^2 (5%)	1.9%	3%	2,434 (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	482km^2 (3.6%)	52km^2 (0.2%)	4%	0.2%	2,315 (0.65%)
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%)	13.5%	1.8%	1,105 (0.3%)
Seismic surveys, based on up two locations, one in	314km^2	314km^2	0.14%	0.07%	163

Potential noise sources during construction at East Anglia TWO	Area in winter cSAC / SCI area (km^2) (% of seasonal area)	Area in summer cSAC / SCI area (km^2) (% of seasonal area)	Seasonal average for winter cSAC / SCI area	Seasonal average for summer cSAC / SCI area	Potential number of harbour porpoise disturbed (% of NS MU)
each seasonal area and maximum overlap with seasonal area	(2.5%)	(1.2%)			(0.05%)
Total (seasonal average based on up to 154 piling days in winter and 173 piling days in summer)	**5,750 (45%)**	**8,275 (31%)**	**38%**	**29%**	**12,964 (4%)**

5.2.5.5.4 Direct interaction: possible increased collision risk

670. An increase in vessel movements and wave / tidal arrays can pose a potential collision risk for harbour porpoise.

671. 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 wind farm 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 5.2.5.1.6***).

672. 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 5.2.5.2.4***). 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.

673. 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.

674. 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.

675. 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.

676. 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 214 individuals, which represents 0.06% of the North Sea MU

reference population (***Table 5.45***). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise**.

Table 5.45 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	255	8
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
East Anglia THREE	L	0.607	301	9
Norfolk Vanguard	O[1]	0.888	592	26
Norfolk Boreas	O[3]	0.888	727	32
Hornsea Project 3	O	0.888	695	31
Thanet Extension	L	0.607	73	2
East Anglia ONE North	L	0.607	206	6
Total				214
% of North Sea MU reference population (345,373 harbour porpoise)				0.06%

[1]NV 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.
[2]Dogger Bank Zone Teesside B overlaps SCANS-III survey block O & N, but majority of site is in block O.
[3]Norfolk Boreas overlaps SCANS-III survey block O & L; therefore higher density estimate from survey block O is used.
**Source: http://www.4coffshore.com/*

5.2.5.5.5 Indirect effects: potential changes in prey resources

677. 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.

678. 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.

679. 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.

680. 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 cSAC / SCI in relation to the conservation objectives for harbour porpoise arising from changes in prey resources**.

5.2.5.5.6 Potential in-combination effects during operation and maintenance

681. 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.

682. 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 cSAC / SCI 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**.

5.2.5.5.7 Summary of potential in-combination effects

683. ***Table 5.46*** 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 5.46 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 cSAC summer and winter areas	Seasonal average in relation to the cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
Disturbance from underwater noise	12,964 harbour porpoise (4% of NS MU)	Maximum overlap with winter area = 45% Maximum overlap with summer area = 31%	Seasonal average for winter area = 38% Seasonal average for summer area = 29%	The use of appropriate management measures to be implemented by the MMO would result in no significant disturbance and no

Potential Effect	Assessment in relation to the North Sea MU population	Spatial assessment in relation to the cSAC summer and winter areas	Seasonal average in relation to the cSAC / SCI summer and winter areas	Potential adverse effect on site integrity
				adverse effect on the integrity of the SNS cSAC / SCI in relation to the conservation objectives for harbour porpoise.
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.

5.2.6 Summary of potential effects for SNS cSAC / SCI

684. 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 cSAC / SCI where harbour porpoise are a qualifying feature (***Table 5.47***).

685. 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 cSAC / SCI for harbour porpoise that:

- Displacement of harbour porpoise should not exceed 20% of the seasonal component of the cSAC area at any one time and / or on average exceed 10% of the seasonal component of the cSAC area over the duration of that season.

686. In the absence of current management measures for the Southern North Sea cSAC / SCI, the Applicant is confident that use of appropriate management measures to be implemented by the MMO can be implemented to ensure no effect on the integrity of the Southern North Sea cSAC / SCI as defined by its conservation objectives from the proposed East Anglia TWO project alone. If required, an EPS licence application for harbour porpoise will be completed post consent, once the project design is defined. The EPS licence will be agreed with the MMO and will be based on best available information at the time, including industry best practice.

Table 5.47 Summary of the Assessment of the Potential Effects of East Anglia TWO (Alone and In-Combination) on the Southern North Sea cSAC / SCI 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
The species is a viable component of the site	×	×	×	×	×	×
There is no significant disturbance of the species	×	×	×	× (with appropriate MMMP and SIP, if required)	×	×
The supporting habitats and processes relevant to harbour porpoises and their prey are maintained	×	×	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives

5.3 The Wash and North Norfolk Coast SAC

687. 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).

688. The Wash and North Norfolk SACis located approximately 159km from the East Anglia TWO windfarm site at the closest point, 94km 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.

689. For the purposes of this assessment, the potential effects are considered in relation to the SAC Conservation Objectives; as outlined in ***Table 5.48***.

Table 5.48 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.

690. Grey seal are not currently a qualifying feature of The Wash and North Norfolk Coast SAC, however, it is recognised that Blakeney Point (located within the SAC) is important for breeding, moulting and haul-out sites. Therefore, consideration is given to grey seal as part of The Wash and North Norfolk Coast SAC.

691. Blakeney Point is located approximately 113km from the East Anglia TWO windfarm site and 120km from the landfall site. The Wash and North Norfolk Coast SAC was screened in to the HRA to take into account the movements of grey seal along the east coast of England.

692. As The Wash and North Norfolk Coast SAC is not designated for grey seal, the relevant Conservation Objectives for harbour seal will be used in the assessment (***Table 5.48***).

5.3.1 Harbour Seal Status and Ecology

693. The harbour seal count for the Wash in 2016 was 3,377 plus 424 harbour seal at Blakeney Point (SCOS 2017).

5.3.1.1 Reference populations

694. The reference population for the project-alone assessment is the south-east England MU of 5,061 harbour seal (SCOS 2017).

695. 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 2017) and the Wadden Sea region (TSEG 2017b).

696. The reference population for the in-combination assessments is therefore 43,161 harbour seal, 5,061 from the south-east England MU (SCOS 2017) plus 38,100 for The Wadden Sea (TSEG 2017b).

5.3.1.2 Density estimates

697. Twelve 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 2018 (21 months), these were not identified to species level (see ***Appendix 11.1*** of the PEIR (SPR 2019)).

698. 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).

699. 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/km^2
- The offshore cable corridor the density is estimated to be 0.01 harbour seal per km^2; and
- The overall density estimate for the offshore development area is 0.006 harbour seal per km^2.

5.3.2 Grey Seal Status and Ecology

700. The most recent August count (2016) of grey seal at haul-out sites was 355 grey seal at Blakeney Point and 431 at The Wash (SCOS 2017).

5.3.2.1 Reference populations

701. The Wash and North Norfolk Coast SAC and Blakeney Point are located in the south-east England MU (IAMMWG 2013), therefore the reference population to be used in the assessment will be the south-east England MU of 6,085 grey seal (SCOS 2017).

702. 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 2017) and the Wadden Sea region (TSEG 2017a).

703. The reference population for the in-combination assessments with other projects and plans is therefore 18,478, based on the most recent estimates for the:

- South-east England MU = 6,085 grey seal (SCOS 2017);
- North-east England MU = 6,948 grey seal (SCOS 2017); and
- Wadden Sea area = 5,445 grey seal (TSEG 2017a).

5.3.2.2 Density Estimates

704. As outlined in ***section 5.4.1.2***, 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 the density of grey seal is estimated to be 0.015/km^2;
- The offshore cable corridor the density is estimated to be 0.08 grey seal per km^2; and
- The overall density estimate for the offshore development area is 0.04 grey seal per km^2.

5.3.3 Assessment of Potential Effects on The Wash and North Norfolk Coast SAC

705. 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.

706. 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 and 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.

5.3.3.1 Potential disturbance of foraging seals from underwater noise

5.3.3.1.1 Potential disturbance of foraging seals from underwater noise during UXO clearance at East Anglia TWO (alone)

5.3.3.1.1.1 Risk of permanent auditory injury during UXO clearance

707. Underwater noise modelling (***Appendix 11.3*** of the PEIR) 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 5.49***).

708. The maximum number of harbour and 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 5.49***).

709. 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 and grey seal (***Table 5.49***).

Table 5.49 Potential Effects of Permanent Auditory Injury (PTS) on Harbour and 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 (9.08km²)	1.9km (11.34km²)	2.3km (16.62km²)	2.6km (21.24km²)
	SEL weighted (NMFS 2018) 185 dB re 1 µPa²s Impulsive criteria	1.0km (3.14km²)	1.2km (4.52km²)	1.5km (7.07km²)	1.8km (10.18km²)
	SEL weighted (NMFS 2018) 201 dB re 1 µPa²s Non-impulsive criteria	0.06km (0.01km²)	0.08km (0.02km²)	0.1km (0.03km²)	0.11km (0.04km²)
Maximum number of harbour seal (based on 0.006/km² density in the offshore development area) and % of SE England MU based on maximum impact area* (21.24km²) for PTS unweighted SPL_{peak}		Up to 0.13 harbour seal (0.0026% of SE England MU; 0.0034% of The Wash and Blakeney Point count).			
Number of harbour seal (based on 0.006/km² density in the offshore development area) and % of SE England MU based on maximum impact area* (10.18km²) for PTS weighted SEL impulsive criteria		Up to 0.061 harbour seal (0.0012% of SE England MU; 0.0016% of The Wash and Blakeney Point count).			
Maximum number of grey seal (based on 0.04/km² density in the offshore development area) and % of SE England MU based on maximum impact area* (21.24km²) for PTS unweighted SPL_{peak}		Up to 0.85 grey seal (0.014% of SE England MU; 0.11% of The Wash and Blakeney Point count).			
Number of grey seal (based on 0.04/km² density in the offshore development area) and % of SE England MU based on maximum impact area* (10.18km²) for PTS weighted SEL impulsive		Up to 0.41 grey seal (0.0067% of SE England MU; 0.052% of The Wash and Blakeney Point count).			

Potential effect	Criteria threshold	Possible maximum charge weight 200kg 300kg 500kg 700kg Maximum predicted impact range (km) and area* (km^2)
criteria		

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

Mitigation

710. As outlined in ***section 5.2.5.1.1.1***, a detailed MMMP will be prepared for UXO clearance. 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 relevant SNCBs and the MMO.

711. The effective implementation of the UXO MMMP will reduce the risk of permanent auditory injury (PTS) to harbour and grey 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 (and grey seal)**.

5.3.3.1.1.2 Potential disturbance from the underwater noise associated with UXO clearance

712. The SNCBs currently recommend that a potential disturbance range of 26km (approximate area of 2,124km^2) around UXO detonations is used to assess harbour porpoise disturbance in the SNS cSAC / SCI. 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 5.50***).

Table 5.50 Estimated Number of Harbour and 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	13 harbour seal (based on 0.006/km^2 density in the	0.26% of the South-East England MU (0.34% of	**No**

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
($2,124km^2$) during underwater UXO clearance - based on 26km	offshore development area). 85 grey seal (based on $0.04/km^2$ density in the offshore development area).	The Wash and Blakeney Point count). 1.4% of the South-East England MU (10.8% of The Wash and Blakeney Point count).	Temporary effect. 0.3% or 1.4% or less of the harbour and grey seal SE England MU, respectively, could be temporarily disturbed during any UXO clearance at East Anglia TWO (alone), based on the worst-case scenario.

713. 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.

714. 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 PEIR ***Chapter 11 Marine Mammals***) indicate that the number of harbour and grey seal is relatively low and infrequent.

715. It is highly unlikely that all harbour and grey seal in the East Anglia TWO offshore development area would be from The Wash and Blakeney Point, which is located over 94km from the offshore development area. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

716. Under these circumstances, there is no potential for any significant disturbance of harbour and grey seal foraging in and around the East Anglia TWO offshore development area. Therefore, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.2 Potential disturbance from the underwater noise associated with piling

5.3.3.1.2.1 Risk of permanent auditory injury during piling

717. 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 11.3*** of the PEIR) and determine the potential effects on harbour and grey seal. The modelling has been based on the worst-case scenarios for:

- Monopile up to 15m diameter with maximum hammer energy 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 of 2,400kJ and starting hammer energy of 10% maximum hammer energy (240kJ).

718. 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 5.51***.

719. The number of seals that could potentially be effected has been estimated based on the density estimates for the East Anglia TWO windfarm site (0.0007/km^2 for harbour seal and 0.015/km^2 for grey seal).

720. 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 (0.00000014% of the South-East England MU; 0.0000002% of The Wash and Blakeney Point count; ***Table 5.51***).

721. 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 0.00015 individuals (0.0000025% of the South-East England MU; 0.00002% of The Wash and Blakeney Point count; ***Table 5.51***).

722. 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 of 2,400kJ is 0.077 harbour seal (0.0015% of the South-East England MU; 0.002% of The Wash and Blakeney Point count).

723. 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

of 2,400kJ is 1.65 grey seal (0.027% of the South-East England MU; 0.2% of The Wash and Blakeney Point count).

Table 5.51 Maximum Predicted Impact Ranges (and Areas) for Permanent Auditory Injury (PTS) for Harbour and 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 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 **(0.01km^2)** for PTS unweighted SPL_{peak}		0.000007 harbour seal (0.00000014% of the South-East England MU; 0.0000002% of The Wash and Blakeney Point count).			
Number of grey seal (based on the 0.015/km^2 density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area **(0.01km^2)** for PTS unweighted SPL_{peak}		0.00015 grey seal (0.0000025% of the South-East England MU; 0.00002% of The Wash and Blakeney Point count).			
PTS without mitigation – single strike	NMFS (2018) SEL_{ss} weighted 185 dB re 1 µPa^2s	<0.05km (<0.01km^2)	0.06km (0.01km^2)	<0.05km (<0.01km^2)	0.06km (0.01km^2)
Number of harbour seal		0.000007 harbour seal (0.00000014% of the South-East England MU;			

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**
(based on the 0.0007/km^2 density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area **(0.01km^2)** for PTS weighted SEL_{ss}		0.0000002% of The Wash and Blakeney Point count).			
Number of grey seal (based on the 0.015/km^2 density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area **(0.01km^2)** for PTS weighted SEL_{ss}		0.00015 grey seal (0.0000025% of the South-East England MU; 0.00002% 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 μPa²s	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 **(110km^2)** for PTS weighted SEL_{cum}		0.077 harbour seal (0.0015% of the South-East England MU; 0.002% of The Wash and Blakeney Point count).			
Number of grey seal (based on the 0.015/km^2 density estimate for the EA2 windfarm site) and % of SE England MU based on maximum impact area **(110km^2)**		1.65 grey seal (0.027% of the South-East England MU; 0.2% of The Wash and Blakeney Point count).			

Potential effect	Criteria threshold	Maximum predicted impact range (km) and area* (km²)			
		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
for PTS weighted SEL_{cum}					

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

724. As outlined in ***section 5.2.5.1.1.1***, 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 and grey seal during piling.

725. The MMMP for piling will reduce the risk of permanent auditory injury to harbour and 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 Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal).**

5.3.3.1.2.2 Potential disturbance during proposed mitigation

726. 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 5.52 Estimated Number of Harbour and 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 (2.54km²) during ADD activation	0.0018 harbour seal (based on 0.0007/km² density in the windfarm site). 0.038 grey seal (based on 0.015/km² density in	0.000036% of the South-East England MU (0.00005% of The Wash and Blakeney Point count). 0.00062% of the South-East England MU (0.0048% of The Wash	**No** Temporary effect. 0.000036% or 0.00062% or less of the harbour and grey seal South-East England MU, respectively, could be temporarily disturbed

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
	the windfarm site).	and Blakeney Point count).	during ADD activation at East Anglia TWO (alone).

727. 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.

728. It is highly unlikely that all harbour and grey seal in the East Anglia TWO windfarm site would be from The Wash and Blakeney Point. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

729. 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 and grey seal in and around the East Anglia TWO windfarm site, there is no potential for any significant disturbance of foraging harbour and grey seal. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

730. 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.

5.3.3.1.2.3Potential disturbance during piling

731. 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 and harbour seal (***Table 5.57***). It is acknowledged that this is not Natural England's advice; however, this approach was agreed by the ETG.

732. In addition, the number of harbour and 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 5.53 Estimated Number of Harbour and 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	1.5 harbour seal (based on 0.0007/km^2 density in the windfarm site). 32 grey seal (based on 0.015/km^2 density in the windfarm site).	0.03% of the South-East England MU (0.04% of The Wash and Blakeney Point count). 0.5% of the South-East England MU (4% of The Wash and Blakeney Point count).	**No** Temporary effect. 0.03% or 0.5% or less of the harbour and grey seal South-East England MU, respectively, 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) 0.0017 harbour seal (based on 0.0007/km^2 density in the windfarm site). 0.036 grey seal (based on 0.015/km^2 density in the windfarm site).	0.00003% of the South-East England MU (0.000045% of The Wash and Blakeney Point count). 0.0006% of the South-East England MU (0.0045% of The Wash and Blakeney Point count).	**No** Temporary effect. 0.00003% or 0.0006% or less of the harbour and grey seal South-East England MU, respectively, 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) 0.91 harbour seal (based on 0.0007/km^2 density in the windfarm site). 19.5 grey seal (based on 0.015/km^2 density in the windfarm site).	0.018% of the South-East England MU (0.024% of The Wash and Blakeney Point count). 0.32% of the South-East England MU (2.5% of The Wash and Blakeney Point count).	**No** Temporary effect. 0.018% or 0.32% or less of the harbour and grey seal South-East England MU, respectively, could be temporarily disturbed during piling at East Anglia TWO (alone).
	Up to 1,600km^2 for pin-piles (2,400kJ) 1.12 harbour seal (based	0.022% of the South-East England MU (0.03% of	**No** Temporary effect.

Potential effect	Estimated number in area	% of reference population	Potential adverse effect on site integrity
	on 0.0007/km² density in the windfarm site). 24 grey seal (based on 0.015/km² density in the windfarm site).	The Wash and Blakeney Point count). 0.39% of the South-East England MU (3% of The Wash and Blakeney Point count).	0.022% or 0.39% or less of the harbour and grey seal South-East England MU, respectively, could be temporarily disturbed during piling at East Anglia TWO (alone).

733. 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.

734. It is highly unlikely that all harbour and grey seal in the East Anglia TWO windfarm site would be from The Wash and Blakeney Point. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

735. 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 and grey seal. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.3 Potential disturbance from underwater noise during non-piling construction and maintenance activities

736. Possible sources of underwater noise during non-piling construction activities, include seabed preparation, rock dumping and cable installation.

737. 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.

738. The results of the underwater noise modelling (***Table 5.54***) indicate that harbour and grey seal would have to remain in close proximity over a 24 hour preiod 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.

739. 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 5.54 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 µPa²s 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 µPa²s 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 ($0.031km^2$)
0.00019 harbour seal (0.000004% of the South-East England MU; 0.000005% of The Wash and Blakeney Point count) based on the 0.006/km² density estimate for the offshore development area.						
0.0012 grey seal (0.00002% of the South-East England MU; 0.00015% of The Wash and Blakeney Point count) based on the 0.04/km² density estimate for the offshore development area.						

740. 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 5.55***). This is very precautionary, as it is highly unlikely that construction and maintenance activities, other than piling activity, 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 5.55 Estimated Number of Harbour and 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 (436km^2)	2.6 harbour seal (based on 0.006/km^2 density in the offshore development area). 17 grey seal (based on 0.04/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). 0.3% of the South-East England MU (2.2% of The Wash and Blakeney Point count).	**No** Temporary effect. 0.00014% or 0.003% or less of the harbour and grey seal South-East England MU, respectively, could be temporarily disturbed during any UXO clearance at East Anglia TWO (alone).

741. It is highly unlikely that all harbour and grey seal in the offshore development area would be from The Wash and Blakeney Point. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

742. 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 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 and grey seal. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.4 Potential disturbance from vessels during construction, operation and maintenance

743. 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.

744. 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.

745. The results of the underwater noise modelling (***Table 5.56***) indicate that harbour and 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.

746. 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 5.56 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 µPa²s non-impulsive criteria PW SEL_{cum}	<0.1km (<0.031km²)	<0.1km (<0.031km²)
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 181 dB re 1 µPa²s non-impulsive criteria PW SEL_{cum}	<0.1km (<0.031km²)	<0.1km (<0.031km²)
Disturbance from 74 vessels (2.3km²) = 0.014 harbour seal (0.0003% of the South-East England MU; 0.0004% of The Wash and Blakeney Point count) based on the 0.006/km² density estimate for the offshore development area.			
Disturbance from 74 vessels (2.3km²) = 0.09 grey seal (0.0015% of the South-East England MU; 0.011% of The Wash and Blakeney Point count) based on the 0.04/km² density estimate for the offshore development area.			

747. The assessment for vessels assumes a very precautionary worst-case scenario, that harbour and grey seal in the offshore development area could be disturbed (***Table 5.55***). However, any disturbance is likely to be limited to the immediate vicinity around the vessel, as indicated by the noise modelling (***Table 5.56***).

748. 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.

749. 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 and grey 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 anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.5 Potential disturbance from underwater noise associated with operational wind turbines

750. 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).

751. 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 11.3*** of the PEIR for further information).

752. The modelling results indicate that at the source levels predicted for operational underwater noise, any harbour or 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 5.57***).

753. 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 5.57 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 μPa²s non-impulsive criteria	<0.1km (<0.031km²)

Potential Impact	Criteria and threshold	Operational wind turbines (300,)
	PW SEL_{cum}	
Temporary auditory injury (TTS) from cumulative exposure	NMFS (2018) 181 dB re 1 µPa²s non-impulsive criteria PW SEL_{cum}	<0.1km (<0.031km²)
Disturbance from 60 x 300m turbines (1.86km²) = 0.0013 harbour seal (0.000026% of the South-East England MU; 0.000034% of The Wash and Blakeney Point count) based on the 0.0007/km² density estimate for the windfarm site.		
Disturbance from 60 x 300m turbines (1.86km²) = 0.023 grey seal (0.00038% of the South-East England MU; 0.0029% of The Wash and Blakeney Point count) based on the 0.015/km² density estimate for the windfarm site.		

754. The assessment for operational wind turbines assumes a very precautionary worst-case scenario, that all harbour and grey seal in the East Anglia TWO windfarm site could potentially be disturbed (***Table 5.58***). However, in reality any disturbance is likely to be limited to the immediate vicinity around the turbines, as indicated by the noise modelling (***Table 5.57***).

Table 5.58 Estimated Number of Harbour and 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 255km²	0.18 harbour seal (based on 0.0007/km² density in the windfarm site). 4 grey seal (based on 0.015/km² density in the windfarm site).	0.004% of the South-East England MU (0.005% of The Wash and Blakeney Point count). 0.07% of the South-East England MU (0.5% of The Wash and Blakeney Point count).	**No** Temporary effect. 0.004% or 0.07% or less of the harbour and grey seal South-East England MU, respectively, could be temporarily disturbed from the East Anglia TWO windfarm site.

755. It is highly unlikely that all harbour and grey seal in the East Anglia TWO windfarm site would be from the Wash and Blakeney Point. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

756. Taking into account evidence of seal foraging in operational windfarms, 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 and grey seal.

Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.6 Potential disturbance from underwater noise during decommissioning

757. 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.

758. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise and UXO clearance).

759. 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.

760. 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 and grey seal. Under these circumstances, there is **no anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.7 Potential overall noise disturbance effects on foraging seals from the proposed East Anglia TWO project (alone)

5.3.3.1.7.1 Potential overall effects during UXO clearance

761. 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.

762. 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 4,248km^2, based on 26km disturbance range around each pile location and UXO location, and assuming no overlap in the potential impact areas.

763. The maximum number of harbour seal that could potentially be disturbed is 25.5, based on 0.006/km^2 density in the offshore development area. This represents 0.5% of the South-East England MU population or, as a worst-case scenario, 0.7% of the population from The Wash and Blakeney Point in The Wash and North Norfolk Coast SAC.

764. The maximum number of grey seal that could potentially be disturbed is 170, based on 0.04/km^2 density in the offshore development area. This represents 3% of the South-East England MU or, as a worst-case scenario, 4.5% of the population from The Wash and Blakeney Point in The Wash and North Norfolk Coast SAC.

765. It is highly unlikely that all harbour and grey seal in the offshore development area would be from the Wash and Blakeney Point. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

766. 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 and grey 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 anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.7.2 Potential overall effects during piling at East Anglia TWO

767. 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 2,124km^2 (based on

26km EDR) with 140km² of cable corridor not overlapped by piling impact area, giving a maximum potential area of disturbance is up to 2,264km².

768. The maximum number of harbour seal that could potentially be disturbed is 14, based on 0.006/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.

769. 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 1.5% of the South-East England MU or, as a worst-case scenario, 11.6% of the 786 grey seals from The Wash and Blakeney Point in The Wash and North Norfolk Coast SAC.

770. It is highly unlikely that all harbour and grey seal in the offshore development area would be from the Wash and Blakeney Point. There would be no direct effect or overlap with The Wash and North Norfolk Coast SAC area.

771. 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 and grey 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 anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.7.3 Other potential overall effects during construction at East Anglia TWO

772. 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 anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.7.4 Potential total effects during operation and maintenance at East Anglia TWO

773. 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**

anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal).

5.3.3.1.7.5 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 (and grey seal)**.

5.3.3.1.8 Potential in-combination disturbance effects on foraging seals

5.3.3.1.8.1 Potential in-combination disturbance effects during piling

774. 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.

775. This scenario is a precautionary approach using the maximum duration of potential piling periods, based on currently available information (see ***section 5.3.3.1.1***). Based upon ***Table 5.30*** this scenario includes three other UK offshore windfarms:

- Creyke Beck A;
- Sofia (formerly Teesside B); and
- Norfolk Vanguard.

776. The number of grey and 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.

777. 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 14,868km^2, using the 26km EDR without any overlap in the potential areas of disturbance at each windfarm or between windfarms.

778. The maximum number of harbour seal that could potentially be temporarily disturbed is 8 individuals (***Table 5.64***). This represents 0.16% of the South-

East England MU or, as a worst-case scenario, 0.26% of the 3,801 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 5.4.1.1***). Therefore, 0.02% of the in-combination reference population (43,161 harbour seal) could potentially be temporarily disturbed.

779. It is also highly unlikely that all grey seal in the windfarm sites would be from the Wash and Blakeney Point. Again, 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. The maximum number of grey seal that could potentially be temporarily disturbed is 634 individuals (***Table 5.64***). This represents up to 3% of the in-combination reference population (18,748 grey seal) could be temporarily affected.

780. Based on the more likely single pile installation at each of the four offshore windfarms, the estimated maximum area of potential disturbance is 8,496km^2, without any overlap in the potential areas of disturbance between windfarms. The maximum number of harbour seal that could potentially be temporarily disturbed is 5 individuals, which represents 0.01% of the in-combination reference population (***Table 5.64***). The maximum number of grey seal that could potentially be temporarily disturbed is 333 individuals, which represents 1.8% of the in-combination reference population (***Table 5.64***).

781. 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 and grey seal. Therefore, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

Table 5.59 Quantified In-Combination Assessment for the Potential Disturbance of Harbour and 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]	Harbour seal density estimate (No/km^2)[1]	Potential number of grey seal disturbed		Potential number of harbour seal disturbed	
			single piling	concurrent piling	single piling	concurrent piling
East Anglia TWO	0.015	0.0007	32	32 (single	1.5	1.5 (single

Name of Project	Grey seal density estimate (No/km²)[1]	Harbour seal density estimate (No/km²)[1]	Potential number of grey seal disturbed		Potential number of harbour seal disturbed	
			single piling	concurrent piling	single piling	concurrent piling
				piling)		piling)
Creyke Beck A	0.05	0.0004	106	212	1	2
Sofia	0.09	0.001	191	382	2	4
Norfolk Vanguard	0.002	0.0001	4	8	0.2	0.4
Total			**333**	**634**	**5**	**8**
% of Wash and Blakeney Point (786 grey seal; 3,801 harbour seal)			42.4 %	80.7%	0.13 %	0.26%
% of South-East England MU (6,085 grey seal; 5,061 harbour seal)			5.5%	10.4%	0.1%	0.16%
% of in-combination reference population (18,748 grey seal; 43,161 harbour seal)			1.8%	3%	0.01 %	0.02%

[1]The 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).

5.3.3.1.8.2 Potential in-combination disturbance effects during offshore windfarm construction

782. 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.

783. The assessment includes offshore windfarms which could potentially have construction activities, other than piling, during the East Anglia TWO construction period (***Table 5.30***). 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.

784. 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.

785. 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.

786. 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 2,862km^2 (based on disturbance from the entire offshore windfarm areas).

787. The maximum number of harbour seal that could potentially be disturbed is 11 individuals, which represents approximately 0.03% of the in-combination reference population or 0.3% of the Wash and Blakeney Point count (***Table 5.60***).

788. The maximum number of grey seal that could potentially be disturbed is 117 individuals, which represents approximately 0.6% of the in-combination reference population or up to 15% of the Wash and Blakeney Point count (***Table 5.60***). However, it is highly unlikely that all grey seal would be from the Wash and Blakeney Point.

789. 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 and grey seal. Therefore, under these circumstance, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

Table 5.60 Quantified In-Combination for the Potential Disturbance of Harbour and 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)	Harbour seal density estimate (No/km^2)	Area of windfarm site (km^2)*	Potential number of grey seal disturbed from entire windfarm area	Potential number of harbour seal disturbed from entire windfarm area
Creyke Beck B	0.09	0.001	599	54	0.6
Teesside A	0.01	0.00004	562	6	0.02
Thanet Extension	0.02	0.06	73	1	4
Hornsea Project 3	0.08	0.008	695	56	6
Norfolk Boreas	0.0006	0.00006	727	0.4	0.04
East Anglia ONE North	0.0009	0.0006	206	0.2	0.1
Total			**2,862**	**117**	**11**
% of Wash and Blakeney Point (786 grey seal; 3,801 harbour seal)				14.9%	0.29%
% of South-East England MU (6,085 grey seal; 5,061 harbour seal)				1.9%	0.22%
% of in-combination reference population (18,748 grey seal; 43,161 harbour seal)				0.6%	0.03%

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

5.3.3.1.8.3 Potential in-combination disturbance effects during operation and maintenance

790. 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.

791. 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.

792. 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 2024.

793. 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 1,829km^2 (based on disturbance from entire offshore windfarm area).

794. The maximum number of harbour seal that could potentially be disturbed is 89 individuals, which represents approximately 0.2% of the in-combination reference population or 2.3% of The Wash and Blakeney Point count (***Table 5.61***).

795. The maximum number of grey seal that could potentially be disturbed is 217 individuals, which represents approximately 1.2% of the in-combination reference population or up to 27.6% of The Wash and Blakeney Point count (***Table 5.61***). However, it is highly unlikely that all grey seal would be from the Wash and Blakeney Point.

796. 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 and grey seal. Therefore, under these circumstance, there **is no anticipated adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

Table 5.61 Quantified In-Combination Assessment for the Potential Disturbance of Harbour and 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)	Harbour seal density estimate (No/km^2)	Area of WF site (km^2)*	Potential number of grey seal disturbed from entire WF area	Potential number of harbour seal disturbed from entire WF area
Blyth Offshore Wind Demo 2[1]	0.03	-	<1	0.03	0
Blyth Offshore Wind Demo 3A & 4[2]	0.040	0.107	4	0.16	0.4
Dudgeon[1]	0.11	0.19	55	6	10

Name of Project	Grey seal density estimate (No/km^2)	Harbour seal density estimate (No/km^2)	Area of WF site (km^2)*	Potential number of grey seal disturbed from entire WF area	Potential number of harbour seal disturbed from entire WF area
East Anglia ONE	0.001	0.0003	205	0.2	0.06
East Anglia THREE	0.00009	0.00009	301	0.03	0.06
Galloper[1]	0.01	0.001	113	1	0.1
Hornsea Project One	0.39	0.05	407	159	20
Hornsea Project Two	0.08	0.008	462	37	4
Norther[2]	0.0003	0.0001	38	0.01	0.004
Northwester 2[2]	0.0004	0.0002	12	0.005	0.002
Race Bank	0.07	0.26	62	4	16
RENTEL[2]	0.0004	0.0002	23	0.009	0.005
Triton Knoll phase 1-3	0.07	0.26	146	10	38
Total			**1,829km^2**	**217**	**89**
% of Wash and Blakeney Point (786 grey seal; 3,801 harbour seal)				27.6%	2.3%
% of South-East England MU (6,085 grey seal; 5,061 harbour seal)				3.6%	1.8%
% of reference population (18,748 grey seal; 43,161 harbour seal)				1.2%	0.2%

**Source: http://www.4coffshore.com/*
[1]Operational after the start of the East Anglia TWO site specific surveys, but before the submission of the PEI
[2]Unknown date of project operation, but assumed to be before the construction of East Anglia TWO

5.3.3.1.8.4 Potential in-combination disturbance effects on during UXO clearance

797. As outlined in ***section 5.3.3.1***, 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 (2,124km^2) in this assessment is considered a worst-case scenario.

798. 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 km^2 and 0.02 harbour seal per km^2. 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.

799. One UXO detonation could potentially disturb up to 42.5 harbour seal (0.1% of the in-combination reference population; or 0.84% of the South-East England MU; or 1.12% of the Wash and Blakeney Point count). However, it is highly unlikely that all harbour seal would be from the Wash and Blakeney Point.

800. One UXO detonation could potentially disturb up to 212 grey seal (1.15% of the in-combination reference population; or 3.5% of the South-East England MU; or 27% of the Wash and Blakeney Point count). However, it is highly unlikely that all grey seal would be from the Wash and Blakeney Point.

801. 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 and grey seal. Under these circumstances, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.8.5 Potential in-combination disturbance effects during seismic surveys

802. As outlined in ***section 5.3.3.1***, it is currently not possible to estimate the number of potential seismic surveys 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 during the East Anglia TWO construction period.

803. The potential disturbance area during a single seismic survey, based on a radius of 10km from each location is $314km^2$.

804. Without knowing the actual location for any seismic surveys, 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 km^2 and 0.1 grey seal per km^2.

805. One seismic survey could potentially disturb up to 6.3 harbour seal (0.015% 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.

806. One seismic survey could potentially disturb up to 31.4 grey seal (0.17% of the in-combination reference population; or 0.52% of the South-East England MU; or 4% of the Wash and Blakeney Point count). However, it is highly unlikely that all grey seal would be from the Wash and Blakeney Point.

807. Disturbance from any seismic surveys 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 and grey seal. Under these circumstances, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

5.3.3.1.9 Summary of potential disturbance effects from underwater noise (alone and in-combination)

808. ***Table 5.62*** summarises the potential effects of East Anglia TWO alone and in-combination with other projects and activities on foraging harbour and grey seal in the context of the Wash and North Norfolk Coast SAC.

809. 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 and grey seal, especially when taking into account the proposed mitigation approach for harbour porpoise in the SNS cSAC / SCI. Under these circumstances, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal)**.

Table 5.62 Potential Effects from East Anglia TWO Alone and In-Combination with Other Project and Activities on Foraging Harbour and Grey Seal in the context of The Wash and North Norfolk Coast SAC

Potential effect	Assessment for harbour seal in relation to reference population	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).	13 harbour seal (based on offshore development area density 0.006/km^2) 0.26% of the South-East England MU (5,061 harbour seal); or 0.34% of the Wash and Blakeney Point count (3,801 harbour seal).	85 grey seal (based on offshore development area density 0.04/km^2) 1.4% of the South-East England MU (6,085 grey seal; or 10.8% of the Wash and Blakeney Point count (786 grey 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).	0.0018 harbour seal (based on offshore windfarm site density 0.0007/km^2) 0.00036% of the South-East England MU; or 0.00005% of the Wash and Blakeney Point count.	0.038 grey seal (based on offshore windfarm site density 0.015/km^2) 0.00062% of the South-East England MU; or 0.0048% 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.	32 grey seal (based on offshore windfarm site density) 0.5% of the South-East England MU; or 4% 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, other than piling (436km^2 offshore development area).	2.6 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.	17 grey seal (based on offshore development area density) 0.3% of the South-East England MU; or 2.2% of the Wash and Blakeney Point count.	No
Potential disturbance from vessels during construction, operation and maintenance at East Anglia TWO (alone)			
Potential disturbance from vessels during construction (436km^2 offshore development area).	2.6 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.	17 grey seal (based on offshore development area density) 0.3% of the South-East England MU; or 2.2% 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 (255km^2 windfarm site).	0.18 harbour seal (based on offshore windfarm site density) 0.004% of the South-East England MU; or 0.005% of the Wash and Blakeney Point count.	4 grey seal (based on offshore windfarm site density) 0.07% of the South-East England MU; or 0.5% 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 (436km^2 offshore development area).	2.6 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.	17 grey seal (based on offshore development area density) 0.3% of the South-East England MU; or 2.2% of the Wash and Blakeney Point count.	No

Potential overall noise effects during UXO clearance and piling at East Anglia TWO (alone)			
UXO detonation in cable corridor and piling at windfarm site (4,248km²).	25.5 harbour seal (based on offshore development area density) 0.5% of the South-East England MU; or 0.7% of the Wash and Blakeney Point count.	170 grey seal (based on offshore development area density) 3% of the South-East England MU; or 4.5% 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 (2,124km²) and other construction activities and vessels in cable corridor (up to 140km²).	14 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.	91 grey seal (based on offshore development area density) 1.5% of the South-East England MU; or 11.6% 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 (2,124km²), 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 (8,496km²).	5 harbour seal (based on density at each windfarm) 0.01% of in-combination reference population. (0.13% of the South-East England MU; or 0.1% of the Wash and Blakeney Point count).	333 grey seal (based on density at each windfarm) 1.8% of in-combination reference population. (5.5% of the South-East England MU; or 42.4% of the Wash and Blakeney Point count).	No It is highly unlikely that all harbour and grey 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 construction at East Anglia TWO and other offshore windfarms			
Offshore windfarm construction activities and vessels, for windfarms	11 harbour seal (based on density at each windfarm)	117 grey seal (based on density at each windfarm)	No It is highly unlikely that all harbour and

that are not piling but potential for other construction activities during construction at East Anglia TWO, based on 100% disturbance from windfarm area (2,862km^2).	0.03% of in-combination reference population. (0.2% of the South-East England MU; or 0.3% of the Wash and Blakeney Point count).	0.6% of in-combination reference population (2% of the South-East England MU; or 15% of the Wash and Blakeney Point count).	grey 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 (1,829km^2).	89 harbour seal (based on density at each windfarm) 0.2% of in-combination reference population. (1.8% of the South-East England MU; or 2.3% of the Wash and Blakeney Point count).	217 grey seal (based on density at each windfarm) 1.2% of in-combination reference population. (3.6% of the South-East England MU; or 27.6% of the Wash and Blakeney Point count).	No It is highly unlikely that all harbour and grey 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) 0.1% of in-combination reference population. (0.84% of the South-East England MU; or 1.12% of the Wash and Blakeney Point count).	212 grey seal (based on density of 0.1/km^2) 1.15% of in-combination reference population. (3.5% of the South-East England MU; or 27% of the Wash and Blakeney Point count)	No It is highly unlikely that all harbour and grey 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 seismic surveys			
Seismic surveys, based onone survey	6.3 harbour seal (based on density of	31.4 grey seal (based on density of	No

at a time (314km²).	0.02/km²); 0.015% of in-combination reference population. (0.13% of the South-East England MU; or 0.17% of the Wash and Blakeney Point count)	0.1/km2); 0.17% of in-combination reference population. (0.5% of the South-East England MU; or 4% of the Wash and Blakeney Point count)	It is highly unlikely that all harbour and grey 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 (maximum total = 15,625km²).	Maximum of 153.8 harbour seal 0.36% of in-combination reference population. (3% of the South-East England MU; or 4% of the Wash and Blakeney Point count).	Maximum of 698.4 grey seal 3.8% of in-combination reference population. (11.5% of the South-East England MU)	No It is expected that management measures outlined for harbour porpoise in SNS cSAC / SCI implemented by MMO would also reduce this impact.

5.3.3.2 Possible vessel interaction (increased collision risk)

5.3.3.2.1 East Anglia TWO (alone)

810. As a precautionary worst-case scenario approach, as outlined in ***section 5.2.5.1.6***, the number of harbour and 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 5.68***).

Table 5.63 Estimated Number of Harbour and Grey 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 (436km^2)	0.1 harbour seal	0.002% of the South-East England MU; or 0.03% of the Wash and Blakeney Point count.	**No**
	0.87 grey seal	0.01% of the South-East England MU; or 0.1% of the Wash and Blakeney Point count.	**No**

811. This is very precautionary, as it is highly unlikely that harbour and grey 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.

812. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where harbour and 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.

813. In addition, based on the assumption that harbour and grey 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.

814. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal).**

5.3.3.2.2 In-combination

815. 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 0.25 harbour seal (0.0006% of the in-combination reference population; or 0.005% of the South-East England MU; or 0.007% of the Wash and Blakeney Point count; ***Table 5.69***).

816. The 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 0.16% of the South-East England MU; or 1.3% of the Wash and Blakeney Point count; ***Table 5.69***).

817. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the Wash and North Norfolk Coast in relation to the conservation objectives for harbour seal (and grey seal)**.

Table 5.64 Quantified In-Combination Assessment for the Potential Increased Collision Risk with Vessels for Harbour and Grey Seal During Offshore Windfarm Construction

Name of Project	Grey seal density estimate (No/km^2)	Harbour seal density estimate (No/km^2)	Area of windfarm site (km^2)	Potential number of grey seal impacted based on 5% collision risk	Potential number of harbour seal impacted based on 5% collision risk
East Anglia TWO	0.01	0.002	255	0.13	0.01
Creyke Beck A	0.05	0.0004	515	1.29	0.004
Creyke Beck B	0.09	0.001	599	2.70	0.01
Teesside A	0.01	0.00004	562	0.28	0.0004
Sofia	0.09	0.001	593	2.67	0.01
East Anglia THREE	0.00009	0.00009	301	0.0015	0.0015
Norfolk Vanguard	0.002	0.0001	592	0.06	0.003
Hornsea Project Three	0.08	0.008	695	2.78	0.11
Thanet Extension	0.02	0.06	73	0.07	0.09
Norfolk Boreas	0.001	0.0001	725	0.04	0.004
East Anglia ONE North	0.0009	0.0006	206	0.01	0.002
Total			**5,116**	**10**	**0.25**
% of Wash and Blakeney Point (786 grey seal; 3,801 harbour seal)				1.3%	0.007%

Name of Project	Grey seal density estimate (No/km²)	Harbour seal density estimate (No/km²)	Area of windfarm site (km²)	Potential number of grey seal impacted based on 5% collision risk	Potential number of harbour seal impacted based on 5% collision risk
% of South-East England MU (6,085 grey seal; 5,061 harbour seal)				0.16%	0.005%
% of in-combination reference population (18,748 grey seal; 43,161 harbour seal)				0.05%	0.0006%

5.3.3.3 Potential changes in prey availability

5.3.3.3.1 East Anglia TWO (alone)

818. 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 5.2.5.5.5***).

819. 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 5.1.1***).
- 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 ***PEIR Appendix 11.3***).
- 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 plains with distance from the

source. Therefore, any potential effect of EMF on fish species would not be expected to be significant.

820. For this decommissioning, it is assumed that the potential effects would be the same or less than for construction.

821. 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 (436km^2).

822. The number of harbour seal that could be present in the area is 2.6 (based on 0.006/km^2 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.

823. The number of grey seal that could be present in the offshore development area is 17, (based on 0.04/km^2 density). This represents 0.3% of the South-East England MU or, as a worst-case scenario, 2.2% of the 786 grey seals from the Wash and Blakeney Point in the Wash and North Norfolk Coast SAC. However, it is highly unlikely that all grey seal in the offshore development area would be from The Wash and Blakeney Point.

824. It is highly unlikely that all harbour and grey seal in the East Anglia TWO offshore development area would be from The Wash and Blakeney Point. There would be no direct effect or overlap with the Wash and North Norfolk Coast SAC area.

825. 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 Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal) arising from changes in prey resources**.

5.3.3.3.2 In-combination

826. 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.

827. 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.

828. 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.

829. There would be no direct effect or overlap with the Wash and North Norfolk Coast SAC area.

830. 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 Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (and grey seal) arising from changes in prey resources**.

5.3.4 Summary of Potential Effects for The Wash and North Norfolk Coast SAC

831. 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 5.65***).

Table 5.65 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 (and Grey Seal)

Conservation Objectives	Disturbance of foraging harbour or grey 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.	×	×	×	×	×	×
The structure and function (including typical species) of qualifying natural habitats.	×	×	×	×	×	×
The structure and function of the habitats of qualifying species.	×	×	×	×	×	×
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	×	×	×	×	×	×

Conservation Objectives	Disturbance of foraging harbour or grey 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 populations of qualifying species.	×	×	×	×	×	×
The distribution of qualifying species within the site.	×	×	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives.

5.4 Humber Estuary SAC

832. 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).

833. The Humber Estuary SAC is located 178km 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.

834. For the purposes of this assessment, the potential effects are considered in relation to the SAC Conservation Objectives; as outlined in ***Table 5.66***.

Table 5.66 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.

5.4.1 Grey Seal Status and Ecology

835. Donna Nook is located in the Humber Estuary SAC and the most recent August count at the site in 2016 was 3,964 grey seals (SCOS 2017).

5.4.1.1 Reference populations

836. 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 6,085 (SCOS 2017). The reference population to be used in the assessment for the Humber Estuary SAC will be the south-east England MU of 6,085 grey seal.

837. 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 2017) and the Wadden Sea region (TSEG 2017a).

838. The reference population for the in-combination assessment is therefore 18,478 grey seal, based on the most recent estimates for:

- South-east England MU = 6,085 grey seal (SCOS 2017);
- North-east England MU = 6,948 grey seal (SCOS 2017); and
- Wadden Sea area = 5,445 grey seal (TSEG 2017a).

5.4.1.2 Density Estimates

839. 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 0.015 grey seal per km^2;
- The offshore cable corridor density is estimated to be 0.08 grey seal per km^2; and
- The overall density estimate for the East Anglia TWO offshore development is 0.04 grey seal per km^2.

5.4.2 Assessment of Potential Effects on Humber Estuary SAC

840. 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.

841. 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.

842. An assessment of the potential risk of PTS for grey seal has been conducted in the PEIR ***Chapter 11 Marine Mammals***. As outlined in ***sections 5.2.5.1.1.1*** and ***5.2.5.1.2.1***, the risk of permanent auditory injury (PTS) during UXO clearance and piling will be reduced with the implementation of the MMMPs. Therefore, it has not been considered further in this assessment.

5.4.2.1 Potential disturbance of foraging seals from underwater noise

843. ***Table 5.67*** 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.

844. The assessment uses the same approach as the assessment of the potential disturbance of foraging grey seal for The Wash and North Norfolk Coast SAC (***section 5.3.3***).

845. 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 taking into the proposed mitigation approach for harbour porpoise in the SNS cSAC / SCI. Under these circumstances, there is **no anticipated adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal**.

Table 5.67 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) 1.4% of the South-East England MU; or 2% of the Donna Nook	No

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
	count.	
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).	0.38 grey seal 0.003% of the South-East England MU; or 0.0096% of the Donna Nook count.	No
Potential disturbance from underwater noise during piling (2,124km^2).	32 grey seal (based on offshore windfarm site density) 0.5% of the South-East England MU; or 0.8% 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 (436km^2 offshore development area).	17 grey seal 0.3% of the South-East England MU; or 0.4% 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 (436km^2 offshore development area).	17 grey seal 0.3% of the South-East England MU; or 0.4% 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 (255km^2 windfarm site).	4 grey seal 0.07% of the South-East England MU; or 0.1% 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	17 grey seal 0.3% of the South-East England	No

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
foundation removal, decommissioning activities and vessels (436km² offshore development area).	MU; or 0.4% of the Donna Nook count.	
Potential overall noise effects during UXO clearance and piling at East Anglia TWO (alone)		
UXO detonation in cable corridor and piling at windfarm site (4,248km²).	170 grey seal 3% of the South-East England MU; or 4% of the Donna Nook count.	No
Potential overall noise effects during piling and construction activities at East Anglia TWO (alone)		
Piling at windfarm site (2,124km²) and other construction activities and vessels in cable corridor (up to 140km²).	91 grey seal 1.5% of the South-East England MU; or 2% 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 (8,496km²).	333 grey seal 1.8% of in-combination reference population. (5.5% of the South-East England MU; or 8% 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 (2,862km²).	117 grey seal 0.6% of in-combination reference population. (2% of the South-East England MU; or 3% 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		

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
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 (1,829km^2).	217 grey seal 1.2% of in-combination reference population. (3.6% of the South-East England MU; or 5.5% 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 UXO clearance		
UXO clearance, based on one detonation at a time (2,124km^2).	212 grey seal 1.15% of in-combination reference population. (3.5% of the South-East England MU; or 5.35% 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		
Seismic survey (314km^2).	31.4 grey seal 0.17% of in-combination reference population. (0.5% of the South-East England MU; or 0.79% 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 (maximum total = 15,625km^2).	Maximum of 698.4 grey seal 3.8% of in-combination reference population. (11.5% of the South-East England MU; or 17.6% of the Donna Nook count)	No It is expected that management measures outlined for harbour porpoise in SNS cSAC / SCI 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)

846. 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.

847. 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).

848. For decommissioning, it is assumed that the potential number of vessels and vessel movements would be the same or less than for construction.

849. 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 5.68***).

Table 5.68 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 (436km^2)	0.87 grey seal	0.01% of the South-East England MU; or 0.02% of the Donna Nook count.	No

850. 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.

851. 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.

852. 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.

853. Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.**

5.4.2.2.2 In-combination

854. 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.

855. 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.

856. 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.

857. 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.

858. 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 0.16% of the South-East England MU; or 0.25% of the Donna Nook count). Therefore, under these circumstances, there is **no anticipated adverse effect on the integrity of the**

Humber Estuary SAC in relation to the conservation objectives for grey seal.

5.4.2.3 Potential changes in prey availability

5.4.2.3.1 East Anglia TWO (alone)

859. 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 (436km^2).

860. The number of grey seal that could be present in the area is 17, based on 0.04/km^2 density. This represents 0.3% of the South-East England MU or, as a worst-case scenario, 0.4% of the 3,964 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 186km from the offshore development area.

861. There would be no direct effect or overlap with the Humber SAC area.

862. 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 Humber Estuary SAC in relation to the conservation objectives for grey seal arising from changes in prey resources**.

5.4.2.3.2 In-combination

863. 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.

864. There would be no direct effect or overlap with the Humber SAC area.

865. 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 Humber Estuary SAC in relation to the conservation objectives for grey seal arising from changes in prey resources**.

5.4.3 Summary of Potential Effects for Humber Estuary SAC

866. 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 5.69***).

Table 5.69 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.	×	×	×	×	×	×
The structure and function (including typical species) of qualifying natural habitats.	×	×	×	×	×	×
The structure and function of the habitats of qualifying species.	×	×	×	×	×	×
The supporting processes on which qualifying	×	×	×	×	×	×

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
natural habitats and the habitats of qualifying species rely.						
The populations of qualifying species.	×	×	×	×	×	×
The distribution of qualifying species within the site.	×	×	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives.

5.5 Winterton-Horsey Dunes SAC

867. Grey seal are not currently a qualifying feature at the Winterton-Horsey Dunes SAC, however, it is recognised that this site is important for the population, as breeding, moulting and haul-out sites. Therefore, consideration is given to grey seal as part of the Winterton-Horsey Dunes SAC.

868. Horsey Corner in the Winterton-Horsey Dunes SAC is located approximately 55km from the East Anglia TWO windfarm site and approximately 60km from the landfall.

869. As the Winterton-Horsey Dunes SAC is not designated for grey seal, the relevant Conservation Objectives for the Humber Estuary SAC will be used in the assessment (***Table 5.66***).

5.5.1 Grey Seal Status and Ecology

870. At Horsey on the Norfolk coastline from Winterton to Waxham, counts undertaken by the Friends of Horsey Seals wardens in the breeding season indicated that the overall numbers of births increased from 1,236 in 2015-2016 to 1,487 in 2016-17 and 1,825 in 2017-18 (Rothney 2016, 2017; Friends of Horsey 2018). The number of adult grey seals recorded varied with the stage in the breeding cycle (Rothney 2016).

5.5.1.1 Reference populations

871. The Winterton-Horsey Dunes SAC is located in the south-east England MU (IAMMWG 2013), therefore the reference population to be used in the assessment will be the south-east England MU of 6,085 grey seal (SCOS 2017).

872. 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 2017) and the Wadden Sea region (TSEG 2017a).

873. The reference population for the in-combination assessment is therefore 18,478 grey seal, based on the most recent estimates for the:

- South-east England MU = 6,085 grey seal (SCOS 2017);
- North-east England MU = 6,948 grey seal (SCOS 2017); and
- Wadden Sea area = 5,445 grey seal (TSEG 2017a).

874. The assessment also considers any potential effects on the south-east England MU of 6,085 grey seal and, where available, counts from designated sites.

5.5.1.2 Density Estimates

875. As outlined in ***section 5.4.1.2***, 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 the density of grey seal is estimated to be 0.015/km^2;
- The offshore cable corridor the density is estimated to be 0.08 grey seal per km^2; and
- The overall density estimate for the East Anglia TWO offshore development is 0.04 grey seal per km^2.

5.5.2 Assessment of Potential Effects on Winterton-Horsey Dunes SAC

876. 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 Winterton-Horsey Dunes SAC have been agreed in consultation with the marine mammal ETG as part of the EPP.

877. 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
- Any in-combination effects

878. An assessment of the potential risk of PTS for grey seal has been conducted in the PEIR ***Chapter 11 Marine Mammals***. As outlined in ***sections 5.2.5.1.1.1*** and ***5.2.5.1.2.1***, the risk of permanent auditory injury (PTS) during UXO clearance and piling will be reduced with the implementation of the MMMPs. Therefore, it has not been considered further in this assessment.

5.5.2.1 Potential disturbance of foraging seals from underwater noise

879. ***Table 5.70*** summarises the potential effects of East Anglia TWO alone and in-combination on foraging grey seal in the context of the Winterton-Horsey Dunes SAC.

880. The assessment uses the same approach as the assessment of the potential disturbance of foraging grey seal for The Wash and North Norfolk Coast SAC (***section 5.3.3***).

881. 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 taking into the proposed mitigation approach for harbour porpoise in the SNS cSAC / SCI. Under these circumstances, there is **no anticipated adverse effect on grey seal at the Winterton-Horsey Dunes SAC**.

Table 5.70 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 Winterton-Horsey Dunes 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) 1.4% of the South-East England MU; or 4.7% of the Horsey count (1,825 grey 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).	0.038 grey seal 0.00062% of the South-East England MU; or 0.002% of the Horsey count.	**No**
Potential disturbance from underwater noise during piling (2,124km^2).	32 grey seal (based on offshore windfarm site density) 0.5% of the South-East England MU; or 1.75% of the Horsey 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 (436km^2 offshore development area).	17 grey seal 0.3% of the South-East England MU; or 0.9% of the Horsey count.	**No**

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
Potential disturbance from vessels during construction, operation and maintenance at East Anglia TWO (alone)		
Potential disturbance from vessels during construction (436km^2 offshore development area).	17 grey seal 0.3% of the South-East England MU; or 0.9% of the Horsey 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 (255km^2 windfarm site).	4 grey seal 0.07% of the South-East England MU; or 0.2% of the Horsey 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 (436km^2 offshore development area).	17 grey seal 0.3% of the South-East England MU; or 0.9% of the Horsey count.	**No**
Potential overall 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 3% of the South-East England MU; or 9.3% of the Donna Nook count.	**No**
Potential overall 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 140km^2).	91 grey seal 1.5% of the South-East England MU; or 5% of the Horsey count.	**No**
Potential in-combination disturbance effects on foraging seals during offshore windfarm piling at East Anglia TWO and other offshore windfarms		
Piling at offshore windfarm projects, based on worst-case scenario for projects that could be piling at the same time as	333 grey seal 2% of in-combination reference population	**No** It is highly unlikely that all harbour and grey seal would be from Horesy. It is more

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
East Anglia TWO (Creyke Beck A, Sofia and Norfolk Vanguard) for single pile installation at each site (8,496km^2).	(5.5% of the South-East England MU; or 18% of the Horsey count).	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 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 (2,862km^2).	117 grey seal 0.6% of in-combination reference population. (2% of the South-East England MU; or 6.4% of the Horsey count)	**No** It is highly unlikely that all harbour and grey seal would be from Horesy. 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 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 (1,829km^2).	217 grey seal 1.2% of in-combination reference population. (3.6% of the South-East England MU; or 11.9% of the Horsey count)	**No** It is highly unlikely that all harbour and grey seal would be from Horesy. 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).	212 grey seal 1.15% of in-combination reference population. (3.5% of the South-East England MU; or 11.6% of the Horsey count)	**No** It is highly unlikely that all harbour and grey seal would be from Horesy. 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 seismic surveys		
Seismic survey (314km^2).	31.4 grey seal 0.17% of in-combination reference population. (0.52% of the South-East	**No** It is highly unlikely that all harbour and grey seal would be from Horesy. It is more

Potential effect	Assessment for grey seal in relation to reference population	Potential adverse effect on site integrity
	England MU; or 1.7% of the Horsey count)	appropriate to use the in-combination reference population to cover the wider area of in-combination affects.
Overall potential in-combination disturbance effects on foraging seals		
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 (maximum total = 15,625km²).	Maximum of 698.4 grey seal 3.8% of in-combination reference population. (11.5% of the South-East England MU)	**No** It is expected that management measures outlined for harbour porpoise in SNS cSAC / SCI 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)

882. During the construction of East Anglia TWO 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 site area.

883. The operation and maintenance ports to be used for the proposed East Anglia TWO project 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.

884. For decommissioning, it is assumed that the potential number of vessels and vessel movements would be the same or less than for construction.

885. 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.

886. The maximum number of grey seal that could be at increased vessel collision risk is 0.87, 0.01% of the South-East England MU or 0.05% of the Horsey count.

887. 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.

888. 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.

889. 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 at the offshore development area.

890. Therefore, under these circumstances, there is **no anticipated adverse effect on grey seal at the Winterton-Horsey Dunes SAC**.

5.5.2.2.2 In-combination

891. 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 wind farm site. 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.

892. 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.

893. 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.

894. 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.

895. 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 0.16% of the South-East England MU; or 0.55% of the Horsey count). Therefore, under these circumstances, there is **no anticipated adverse effect on grey seal at the Winterton-Horsey Dunes SAC**.

5.5.2.3 Potential changes in prey availability

5.5.2.3.1 Potential changes in prey availability during construction, operation, maintenance and decommissioning at East Anglia TWO (alone)

896. 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 (436km^2).

897. The number of grey seal that could be present in the area is 17, based on 0.04/km^2 density in the offshore development area. This represents 0.3% of the South-East England MU or, as a worst-case scenario, 0.9% of the Horsey count.

898. There would be no direct effect or overlap with the Winterton-Horsey Dunes SAC area.

899. 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 anticipated adverse effect on grey seal at the Winterton-Horsey Dunes SAC.**

5.5.2.3.2 Potential in-combination effects on prey availability at East Anglia TWO and other offshore windfarms

900. 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.

901. There would be no direct effect or overlap with the Winterton-Horsey Dunes SAC area.

902. 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 anticipated adverse effect on grey seal at the Winterton-Horsey Dunes SAC.**

5.5.3 Summary of Potential Effects for Winterton-Horsey Dunes SAC

903. 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 grey seal at the Winterton-Horsey Dunes SAC and in relation to the Conservation Objectives of the Humber Estuary SAC (***Table 5.71***).

Table 5.71 Summary of the Assessment of the Potential Effects of East Anglia TWO and In-Combination Effects of Grey Seal at the Winterton-Horsey Dunes SAC in Relation to the Humber Estuary SAC 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 noise effects)	In-combination	Project alone (including total noise effects)	In-combination	Project alone (including total noise effects)	In-combination
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	×	×	×	×	×	×
The structure and function (including typical species) of qualifying natural habitats.	×	×	×	×	×	×
The structure and function of the habitats of qualifying species.	×	×	×	×	×	×
The supporting processes on which qualifying natural habitats and the habitats of qualifying species	×	×	×	×	×	×

Conservation Objectives	Disturbance of foraging grey seal		Vessel interaction (increased collision risk)		Changes in prey availability	
	Project alone (including total noise effects)	In-combination	Project alone (including total noise effects)	In-combination	Project alone (including total noise effects)	In-combination
rely.						
The populations of qualifying species.	×	×	×	×	×	×
The distribution of qualifying species within the site.	×	×	×	×	×	×

× = no potential for any adverse effect on the integrity of the site in relation to the conservation objectives.

5.6 Other European Designated Sites Where Grey and Harbour Seal are a Qualifying Feature

904. **Table 5.72** 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.

905. All these European Designated Site use the OSPAR Conservation Objectives, with some sites also having sites reiterate individual objectives (***Table 5.72***):

- 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.

906. 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 5.3.3***).

907. As summarised in **Table 5.62**, 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 has a maximum total area of up to 19,435km^2, as a worst-case scenario. The maximum of 204 harbour seal (0.5% of in-combination reference population) and up to 1,201 grey seal (6.5% of in-combination reference population) could potentially be temporarily disturbed.

908. 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 cSAC / SCI. Under these circumstances, there is **no anticipated adverse effect on the integrity of the other European Designated Sites in relation to the conservation objectives for grey seal and harbour seal.**

Table 5.72: 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 and Grey seal	Harbour seal population = unknown Grey seal population = unknown	OSPAR Conservation Objectives	Maximum of 153.8 harbour seal (0.36% of in-combination reference population) and up to 698.4 grey seal (3.8% 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 698.4 grey seal (3.8% 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 offshore cable corridor	Grey seal	Grey seal population = unknown	OSPAR Conservation Objectives	Up to 698.4 grey seal (3.8% 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
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 698.4 grey seal (3.8% 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 698.4 grey seal (3.8% 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. Seals move between Westerschelde, through Vlakte van de Raan	OSPAR Conservation Objectives	Up to 698.4 grey seal (3.8% 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
			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 698.4 grey seal (3.8% 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 698.4 grey seal (3.8% of in-combination reference population). Not all from this site alone.	**No**

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Annex 1: Supporting Figures

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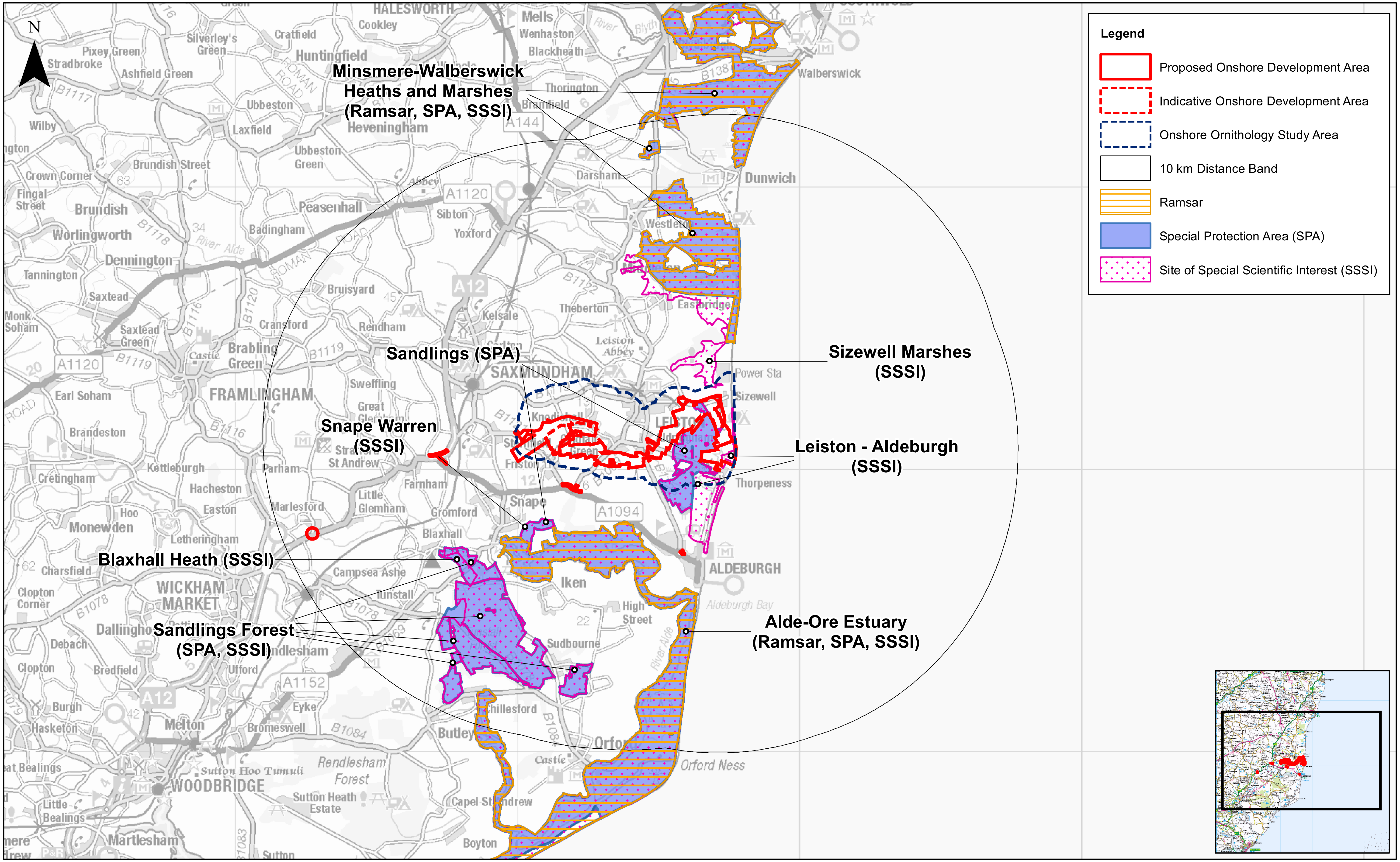

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02	24/09/2018	BJF	Third Issue	Checked:	BJF	Scale @ A3	0 1.25 2.5 5 Km
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Rev	Date	By	Comment	Approved:	RD		

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East Anglia TWO

Onshore Ornithological Designated Sites within 10km

Drg No	HRA_Fig1 - S1SR	
Rev	03	Coordinate System: BNG
Date	13/11/18	Datum: OSGB36
Figure	1	

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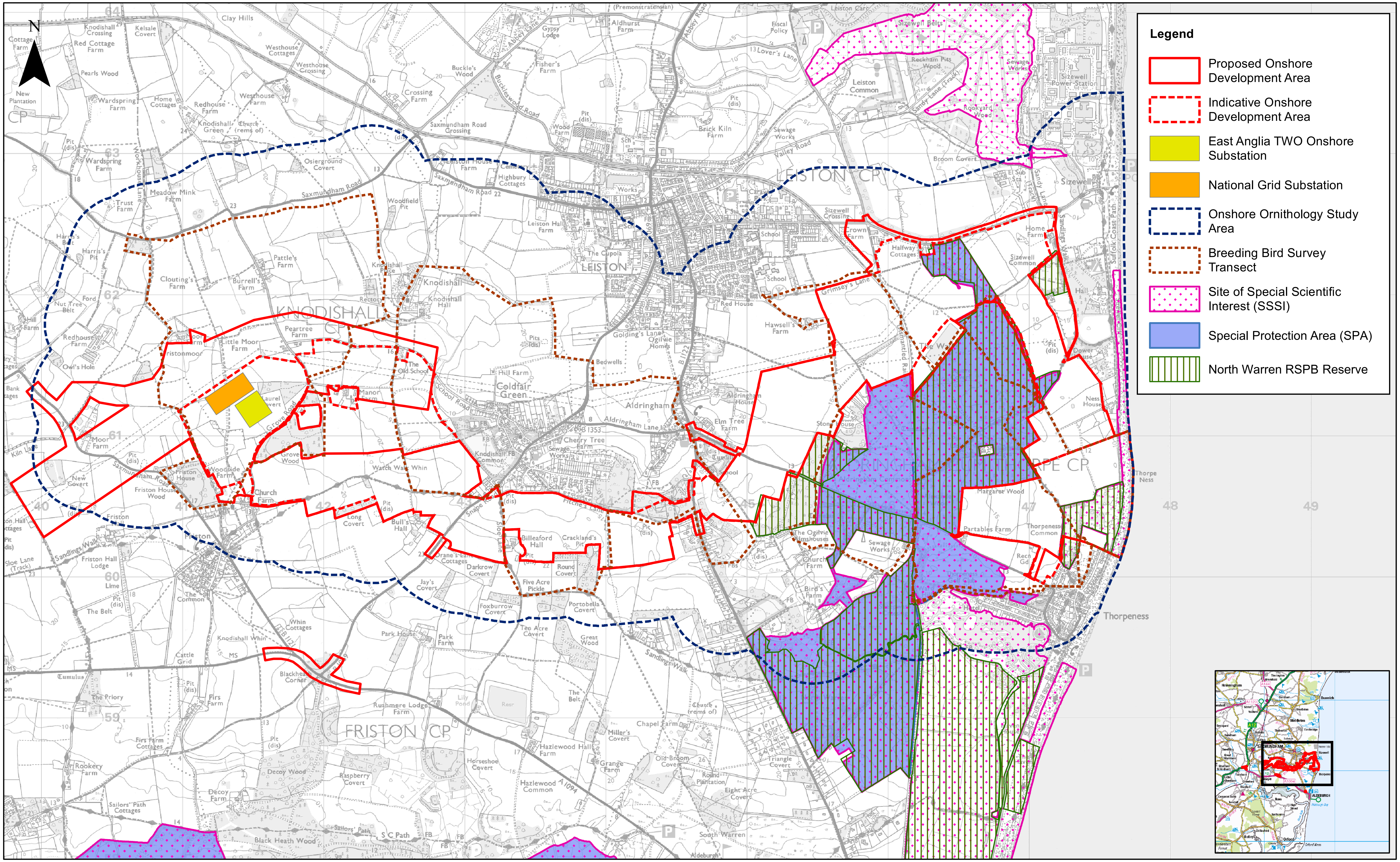

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
05	18/12/2018	BJF	Fifth Issue	Checked:	BJF
04	13/11/2018	BJF	Fourth Issue	Checked:	BJF
03	26/10/2018	BJF	Third Issue	Checked:	BJF
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East Anglia TWO

Onshore Ornithology Study Area

Drg No	HRA_Fig2 - S1SR
Rev	05
Date	18/12/18
Figure	2

Coordinate System: BNG
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Legend

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
03	13/11/2018	BJF	Third Issue.
02	24/09/2018	BJF	Second Issue.
01	30/08/2018	BJF	First Issue.

Prepared: BJF
Checked: BJF
Approved: RD

1:25,000
Scale @ A3

0 0.5 1 Km

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East Anglia TWO

Nightjar Observations 2018

CONFIDENTIAL

Drg No	HRA_Fig3 - S1SR
Rev	03
Date	13/11/18
Figure	3

Coordinate System: BNG
Datum: OSGB36

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Confidential - Figure Removed

Legend

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment
03	13/11/2018	BJF	Third Issue.
02	24/09/2018	BJF	Second Issue.
01	30/08/2018	BJF	First Issue.

Prepared:	BJF
Checked:	BJF
Approved:	RD

1:25,000
Scale @ A3

0 0.5 1 Km

East Anglia TWO

Woodlark Observations 2018

CONFIDENTIAL

Drg No	HRA_Fig4 - S1SR
Rev	03
Date	13/11/18
Figure	4

Coordinate System: BNG
Datum: OSGB36

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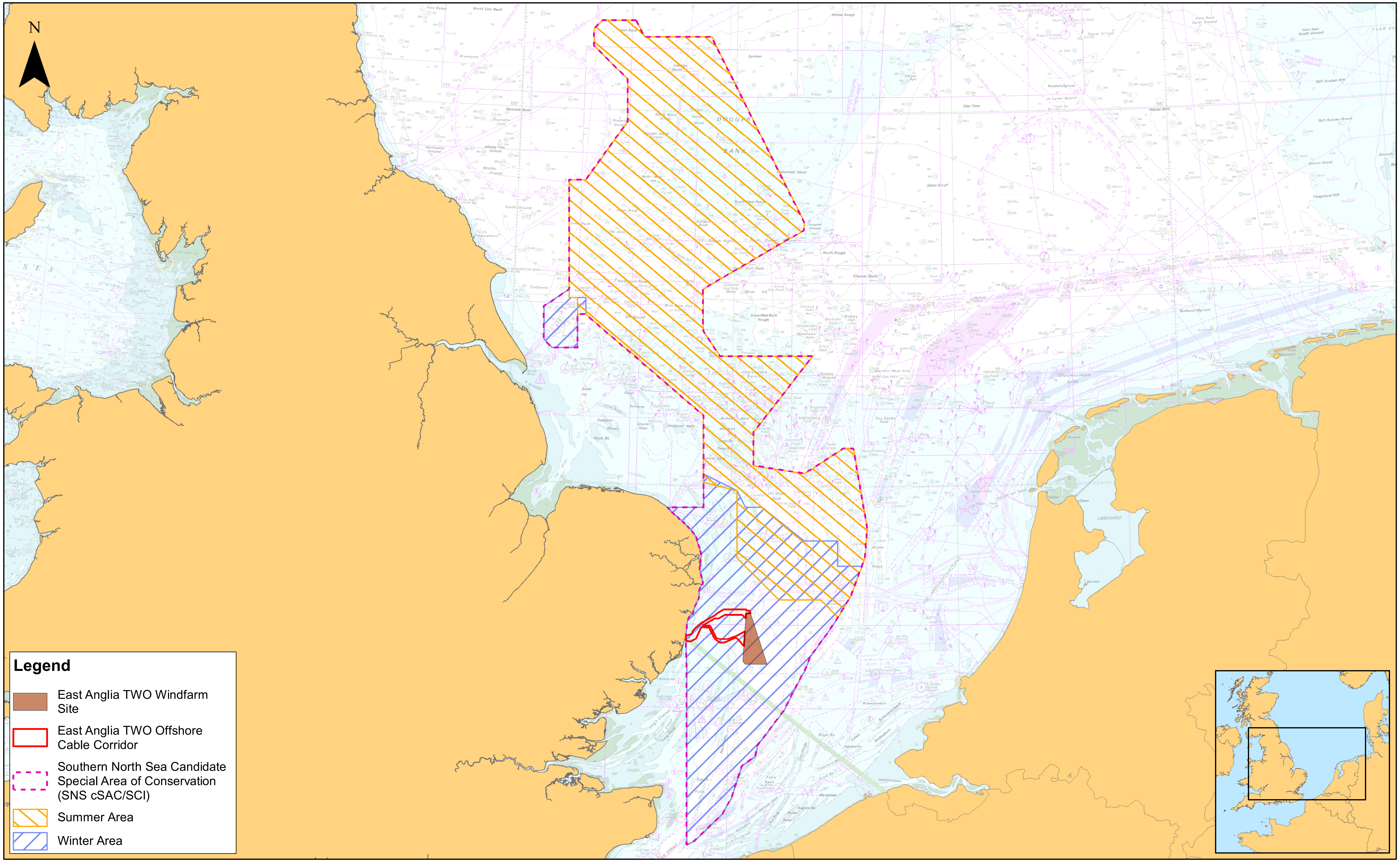

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
2	16/11/2018	FC	Second Issue.	Prepared:	FC
1	23/10/2018	FC	First Issue.	Checked:	JL
				Approved:	PP

1:2,100,000 Scale @ A3

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East Anglia TWO

Southern North Sea Candidate Special Area of Conservation / Site of Community Importance (SNS cSAC/SCI)

Drg No	EA1N-EA2-DEV-DRG-IBR-00TBC233	
Rev	2	Datum: WGS 1984 Projection: Zone 31N
Date	16/11/18	
Figure	5	

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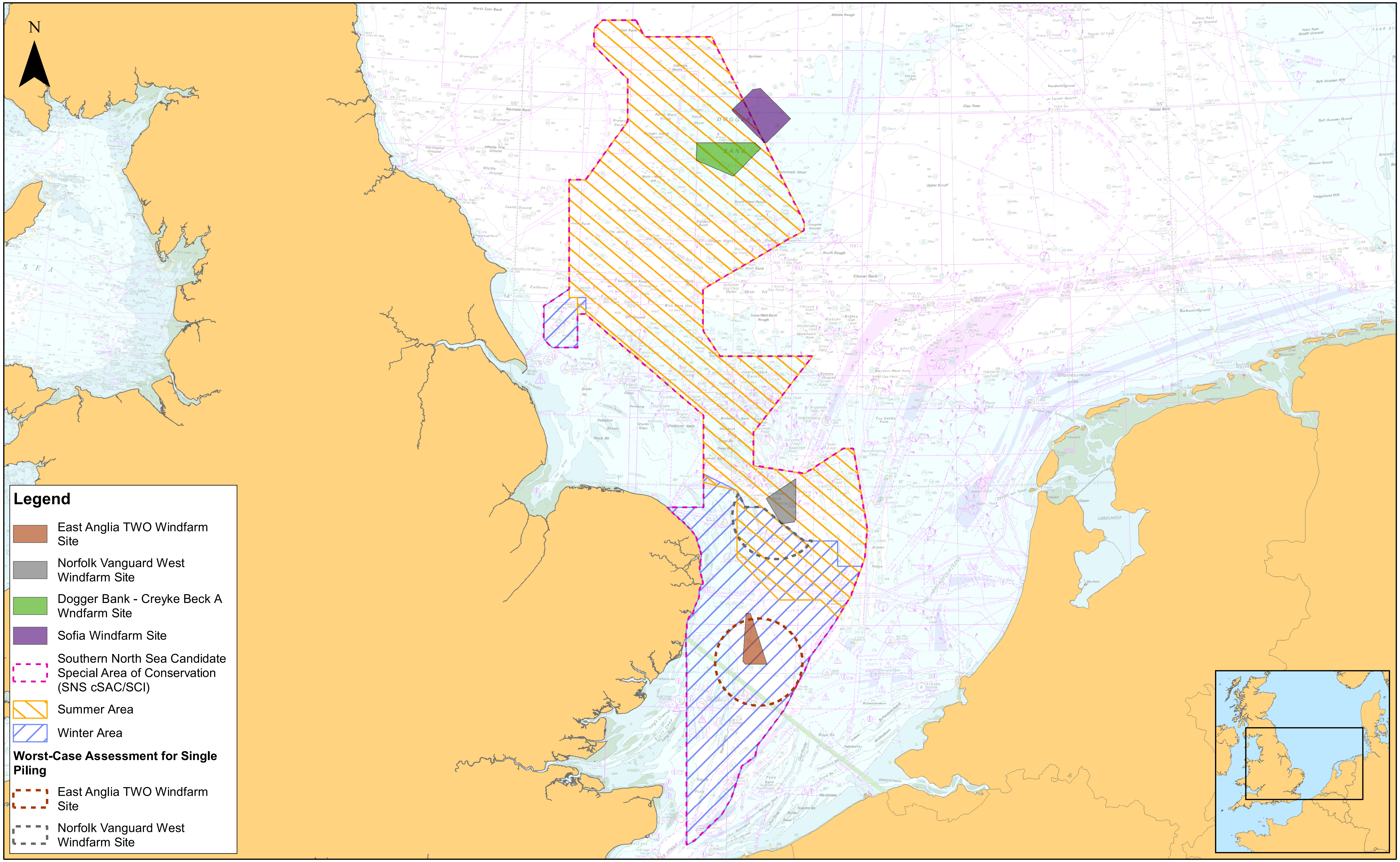

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
2	16/11/2018	FC	Second Issue.	Prepared:	FC
1	09/10/2018	FC	First Issue.	Checked:	JL
				Approved:	PP

1:2,100,000 Scale @ A3

0 25 50 100 Km

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East Anglia TWO

Maximum Overlap with the SNSc SAC/SCI Winter Area for In-Combination Effect of Single Piling

Drg No	EA1N-EA2-DEV-DRG-IBR-00TBC257	
Rev	2	Datum: WGS 1984 Projection: Zone 31N
Date	16/11/18	
Figure	6	

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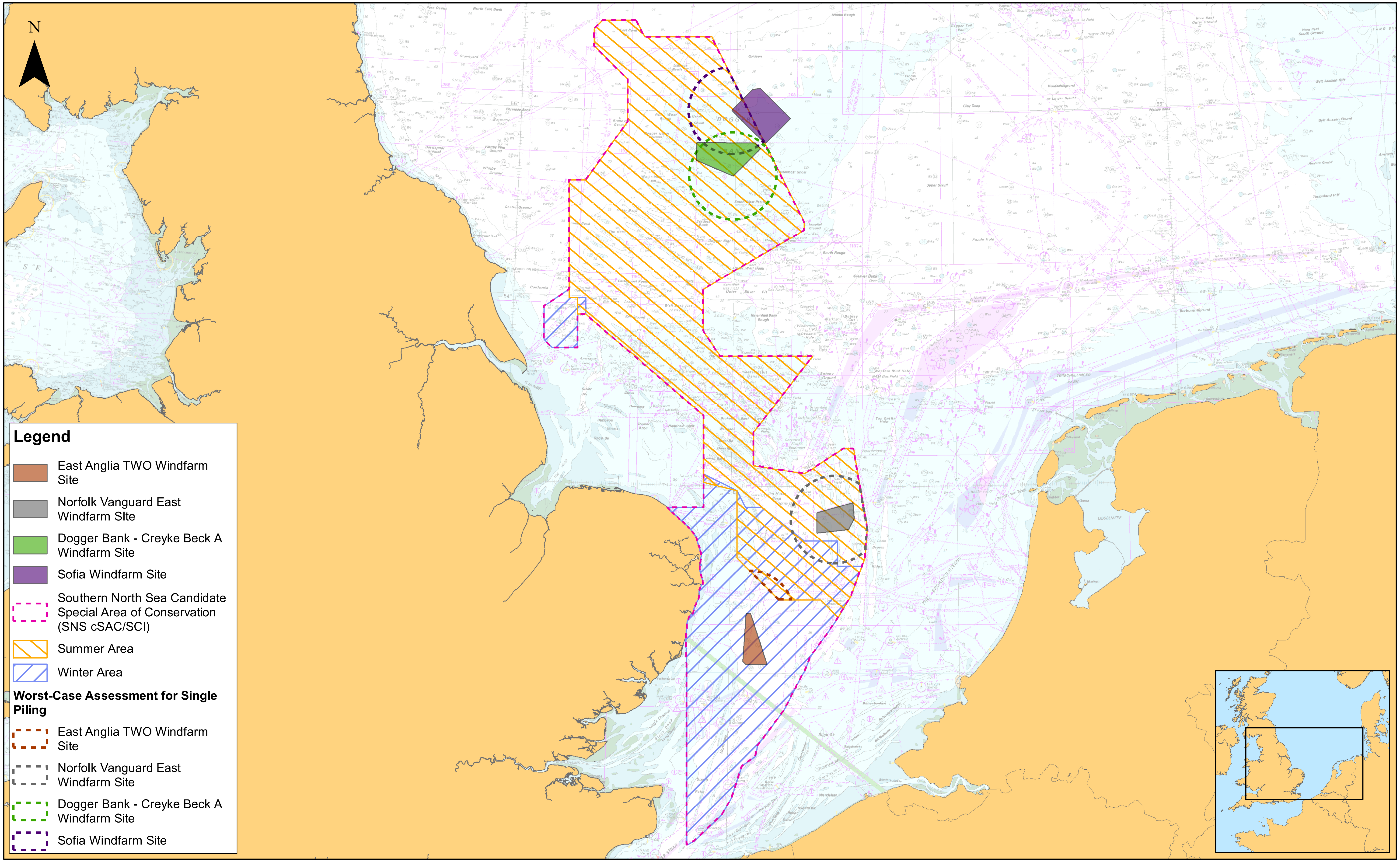

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
2	16/11/2018	FC	Second Issue.	Prepared:	FC
1	09/10/2018	FC	First Issue.	Checked:	JL
				Approved:	PP

1:2,100,000
Scale @ A3

0 25 50 100 Km

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East Anglia TWO

Maximum Overlap with the SNS cSAC/SCI Summer Area for In-Combination Effect of Single Piling

Drg No	EA1N-EA2-DEV-DRG-IBR-00TBC256	
Rev	2	Datum: WGS 1984 Projection: Zone 31N
Date	16/11/18	
Figure	7	

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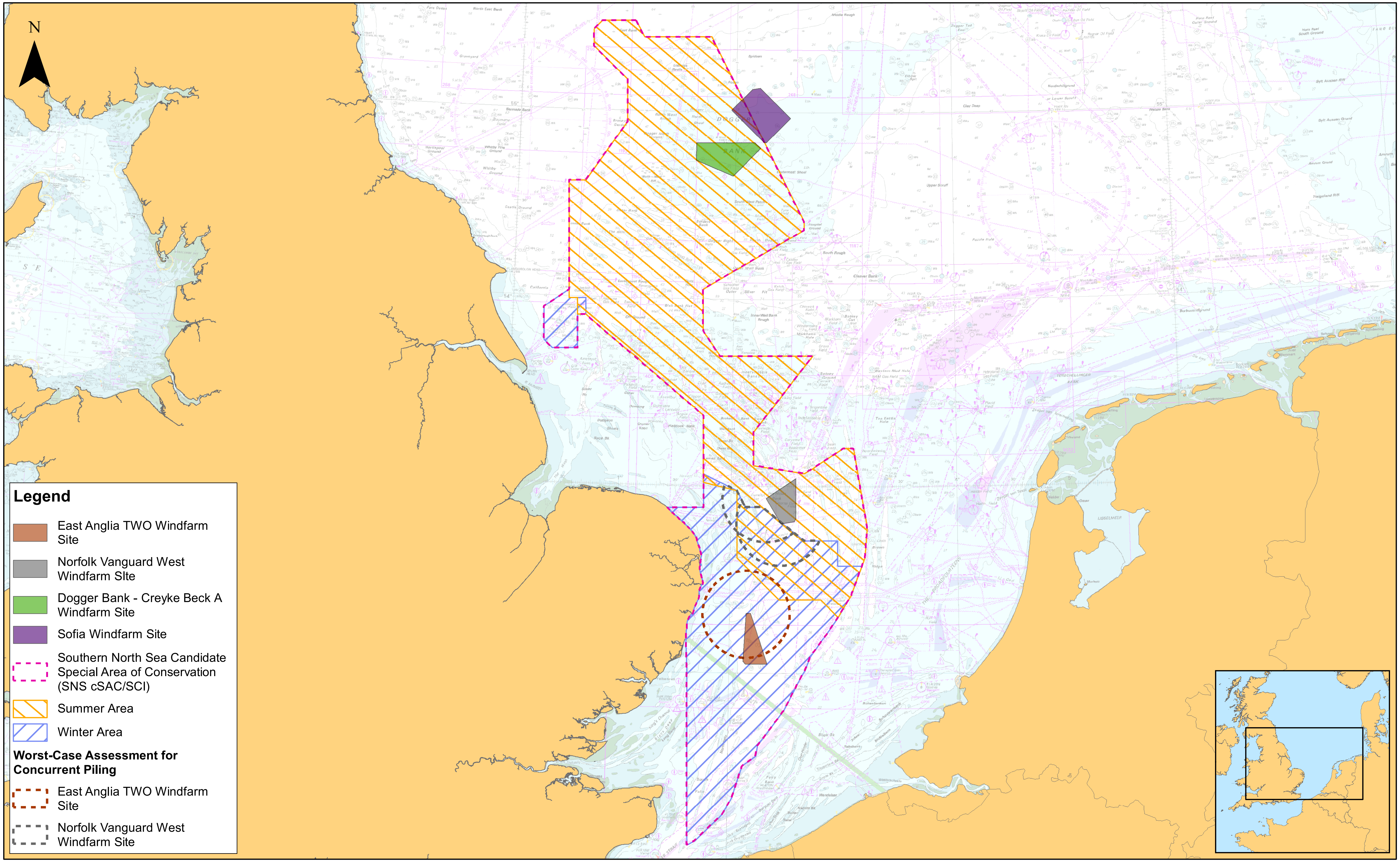

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
2	16/11/2018	JT	Second Issue.	Prepared:	FC
1	09/10/2018	FC	First Issue.	Checked:	JL
				Approved:	PP

1:2,100,000 Scale @ A3

0 25 50 100 Km

East Anglia TWO

Maximum Overlap with the SNS cSAC/SCI Winter Area for In-Combination Effect of Concurrent Piling

Drg No	EA1N-EA2-DEV-DRG-IBR-00TBC259	
Rev	2	Datum: WGS 1984 Projection: Zone 31N
Date	16/11/18	
Figure	8	

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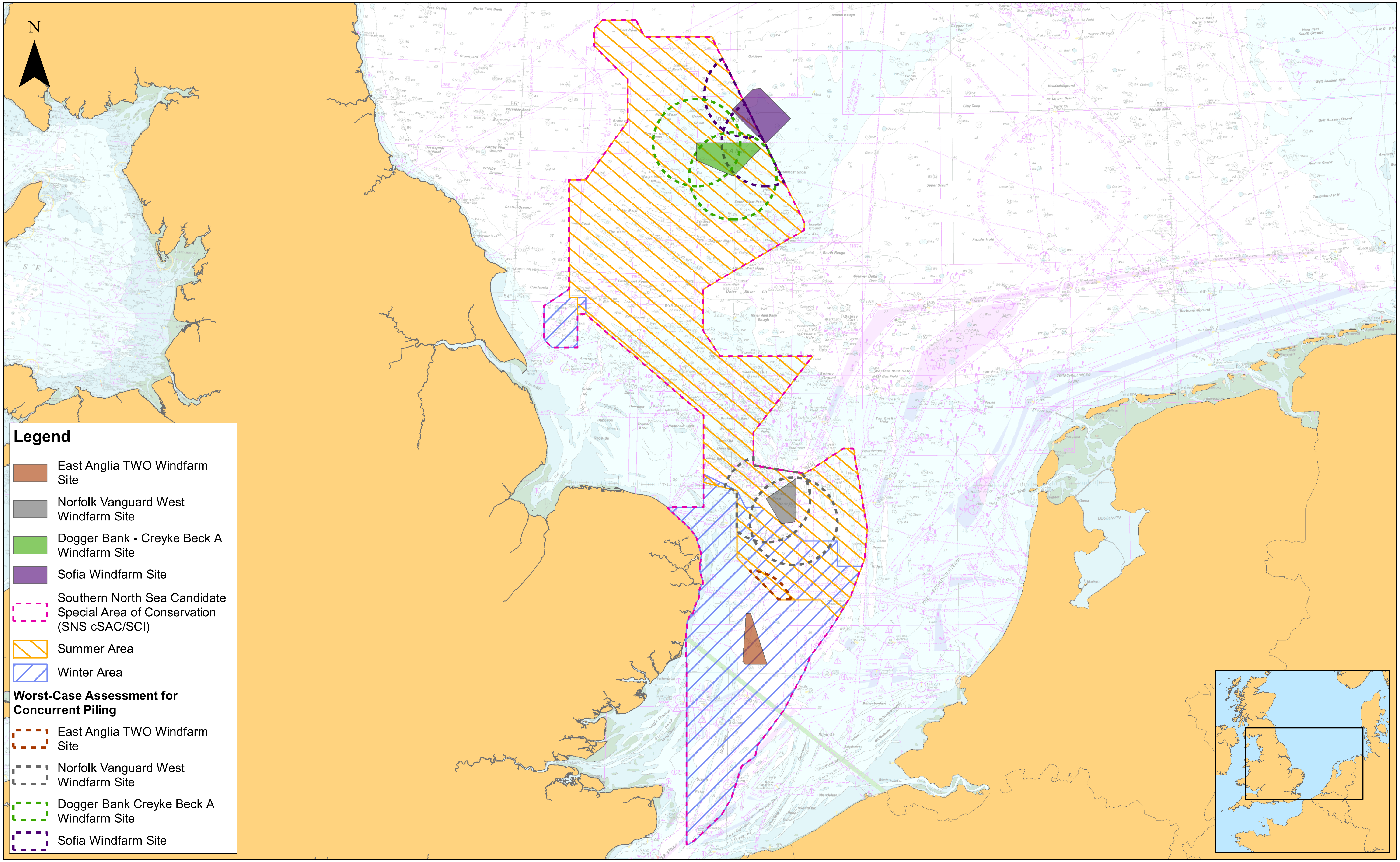

SCOTTISHPOWER RENEWABLES

Rev	Date	By	Comment		
2	16/11/2018	FC	Second Issue.	Prepared:	FC
1	09/10/2018	FC	First Issue.	Checked:	JL
				Approved:	PP

1:2,100,000
Scale @ A3

0 25 50 100 Km

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East Anglia TWO

Maximum Overlap with the SNS cSAC/SCI Summer Area for In-Combination Effect of Concurrent Piling

Drg No	EA1N-EA2-DEV-DRG-IBR-00TBC258
Rev	2
Date	16/11/18
Figure	9

Datum: WGS 1984
Projection: Zone 31N

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