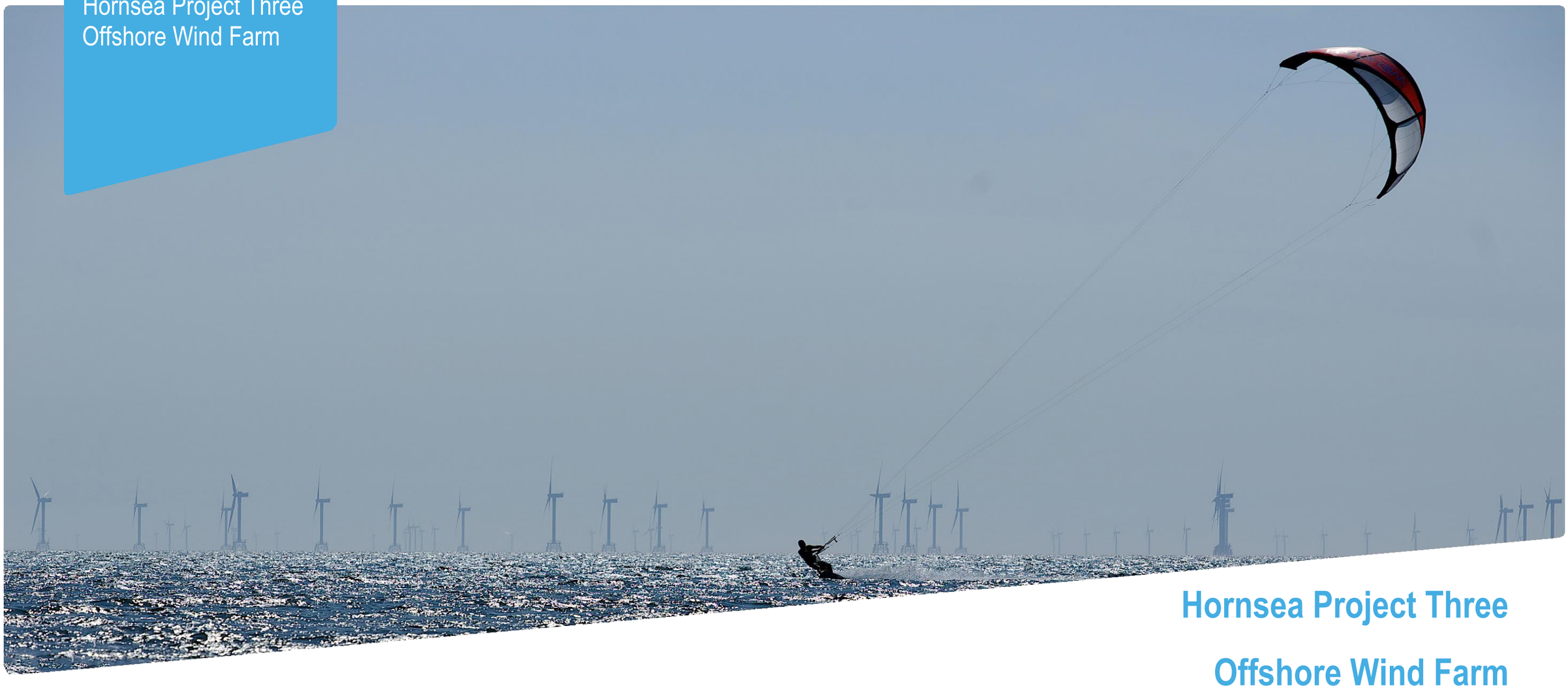
Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three

Offshore Wind Farm

Report to Inform Appropriate Assessment:
HRA Screening Report

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Hornsea 3
Offshore Wind Farm

Ørsted

Habitats Regulations Assessment

Report to Inform Appropriate Assessment

Annex 1 – HRA Screening Report

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This report is also downloadable from the Hornsea Project Three offshore wind farm website at:
www.hornseaproject3.co.uk

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Hornsea Project Three Offshore Wind Farm

Habitat Regulations Assessment:

Screening Report

December 2016

Hornsea Project Three Offshore Wind Farm

Habitat Regulations Assessment
Screening Report

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Glossary and Abbreviations

Glossary

Appropriate Assessment (AA)	An assessment to determine the implications of a plan or project on a European site in view of that site's conservation objectives. An AA forms part of the Habitats Regulations Assessment and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.
Annex I Habitat	Natural habitat types of community interest defined in Annex I of the Habitats Directive, whose conservation requires the designation of Special Areas of Conservation.
Annex II Species	Animal and plant species of community interest defined in Annex II of the Habitats Directive whose conservation requires the designation of Special Areas of Conservation.
Bern Conventiion	The Convention on the Conservation of European Wildlife and Natural Habitats (the Bern Convention) was adopted in Bern, Switzerland in 1979, and came into force in 1982. The principal aims of the Convention are to ensure conservation and protection of wild plant and animal species and their natural habitats (listed in Appendices I and II of the Convention), to increase cooperation between contracting parties, and to regulate the exploitation of those species (including migratory species) listed in Appendix III. To this end the Convention imposes legal obligations on contracting parties, protecting over 500 wild plant species and more than 1,000 wild animal species. The UK government ratified the Bern Convention in 1982. The obligations of the Convention is transposed into national law by means of the Wildlife and Countryside Act (1981 as amended), Nature Conservation (Scotland) Act 2004 (as amended), Wildlife (Northern Ireland) Order 1985, and the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. As a signatory to the European Community meets its obligations under the Convention by means of the Council Directive 79/409/EEC on the Conservation of Wild Birds (the Birds Directive) and the Council Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the Habitats Directive). (http://jncc.defra.gov.uk/page-1364)
EC Birds Directive	The European Union meets its obligations for bird species under the Bern Convention and Bonn Convention and more generally by means of Directive 2009/147/EC (**Birds Directive**)on the conservation of wild birds (the codified version of Council Directive 79/409/EEC as amended). The Directive provides a framework for the conservation and management of, and human interactions with, wild birds in Europe.

Bonn Convention	The Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention or CMS) was adopted in Bonn, Germany in 1979 and came into force in 1985. Contracting Parties work together to conserve migratory species and their habitats by providing strict protection for endangered migratory species (listed in Appendix I of the Convention), concluding multilateral Agreements for the conservation and management of migratory species which require or would benefit from international cooperation (listed in Appendix II), and by undertaking cooperative research activities. The UK ratified the Convention in 1985. The legal requirement for the strict protection of Appendix I species is provided by the Wildlife & Countryside Act (1981 as amended), the Wildlife (Northern Ireland) Order 1985, and the Nature Conservation and Amenity Lands (Northern Ireland) Order 1985. In addition the Countryside and Rights of Way Act 2000 (CRoW) was enacted in England and Wales to strengthen the protection of certain species by increasing penalties and enforcement powers; and strengthened the protection of sites from damage caused by third parties. The UK has currently ratified four legally binding Agreements under the Convention, namely the Agreement on the Conservation of Populations of European Bats (EUROBATS); the African-Eurasian Migratory Waterbird Agreement (AEWA); and the Agreement on the Conservation of Small Cetaceans in the Baltic, North-East Atlantic, Irish and North Seas (ASCOBANS), and the Agreement on the Conservation of Albatrosses and Petrels (ACAP). The UK has also ratified the Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean, in respect of the British Indian Ocean Territory, the Memorandum of Understanding on the Aquatic Warbler, the Memorandum of Understanding concerning the Conservation of Migratory Birds of Prey in Africa and Eurasia and Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region in respect of Pitcairn. (http://jncc.defra.gov.uk/page-1366).
Competent Authority	The Habitats Regulations define a competent authority as any public body or statutory undertaker that has the power to undertake or give any consent or other authorisation for a plan or project.
Design Envelope	A description of the range of possible elements which make up the project design options under consideration, as set out in detail in the project description. This envelope is used to define the project for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is also often referred to as the "Rochdale Envelope" approach.
Displacement	The potential for birds and other animals to avoid an area of land or sea during construction works, operational or maintenanance activities. Displacement may be temporary or permanent dependent on the activity undertaken and the infrastructure involved and the sensitivities of the species concerned.
European site	A Special Area of Conservation (SAC), possible SAC (pSAC), or candidate SAC, (cSAC), a Special Protection Area (SPA) or potential SPA (pSPA), a site listed as a site of community importance (SCI), or, as UK policy, a Ramsar site.
Evidence Plan	An (HRA) Evidence Plan is a formal mechanism to agree upfront what information the applicant needs to supply to the Planning Inspectorate (PINS) as part of a Development Consent Order (DCO) application. This will help ensure compliance with the Habitats Regulations. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69601/pb13825-habitats-evidence-plans.pdf
Export cable route (ECR) corridor	The specific corridor of seabed (seaward of MHWS) and land (landward of MHWS) from the Hornsea Three array area to the Norwich Main National Grid substation, within which the export cables will be located. The final ECR corridor will be located within the ECR corridor search area and will be defined via a site selection process considering technical, physical and environmental constraints
Export cable route (ECR) corridor search area	The broad offshore corridor of seabed (seaward of MHWS) and land (landward of MHWS) from the Hornsea Three array area to the Norwich Main National Grid substation considered within this Habitats Regulation Assessment Screening Report, within which the refined ECR corridor will be located.
EC Habitats Directive	The Habitats Directive (Council Directive 92/43/EEC on the Conservation of natural habitats and

	of wild fauna and flora) is a European Union directive adopted in 1992 as an EU response to the Bern Convention.
Habitat Regulations	UK legislation transposing the EC Habitats Directive. The Conservation of Habitats and Species Regulations 2010 (as amended) in respect of England and Wales and coastal waters out to the 12 NM limit. See also Offshore Habitats Regulations.
Habitat Regulations Assessment	A process to identify likely significant effects and (where likely significant effects are predicted or cannot be discounted) to assesses if there would be an adverse affect on the integrity of a European site. The process may consist of up to four stages: screening, appropriate assessment, assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI).
High Voltage Alternating current (HVAC)	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
High Voltage Direct Current (HVDC)	High voltage direct current is the bulk transmission of electricity by direct current (DC), whereby the flow of electric charge is in one direction.
Hornsea Project One	The first offshore wind farm project within the former Hornsea Zone. It has a maximum capacity of 1.2 gigawatts (GW) or 1,200 MW and includes all necessary offshore and onshore infrastructure required to connect to the existing National Grid substation located at North Killingholme, North Lincolnshire.
Hornsea Project Two	The second offshore wind farm project within the former Hornsea Zone. It has a maximum capacity of 1.8 GW (1,800 MW) and includes offshore and onshore infrastructure to connect to the existing National Grid substation located at North Killingholme, North Lincolnshire.
Hornse Three	The third offshore wind farm project within the former Hornsea Zone. It has a maximum capacity of 2.4 GW (2,400 MW) and includes offshore and onshore infrastructure to connect to the existing National Grid substation located at Norwich Main, Norfolk.
Landfall Area	The area between MHWS and MLWS in which all of the export cables will be landed and is the transitional area between the offshore export cabling and the onshore export cabling.
Likely Significant Effect	Any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the European site was designated, but excluding trivial or inconsequential effects.
Marine Mammal Mitigation Protocol (MMMP)	A document detailing the protocol to be implemented in the event that offshore driven or part-driven pile foundations are proposed to be used. The protocol identifies the methods for detection, potential mitigation and monitoring/reporting protocols for marine mammals.
Marine Pollution Contingency Plan (MPCP)	A document addressing the risks, methods and procedures to deal with spills and collision incidents during the construction, and operation and maintenance phase.
Mean High Water Spring (MHWS)	The height of mean high water during spring tides in a year.
Mean Low Water Spring (MLWS)	The height of mean low water during spring tides in a year.
Nationally Significant Infrastructure Project (NSIP)	Large scale infrastructure development including power generating stations, which requires development consent under the Planning Act 2008. An offshore wind farm project with a capacity of more than 100 MW constitutes a NSIP.
Natura 2000 network	A coherent European ecological network of Special Areas of Conservation and Special Protection Areas.
Offshore Habitats Regulations	The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended) which applies to marine habitats beyond 12 nautical miles (nm).

Planning Inspectorate (PINS)	An executive agency sponsored by the Department for Communities and Local Government, responsible, amongst other things, for operating the planning process for NSIPs prior to a DCO being considered and dermined by the Secretary of State
Preliminary Environmental Information Report	Planning Inspectorate Advice Note 7 identifies the requirement under the Infrastructure Planning EIA Regulations for Preliminary Environmental Information to be published and consulted on by an applicant before the submission of an application for a Development Consent Order. Its purpose is to allow consultees (both specialist and non-specialist) to understand the likely environmental effects of the development so as to inform their consultation responses (https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2015/03/Advice-note-7v4.pdf)
Ramsar Convention	The Convention on Wetlands of International Importance especially as Waterfowl Habitat, which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.
Ramsar Site	Wetlands of international importance, designated under the Ramsar Convention.
Special Area of Conservation (SAC)	Special Areas of Conservation (SACs) are strictly protected sites designated under the EC Habitats Directive. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).
Site of Community Importance (SCI)	Defined in the Habitats Directive as a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type in Annex I, or of a species in Annex II, of the Habitats Directive and may also contribute significantly to the coherence of the Natura 2000 network. The site may also contribute significantly to the maintenance of biological diversity within the biogeographic region or regions concerned. For animal species ranging over wide areas, SCIs shall correspond to the places within the natural range of such species which represent the physical or biological factors essential to their life and reproduction.
Special Protection Area (SPA)	Special Protection Areas (SPAs) are strictly protected sites classified in accordance with Article 4 of the EC Birds Directive, which came into force in April 1979. They are classified for rare and vulnerable birds (as listed on Annex I of the Directive), and for regularly occurring migratory species.
Waterfowl	Term used within SPA / Ramsar citations to describe ducks, geese, swans, waders and other waterbirds.
Wildfowl	Ducks, geese and swans.
Zone Appraisal and Planning (ZAP)	A framework intended to rationalise and balance the commercial aim of maximising development capacity aspirations with the practicalities of deliverability.
Zone Characterisation (ZoC)	A broad description of the physical, biological, socio-economic and cultural heritage characteristics of the former Hornsea Zone, at a resolution sufficient to support zonal layout and subsequent project identification. This does not take the form of a tangible output, but reflects the increase in understanding of the former Hornsea Zone over time.

Acronyms and Terms

AA	Appropriate Assessment
BDMPS	Biologically Defined Minimum Population Scale
Cefas	Centre for Environment Fisheries and Aquaculture Science
CoCP	Code of Construction Practice
cSAC	Candidate SAC
DCO	Development Consent Order
EMF	Electromagnetic Field
EEZ	Exclusive Economic Zone
GBF	Gravity base foundation
HDD	Horizontal Directional Drilling
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
kJ	Kilojoule
km	Kilometre
kV	Kilovolt
LSE	Likely Significant Effect
MMO	Marine Management Organisation
MV	Medium Voltage
MW	Megawatt
NPS	National Policy Statement
nm	Nautical Mile
PEIR	Preliminary Environmental Information Report
PEMMP	Project Environmental Management and Monitoring Plan
PINS	Planning Inspectorate
Project One	Hornsea Project One
Project Two	Hornsea Project Two
PRoW	Public Right of Way
pSCI	Proposed Site of Community Importance
pSPA	Potential SPA
RSPB	Royal Society for the Protection of Birds

SAC	Special Area of Conservation
cSAC	Candidate Special Area of Conservation
pSAC	Possible Special Area of Conservation
SCI	Site of Community Importance
SCOS	Special Committee on Seals
SMRU	Sea Mammal Research Unit
SNCB	Statutory Nature Conservation Body
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate
TJB	Transition Joint Bay
TP	Transition piece
UXO	Unexploded Ordnance
WeBS	Wetland Bird Survey
WWT	Wildfowl and Wetlands Trust
ZAP	Zone Appraisal and Planning
ZEA	Zone Environmental Appraisal
ZOI	Zone of Influence

1. Introduction

1.1 Purpose of this report

1.1.1 This document has been produced to inform the Habitat Regulations Assessment (HRA) process for the Hornsea Project Three Offshore Wind Farm (hereafter referred to as Hornsea Three). It provides information to enable the screening of Hornsea Three with respect to its potential to have a likely significant effect (LSE) on European sites of nature conservation importance. This step in the process and associated reporting requirements are further described in the following sections.

1.1.2 In this context[1], European sites are defined as Special Areas of Conservation (SACs), Sites of Community Importance (SCIs) and Candidate SACs (cSACs) designated under the Habitats Directive (92/43/EEC) and Special Protection Areas (SPAs) designated under Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'). In addition to sites designated under European nature conservation legislation, UK Government policy (ODPM Circular 06/2005) states that internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites and potential Ramsar sites) are afforded the same protection as SPAs and SACs, for the purpose of considering development proposals that may affect them (and so are considered in this report as "European sites").

1.1.3 The European Commission's guidance on Planning for the Protection of European Sites: Appropriate Assessment (2001) identifies a staged process to the assessment of the effects of plans or projects on European sites. Cumulatively, these stages are referred to as the Habitat Regulations Assessment, in order to clearly distinguish the whole process from the second stage within it, which is referred to as the 'appropriate assessment'. There are potentially up to four stages:

i) Screening;
ii) Appropriate Assessment;
iii) Mitigation and alternatives; and
iv) Imperative Reasons of Overriding Public Interest (IROPI).

1.1.4 This report comprises the Screening Stage, where the identification of LSE is reported. LSE is, in this context, any effect that may be reasonably predicted as a consequence of a project that may affect the conservation objectives of the features for which the European site was designated, but excluding trivial or inconsequential effects.

1.1.5 Please note that for the purposes of this report an initial pre-LSE screening stage has been introduced into the process. This stage is essentially a site-identification / selection process, which, while it forms part of the overall LSE determination stage of HRA, has been separated out to refine the need to undertake more detailed consideration of LSE across all of the possible sites and features that could be influenced by Hornsea Three.

[1] Note that consideration in this resport has also be given to sites which are currently at an early statge in the designation process, including possible SACs (pSACs) and potential SPAs (pSPAs)

1.1.6 It should also be noted that the assessment provided in this document is based on Hornsea Three's current understanding of the baseline environment and the scope and nature of the proposed project activities. Further environmental survey and assessment work, consultee and advisor responses to this document, and refinements to the project design may change this assessment. These changes will be reflected in the draft HRA Report to be consulted on as part of the pre-application consultation activity.

1.2 Project overview

Hornsea Zone

1.2.1 The Hornsea Zone was one of nine offshore wind generation zones around the UK coast identified by The Crown Estate (TCE) during its third round of offshore wind licensing. The Hornsea Zone was located in the southern North Sea, approximately 31 km east of the Yorkshire coast and 1 km from the median line between UK and Dutch waters.

1.2.2 As part of a competitive tender, SMart Wind Ltd. (a 50/50 joint venture between International Mainstream Renewable Power (Offshore) Limited and Siemens Project Ventures GmbH; hereafter referred to as SMart Wind) was awarded the rights to the development of the former Hornsea Zone by TCE in 2009. The subsequent Zone Development Agreement between SMart Wind and TCE established a target capacity of 4,000 MW of generating capacity within the former Hornsea Zone, which was to be met through the development of several offshore wind farms.

1.2.3 DONG Energy Wind Power A/S acquired the development rights to Project One in February 2015 and, in August 2015, DONG Energy Power (UK) Ltd. acquired SMart Wind Ltd and the Hornsea Zone, together with the development rights for Project Two, Hornsea Three and Hornsea Project Four offshore wind farm (hereafter referred to as Hornsea Four). Subsequently in March 2016, the Hornsea Zone Development Agreement was terminated and project specific agreements, Agreement for Leases (AfLs), were agreed with TCE for Project One, Project Two, Hornsea Three and Hornsea Four. The Hornsea Zone has therefore been dissolved and is referred to throughout the Hornsea Three HRA Screening Report as the former Hornsea Zone.

1.2.4 The first project to be proposed within the former Hornsea Zone was Project One. Project One comprises up to three offshore wind farm arrays with a maximum generating capacity of 1,200 MW. The Secretary of State granted development consent for Project One on 10th December 2014. The second project to be proposed within the former Hornsea Zone was Project Two. Project Two comprises up to two offshore wind farm arrays with a maximum generating capacity of 1,800 MW. The Secretary of State granted development consent for Project Two on 16th August 2016.

1.2.5 DONG Energy Power (UK) Ltd., on behalf of DONG Energy Hornsea Project Three (UK) Ltd., is promoting the development of the Hornsea Project Three offshore wind farm (Hornsea Three). Hornsea Three is a proposed offshore wind farm located in the southern North Sea, with a total generating capacity of up to 2,400 MW. This HRA Screening Report considers the likely impact on European sites from the Hornsea Three project alone and in-combination with other relevant plans and projects.

1.2.6 The location of the proposed Hornsea Three array site within the former Hornsea Zone and the export cable route (ECR) corridor search area is shown in Figure 1.1.

Hornsea Three

Introduction

1.2.7 Hornsea Three will have a total capacity of up to 2,400 MW and will include up to 400 turbines and all associated offshore and onshore infrastructure. The Hornsea Three offshore Export Cable Route (ECR) corridor search area extends from the Norfolk coast, offshore in a northeasterly direction to the western and southern boundary of the Hornsea Three array area. The Hornsea Three offshore ECR corridor is approximately 120 km in length. If HVAC (High Voltage alternating Current) is used a booster station will be required, located either onshore (along the onshore cable corridor route) or offshore (located within the ECR corridor search area).

1.2.8 From the Norfolk coast, onshore cables will connect the offshore wind farm to an onshore High Voltage Alternating Current (HVAC) substation/High Voltage Direct Current (HVDC) converter substation, which will in turn, connect to an existing National Grid substation. Hornsea Three will connect to the Norwich Main National Grid substation, located to the south of Norwich. The onshore ECR corridor search area is approximately 55 km in length, at its fullest extent.

1.2.9 The Hornsea Three search area, including both onshore and offshore components, was selected following both engineering and environmental considerations.

Key project components

1.2.10 Key project components of Hornsea Three include:

- Turbines;
- Turbine foundations;
- Array cables;
- Offshore substation(s), station(s) and platform(s);
- Offshore accommodation platform/s;
- Offshore export cable/s;
- Onshore cabling; and
- Onshore substation and onshore HVAC booster stations.

1.2.11 The electricity generated from Hornsea Three will be transmitted via buried High Voltage (HV) cables using either Direct Current (DC) or Alternating Current (AC), or a combination of the two.

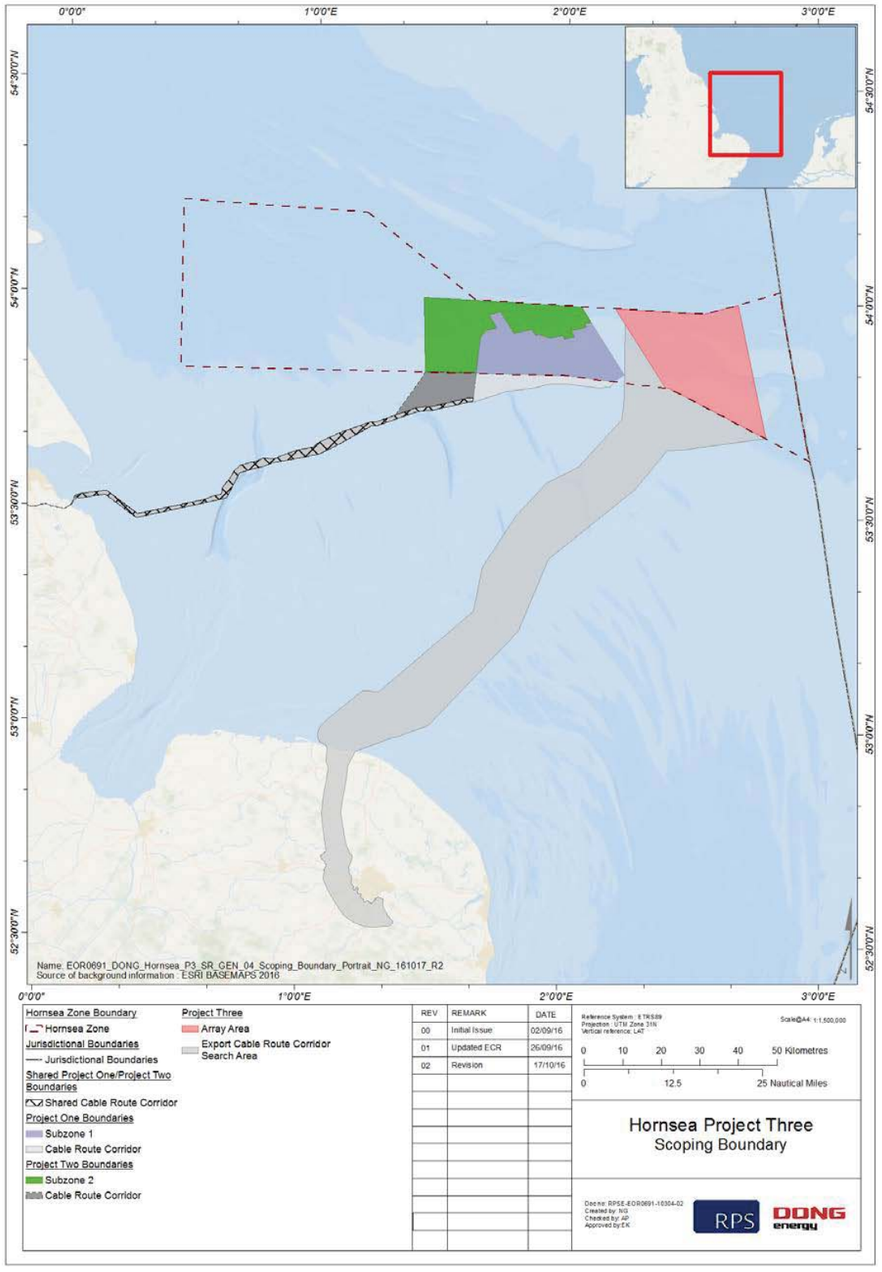

Figure 1.1 Location of the proposed Hornsea Three offshore wind farm and Export Cable Route (ECR) corridor search area within the former Hornsea Zone.

1.3 Outline of the structure and contents of this report

1.3.1 This document is set out in a number of stages that mirror the HRA process and the following is provided:

- A brief summary of the Habitat Regulations Assessment Process (Section 2);
- A brief summary of the main components of Hornsea Three (Section 3);
- A summary description of the environmental baseline relevant to the screening process (Section 4);
- Initial identification of sites and features which may potentially be affected by Hornsea Three (Section 5);
- Screening - an assessment of the potential for LSEs to arise with regard to the designated features of the European sites under consideration (Section 6);
- Approach to in-combination assessment (Section 7); and
- A summary of the European sites and features for which the screening process has identified potential for a LSE (Section 8).

1.3.2 At this stage in the assessment, it is important to note that the screening of sites into the HRA process and the determination of LSE is provisional. As environmental assessment outcomes for Hornsea Three are presently unavailable and the information available to relevant parties, including the Statutory Nature Conservation Bodies (SNCBs), is largely limited to a description of parameters at the Hornsea Zone level, a precautionary stance has been adopted.

2. The Habitat Regulations Assessment Process

2.1 Legislative context

2.1.1 The Habitats Directive (92/43/EEC), on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance. Together with Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Habitats Directive establishes a network of internationally important sites, designated for their ecological status. SACs are designated under the Habitats Directive and promote the protection of flora, fauna and habitats. Special Protection Areas (SPAs) are designated under the Birds Directive in order to protect rare, vulnerable and migratory birds. These sites combine to create a Europe-wide 'Natura 2000' network of designated sites, which are hereafter referred to as 'European sites'.

2.1.2 Terrestrial areas of the UK and territorial waters out to 12 nautical miles (nm) are covered under The Conservation of Habitats and Species Regulations 2010 (herein referred to as the Habitats Regulations). The Habitats Regulations incorporate all SPAs into the definition of 'European sites' and, consequently, the protections afforded to European sites under the Habitats Directive apply to SPAs designated under the Birds Directive.

2.1.3 The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007 (the Offshore Habitats Regulations) transpose the Habitats and Birds Directives into national law, covering waters beyond 12 nautical miles, to the extent of the British Fishery Limits and UK Continental Shelf Designated Area. The Offshore Habitats Regulations came into force on 21 August 2007.

2.1.4 In addition, UK Government policy (ODPM Circular 06/2005) states that internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites) are afforded the same protection as SPAs and SACs for the purpose of considering development proposals that may affect them. The Government also affords the same level of protection to potential SPAs (pSPAs) and candidate SACs (cSACs).

2.1.5 Under the Habitats Regulations and the Offshore Habitats Regulations, before granting approval (i.e. planning permissions, licenses and consents) for a development likely to have a significant effect on an SAC or SPA / Ramsar site, an appropriate assessment must be made by a Competent Authority of its implications for the site in view of that site's conservation objectives.

2.2 The Habitat Regulations process

2.2.1 The Habitat Regulations require that wherever a project that is not directly connected to, or necessary for, the management of a Natura 2000 site is likely to have a significant effect on the conservation objectives of the site (directly, indirectly, alone or in-combination with other plans or projects) then an 'Appropriate Assessment' (AA) must be undertaken by the Competent Authority (Regulation 61 of the Habitats Regulations). The Appropriate Assessment must be carried out before consent or authorisation can be given for the project.

2.2.2 The Planning Inspectorate (PINS) Advice Note Ten 'Habitat Regulations Assessment relevant to nationally significant infrastructure projects' (version 7, January 2016), defines HRA as a step by step process which determines likely significant effect (LSE) and (where appropriate) assesses adverse impact on the integrity of a European site, examines alternative solutions, and provides justification of Imperative Reasons of Overriding Public Interest (IROPI) This constitutes a four stage process as summarised below and illustrated in Figure 2.1.

- HRA Stage 1 - Screening: Screening for LSE (alone or in-combination with other projects or plans);
- HRA Stage 2 - Appropriate Assessment: Assessment of implications of identified LSEs on the conservation objectives of a European site to ascertain if the proposal will adversely affect the integrity of a European site;
- HRA Stage 3 – Assessment of Alternative Solutions (where it cannot be ascertained that the proposal will not adversely affect the integrity of a European site); and
- HRA Stage 4 – Assessment of IROPI (where no alternative solutions are identified).

2.2.3 All four stages of the process are referred to as the Habitats Regulations Assessment (HRA) to clearly distinguish the whole process from the one step within it referred to as the "Appropriate Assessment" (AA).

2.2.4 The integrity of a site is defined as the coherence of the site's ecological structure and function, across the whole of its area, which enables it to sustain the habitat, complex of habitats and/or populations of species for which the site has been designated (EC, 2001). An adverse effect on integrity is likely to be one which prevents the site from making the same contribution to favourable conservation status as it did at the time of designation.

2.3 Roles and responsibilities

2.3.1 The National Infrastructure Directorate within the Planning Inspectorate (hereafter known as "the Examining Authority") is the body responsible for examining applications for development consent under the Planning Act 2008. The Examining Authority will not make the final decision on Hornsea Three; this decision will fall to the Secretary of State for Business, Energy and Industrial Strategy (BEIS) (hereafter referred to as "the Secretary of State").

2.3.2 This Screening Report and the Report to Inform the Appropriate Assessment (HRA Report) produced for Hornsea Three will provide the information required by the Competent Authority to enable it to undertake an Appropriate Assessment, if required, in accordance with Article 6(3) of the Habitats Directive.

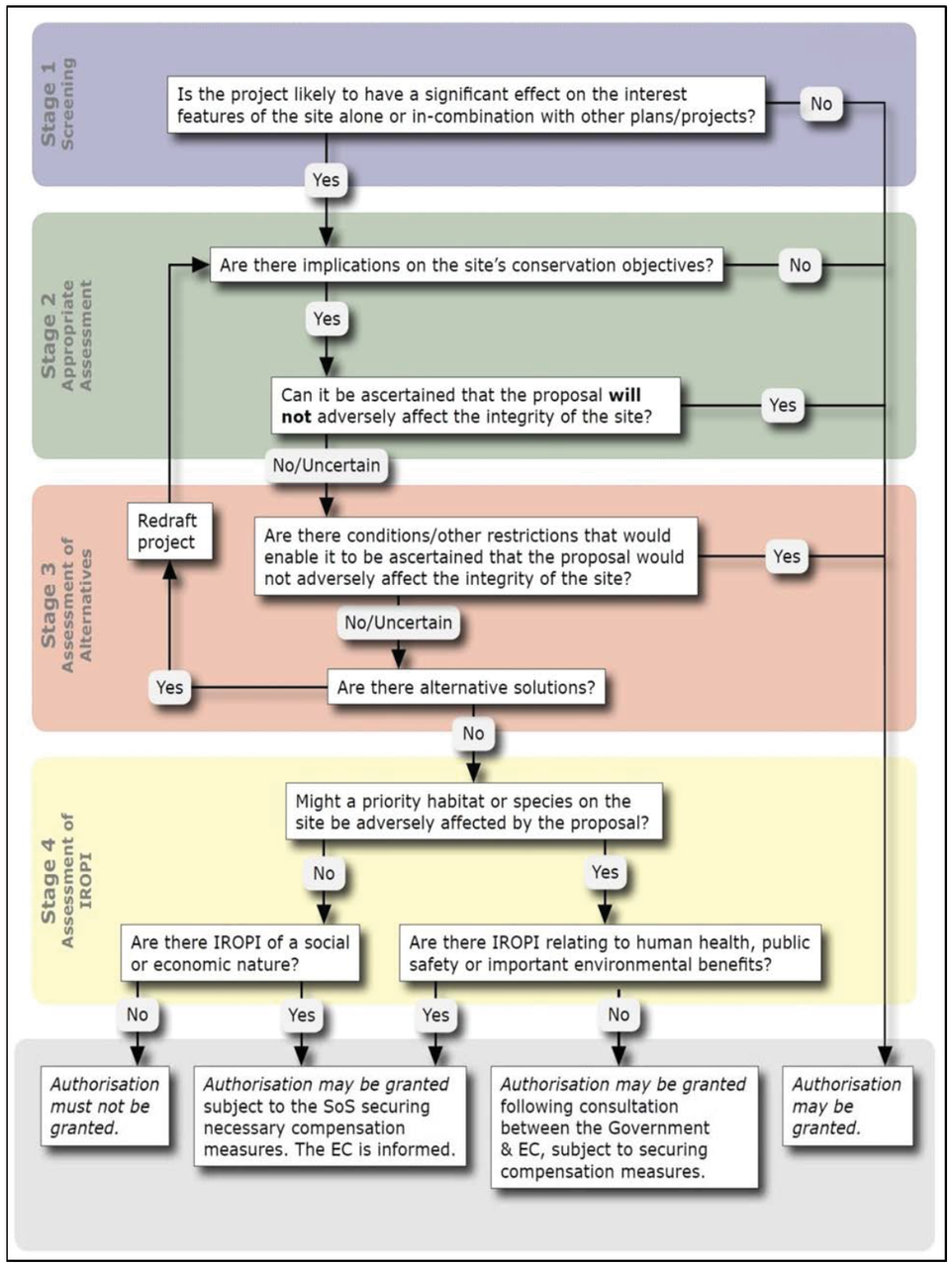

Figure 2.1 Four stage HRA process (The Planning Inspectorate, 2016).

2.4 Approach to screening

2.4.1 Screening is a relatively coarse filter to identify those sites and features for which a LSE cannot be discounted. For the purposes of this report an initial pre-LSE screening stage has been introduced into the process (Section 5). This stage is essentially a site-identification / selection process, which, while it forms part of the overall LSE determination stage of HRA, has been separated out to refine the list of sites taken forward for a more detailed consideration of LSE. Once a site/feature is identified, the screening exercise considers whether or not a significant effect can be foreseen, both directly and indirectly. A precautionary approach is followed, where it is not currently possible to exclude a LSE, then the site/feature is progressed to the AA Stage (Stage 2 of the HRA).

2.4.2 In relation to each European site considered in the screening exercise, at Stage 1 of the HRA (Screening), it will be concluded that either:

- There are no LSEs on the European site(s) and therefore no further assessment is required; or
- LSEs on the European site(s) cannot be discounted and these require an Appropriate Assessment by the Competent Authority.

2.4.3 With respect to in-combination effects, this screening report identifies the categories of plans and projects that will need to be considered, but recognises that further discussion with local authorities and SNCBs will be required to identify specific projects for inclusion in the in-combination assessment. The HRA Report will include, for those sites screened into assessment, a detailed in-combination assessment drawing on the environmental impact assessments (including cumulative assessment) undertaken specifically for Hornsea Three to understand the magnitude of those effects and whether they may lead to an adverse effect on site integrity.

3. Project Description

3.1 Introduction

3.1.1 This section of the HRA Screening Report provides an outline description of the potential design of Hornsea Three, based on preliminary conceptual design information and current understanding of the environment from initial survey work. It sets out the Hornsea Three design and components for both the onshore and offshore infrastructure, as well as the activities associated with the construction, operation and maintenance, and decommissioning of the project.

3.1.2 At this early stage, the Hornsea Three project description is indicative and, like all offshore wind farms, the turbine design may not be confirmed until after consent has been granted. Consequently the 'Design Envelope' (also referred to as a Rochdale Envelope) includes sufficient flexibility to allow the detailed design to vary within the envelope whilst ensuring that the project as constructed has been properly assessed[2]. This section therefore sets out a series of options and parameters for which (unless otherwise noted as minimum values) maximum values are shown. From these values the "maximum adverse scenarios" for impact assessment (for both HRA and EIA) are developed. The envelope values may change as the final design is developed but should not be exceeded.

3.1.3 A further refined and detailed project description will be provided in the project's Preliminary Environmental Information Report (PEIR) issued during pre-application consultation and the Environmental Statement that will accompany the application for a Development Consent Order.

3.2 Proposed Hornsea Three boundary

3.2.1 The proposed Hornsea Three boundary is illustrated in Figure 1.1 above. This area encompasses the:

- Hornsea Three Array area: This is where the offshore wind farm will be located, which will include the wind turbines, wind turbine foundations, array cables, and a range of offshore substations, offshore interconnector cables, and offshore accommodation platform(s);
- Hornsea Three offshore ECR corridor search area: This is where the permanent offshore electrical infrastructure (offshore export cable(s), as well as the offshore HVAC booster station(s), if required) will be located; and
- Hornsea Three onshore ECR corridor search area: This is where the permanent onshore electrical infrastructure (onshore export cable(s), as well as the onshore HVAC booster station, if required), onshore substation and connections to the National Grid will be located.

[2] National Policy Statement for Renewable Energy Infrastructure (EN-3) refers, see EN-3 section 2.6.43 Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/37048/1940-nps-renewable-energy-en3.pdf

3.3 The Agreement for Lease area

3.3.1 The Agreement for Lease (AfL) from The Crown Estate (TCE) allows DONG Energy to carry out investigations, such as seabed surveys, to inform the project design and the DCO application and, if development consent is granted, to subsequently call for TCE to grant a Lease for the lifetime of the wind farm.

3.3.2 The AfL area for Hornsea Three array area covers approximately 696 km^2 and is broadly a diamond shape with a length of approximately 29 km west to east and 35 km north to south. The AfL area is where the offshore infrastructure, such as the turbines, offshore substation(s) and array cables, will be located. This area is hereafter referred to as the array area throughout the Screening Report.

3.3.3 Hornsea Three does not yet have an AfL area for the offshore ECR corridor. This will be applied for once an offshore ECR has been defined following initial survey and design work. Details of the Hornsea Three offshore ECR corridor AfL area will be included in the Environmental Statement.

3.4 Offshore infrastructure

Wind turbines

3.4.1 The Hornsea Three design currently assumes construction of up to 400 wind turbines. A range of turbine models with a range of capacities will be considered. The design assumption is that all turbines will follow the traditional offshore wind turbine design with three blades and a horizontal rotor axis.

3.4.2 Each turbine will have a maximum rotor blade diameter of 265 m and a maximum blade tip height of 325 m LAT (highest point of the structure). The minimum distance between the bottom of the blade and the water surface will be 34.97 m LAT.

3.4.3 The Environmental Statement will contain more detail on the turbine model options being considered but the decision on turbine selection will not have been made when the Environmental Statement is submitted hence the environmental assessment uses a 'Design Envelope' to include the worst case parameters to be assessed for environmental impact. The Design Envelope for Hornsea Three's wind turbines is shown Table 3.1.

Table 3.1 Design Envelope: wind turbines.

Parameter	Maximum Design Envelope
Maximum number of turbines	400
Minimum height of lowest blade tip above LAT (m)	34.97
Maximum blade tip height above LAT (m)	325
Maximum rotor blade diameter (m)	265

Foundations

3.4.4 The wind turbines, offshore substation(s) and offshore accommodation platforms(s) are fixed to the seabed by foundation structures. There are a number of foundation types that can be used and the type(s) used will not be confirmed until the final design of the wind farm, post-consent. Consequently, the environmental assessment is likely to consider a range of types, including monopiles, suction bucket jacket foundations, piled jacket foundations, mono suction buckets, gravity base structures and floating foundations.

3.4.5 Some form of seabed preparation will be required for each foundation type. Seabed preparations may include seabed levelling and removing surface and subsurface debris such as boulders, fishing nets, lost anchors etc. If debris is present below the seabed surface, then excavation may be required for access and removal. Any unexploded ordnance (UXO) found with a potential to contain live ammunition will be detonated on site in consultation with the MMO and TCE.

3.4.6 The foundations are fabricated offsite, stored at a suitable port facility and transported to site as needed. Specialist vessels are needed to transport and install foundations. A scour protection layer (typically rock) may be needed on the seabed and is installed either before or after foundation installation. The foundation types that will be considered in the environmental assessment are described in the following sections.

Monopile foundations

3.4.7 Monopile foundations typically consist of a single steel tubular section and a transition piece (TP) which may include boat landing features, ladders, and other ancillary components as well as a flange for connection to the wind turbine tower. The TP is usually painted yellow and marked according to relevant regulatory guidance and may be installed separately following the monopile installation.

3.4.8 In most instances, monopiles are driven into the seabed from a jack-up barge using hydraulic hammers, which are available in various capacities for operation either above or under the water surface. In areas of hard soil or bedrock close to the seabed surface where piling with a hammer is difficult or impossible, drilling may be used to assist piling. Drilling operations produce spoil which is typically disposed of at the drill site.

3.4.9 During the construction phase of Hornsea Three, up to four installation vessels may be in operation at any one time, usually operating over a 24-hour period, with up to two vessels piling simultaneously. The installation of a single monopile foundation may take between 1 and 3 days allowing for logistical delays, vessel re-positioning and commissioning at each installation location, although continuous piling itself typically lasts only two to eight hours. Piling always commences with low hammer energies ('soft start') and maximum hammer energies are used only where ground conditions require.

3.4.10 The Design Envelope for monopile foundations is shown in Table 3.2.

Table 3.2 Design Envelope: monopile foundations.

Parameter	Maximum Design Envelope
Number of monopiles (includes wind turbines, offshore accommodation platforms and offshore substations)	420
Maximum diameter (m)	15
Maximum hammer energy (kJ)	5,000
Number of simultaneous piling events	2
Maxium piling duration (per monopile) (hrs)	8

Piled jacket foundations

3.4.11 Piled jacket foundations are formed of a steel lattice construction (comprising tubular steel members and welded joints) secured to the seabed by driven pin piles attached to the jacket feet. Jacket structures can be used to support wind turbines, accommodation platforms or offshore substations. Typically, the hollow steel pin piles are driven, drilled or vibrated into the seabed relying on the frictional and end bearing properties of the seabed for support. Unlike monopiles, there is no separate TP. The TP and ancillary structure is fabricated as an integrated part of the jacket structure and is not installed separately offshore. Pin piles will typically be narrower than monopiles and piling operations will need to continue underwater to drive the pin pile to the seabed surface.

3.4.12 The Design Envelope for jacket foundations with pin piles is shown in Table 3.3.

Table 3.3 Design Envelope: jacket foundation with pin piles.

Parameter	Maximum Design Envelope
Number of jackets (includes wind turbines, offshore accommodation platforms and offshore substations)	420
Number of legs	4
Height of platform above LAT (m)	40
Separation of adjacent legs at seabed level (m)	40
Separation of adjacent legs at LAT (m)	25
Leg diameter (m)	4.6
Pin pile diameter (m)	4
Hammer energy (kJ)	2,500

Suction bucket jacket foundations

3.4.13 Suction bucket jacket foundations are formed with a steel lattice construction (comprising tubular steel members and welded joints) fixed to the seabed by suction buckets installed below each leg of the jacket. The suction buckets are typically hollow steel cylinders which are fitted in a horizontal position underneath the legs of the jacket structure. They do not require a hammer or drill for installation. Unlike monopiles, there is no separate TP. The TP and ancillary structure is fabricated as an integrated part of the jacket structure and is not installed separately offshore.

3.4.14 Once at site, the jacket foundation will be lifted by the installation vessel using a crane, and lowered towards the seabed in a controlled manner. When the steel caisson reaches the seabed, a pipe running up through the stem above each caisson will begin to suck water out of each bucket. The buckets are pressed down into the seabed by the resulting suction force. When the bucket has penetrated the seabed to the desired depth, the pump is turned off. A thin layer of grout is then injected under the bucket to fill the air gap and ensure contact between the soil within the bucket, and the top of the bucket itself.

3.4.15 The Design Envelope for jacket foundations with suction buckets is shown in Table 3.4.

Table 3.4 Design Envelope: jacket foundation with suction buckets.

Parameter	Maximum Design Envelope
Number of jackets with suction buckets (includes wind turbines, offshore accommodation platforms and offshore substations)	420
Number of legs	4
Height of platform above LAT (m)	40
Separation of adjacent legs at seabed level (m)	40
Separation of adjacent legs at sea surface (m)	25
Bucket diameter (m)	20

Mono suction bucket foundations

3.4.16 A mono suction bucket consists of a single suction bucket supporting a single steel or concrete structure, which supports the wind turbine. The installation method is similar to that described for the suction bucket jacket, and as with the jacket structures this foundation type does not require a TP to be installed offshore.

3.4.17 The Design Envelope for this foundation type is shown in Table 3.5.

Table 3.5 Design Envelope: mono suction bucket.

Parameter	Maximum Design Envelope
Number of jackets with mono suction buckets (includes wind turbines, offshore accommodation platforms and offshore substations)	420
Suction bucket diameter (m)	40
Suction bucket penetration depth (m)	20
Suction bucket height above seabed (m)	10

Gravity base foundations

3.4.18 Gravity base foundations are heavy steel, concrete, or steel and concrete structures sometimes including additional ballast that sit on the seabed to support the turbine tower. Gravity bases vary in shape and are placed in pre-prepared areas of seabed, preparation that may involve levelling and dredging soft mobile sediments. A gravity base does not require piling or drilling to remain in place. Scour protection is usually required to avoid the structure being undermined. The amount of ballast and scour protection will depend on structure design and location.

3.4.19 The Design Envelope for gravity base foundations is shown in Table 3.6.

Table 3.6 Design Envelope: gravity base foundation.

Parameter	Maximum Design Envelope
External diameter (excluding scour protection) (m)	53
Number of gravity base foundations (includes wind turbines, offshore accommodation platforms and offshore substations)	420
Seabed preparation diameter (m)	61
Scour protection width (m)	93

Floating foundations

3.4.20 Floating foundations can consist of a range of structure types, typically classed as spar buoys, tensioned-leg platforms or semi-submersibles. This classification depends on how stability is achieved; by ballast at the base of the spar, by tension in the mooring lines or by a wide structure at the water surface. Typically, the structure will consist of either a single slender vertical cylindrical structure, called a spar buoy, or a shallower and more complex structure consisting of various tubular and plate elements, called a tensioned-leg platform or semi-submersible platform.

3.4.21 The foundations are typically fabricated from steel and/or concrete and are held in place by mooring lines connected to anchors in the seabed. The anchors could be piles, suction buckets, gravity structures or drag anchors. The structures will either be floated into place from harbour or brought to site on suitable installation vessels and lifted into the water. The anchors will be installed using a range of methods dependent on the anchor type, including piling, drilling, suction, and placement. The installation of the anchors is likely to be carried out by a separate vessel.

3.4.22 The Design Envelope for floating foundations is shown in Table 3.7.

Table 3.7 Design Envelope: floating foundation.

Parameter	Maximum Design Envelope
Foundation surface dimension (m)	70
Depth of structure (m)	50
Number of mooring lines and anchors (per turbine)	12
Mooring cable radius (m)	1,000
Number of floating foundations (includes wind turbines, offshore accommodation platforms and offshore substations)	420

Scour protection for foundations

3.4.23 Scour protection is designed to prevent any foundation structures for turbines, substations and offshore accommodation platforms, being undermined by sediment processes and seabed erosion. The shape of the foundation structure is an important parameter influencing the potential depth of scour hole formation. Scour around foundations is typically mitigated by the use of scour protection measures. Several types of scour protection exist, including mattress protection, sand bags, stone bags and artificial seaweeds. However, the placement of large quantities of crushed rock around the base of the foundation structure is the most frequently used solution (‘rock placement’).

3.4.24 The preferred scour protection solution may comprise a rock armour layer resting on a filter layer. The filter layer can either be installed before the foundation is installed (‘pre-installed’) or afterwards (‘post-installed’). Alternatively, by using heavier rock material with a wider gradation, it is possible to avoid using a filter layer and pre-install a single layer of scour protection.

3.4.25 The amount of scour protection required will vary for the different foundation types being considered for Hornsea Three. The final choice and detailed design of a scour protection solution for the wind farm will be made after detailed design of the foundation structure, taking into account a range of aspects including geotechnical data, meteorological and oceanographical data, water depth, foundation type, maintenance strategy and cost.

3.4.26 The Design Envelope for scour protection is shown in Table 3.8.

Table 3.8 Design Envelope: scour protection.

Parameter	Maximum Design Envelope*
Total wind farm scour protection material volume (includes wind turbines, offshore accommodation platforms and offshore substations) (m^3)	3,390,000
Total wind farm scour protection seabed area (includes wind turbines, offshore accommodation platforms and offshore substations) (km^2)	1.7

* Note - Worst case derived from the use of gravity base foundations for all relevant infrastructure.

Array cables

3.4.27 Cables carrying the electrical current produced by the wind turbine generators will link the wind turbines to an offshore substation. A small number of turbines will typically be grouped together on the same cable 'string' connecting those turbines to the substation, and multiple cable 'strings' will connect back to each offshore substation.

3.4.28 The cables will be buried below the seabed wherever possible. It may be necessary in places, where crossing pre-existing cables or exposed bedrock for example, to cover the cables with a hard protective layer (such as rock or concrete mattresses) to ensure that the cable remains secure and is not a hazard to other sea users and does not risk becoming exposed and damaged by tidal currents.

3.4.29 The indicative Design Envelope for array cables is shown in Table 3.9.

Table 3.9 Design Envelope: array cables.

Parameter	Maximum Design Envelope
Cable diameter (mm)	200
Burial depth	To be determined via a cable burial assessment
Installation methodology	Trenching, dredging, jetting, ploughing, vertical injection, rock cutting
Total length of cable (km)	850
Width of seabed affected by installation per cable (m)	10
Total seabed disturbed (km^2)	8.5

Offshore accommodation platforms

3.4.30 Hornsea Three may construct up to three offshore accommodation platforms to allow operations staff to be housed at the wind farm site for a number of weeks at a time, and to allow spares and tools to be stored at the wind farm site. This aims to reduce trips to the wind farm and time spent in transit, in order to decrease down time for faults and repairs. The accommodation platforms would be accessed by vessel and/or helicopter, and may have associated captive vessels to access the turbines and substations. The accommodation platforms may also be co-sited with offshore substations, including bridge access between the two platforms. The accommodation platforms would use the same substructure and foundation concepts as the turbines and offshore substations.

3.4.31 The Design Envelope for the offshore accommodation platforms is shown in Table 3.10 below.

Table 3.10 Design Envelope: offshore accommodation platforms.

Parameter	Maximum Design Envelope
Number	3
Length and width (m)	60
Main structure height above LAT (m)	60
Structure height max above LAT (m)	64

Transmission system

3.4.32 The wind farm transmission system is used to transport the power produced at the wind turbines and delivered by the array cables, to the UK National Grid. The system transforms the Medium Voltage (MV) power produced at the wind turbines to HV at the offshore transformer substations (located in the array area), and transports this via export cables and a number of other offshore and onshore components. The transmission system is paid for and constructed by the wind farm developer (DONG Energy in the case of Hornsea Three), but must be purchased by an Offshore Transmission Operator (OFTO) after the wind farm is constructed in a transaction overseen by the Office of Gas and Electricity Markets (Ofgem).

Project capacity

3.4.33 The point at which the energy produced by the wind farm is metered is at the offshore substation (currently MV side of the Transformer), therefore all wind farm capacities defined through the consenting process will be in reference to the capacity at the offshore substation. Hornsea Three has a planned maximum capacity of 2.4 GW. This may be split into multiple phases, developed and constructed either separately or together.

HVAC/HVDC transmission systems

3.4.34 There are a range of transmission system designs that can be used to transport the power from the wind farm to the UK National Grid. These fall under two primary transmission types defined by how the current is delivered to the export cables; HVAC or HVDC. Both transmission types have a range of relative benefits and drawbacks. Offshore wind farms have traditionally used HVAC connections; however, HVDC connections become more viable at far from shore projects and are used on a number of projects in Germany. Hornsea Three requires flexibility in transmission system choice to ensure that anticipated changes in available technology and project economics can be accommodated within the Hornsea Three design, and will make a decision on which transmission type to use during the detailed design phase (likely to be post consent).

3.4.35 An overview of the differences between the component requirements of the two transmission technologies is provided in Table 3.11.

Table 3.11 Infrastructure required for High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC) systems.

Component	HVAC	HVDC	Comment
Offshore transformer substation	Y	M	HVDC: may be combined with converter substation
Offshore interconnector cable	M	M	Interconnector cables may be required between offshore substations.
Offshore converter substation	N	Y	-
Offshore export cable	Y	Y	-
Offshore HVAC booster station(s)	M	N	HVAC: onshore and/or offshore HVAC booster station.
Onshore HVAC booster station	M	N	
Onshore export cable	Y	Y	-
Onshore substation	Y	Y	HVDC systems require larger onshore converter substations for conversion to HVAC.
Grid connection export cable	Y	Y	-
Table Key	*Required (Y)*	*May be required (M)*	*Not required (N)*

Circuit description

3.4.36 A circuit is an electrical system that allows the flow of electrons from one location to another. Typical HVAC transmission systems are three phase designs and require three conductors per electrical circuit to transport the power. Offshore these three conductors are usually combined into a single cable. Onshore these three conductors are usually housed within one cable per conductor (so three cables per circuit) (Table 3.12).

3.4.37 Typical HVDC transmission systems are Bi-Pole designs and require two conductors per circuit to transport the power. Offshore these are generally housed in separate cables but these cables may be installed together. Onshore these conductors are housed in separate cables (Table 3.12).

Table 3.12 Cables required per circuit.[3]

	HVAC	HVDC
Offshore Cables/Circuit	1	2
Onshore Cables/Circuit	3	2

Offshore substations

3.4.38 All offshore substations will carry navigation markings and lighting, for aviation and navigation purposes. The exact substation(s) location will be determined during wind farm design (typically post consent), taking account of ground conditions and the most efficient cable routing, amongst other considerations. Offshore substations will not be manned but once functional will be subject to periodic operational and maintenance visits by staff by helicopter or crew boat.

3.4.39 Hornsea Three requires flexibility in location and foundation choice of offshore transformer substations to ensure anticipated changes in available technology and project economics can be accommodated within the Hornsea Three design.

[3] Irrespective of the electrical system chosen (AC or DC) the total number of export cables will not exceed 6 offshore and 18 onshore.

3.4.40 A description of the offshore substations is provided below.

Offshore HVAC transformer substation

3.4.41 Offshore Transformer Substations are required in HVAC transmission systems and may be required in HVDC transmission systems, dependent on the system design.

3.4.42 One or more offshore transformer substations will collect the electricity generated by the operational wind turbines via the array cables. The voltage will be “stepped up” by transformers on the substation before transmission to the onshore substation by export power cables (via the offshore converter substation in the case of HVDC, or the offshore and/or onshore HVAC booster station(s) in the case of HVAC). For some HVDC transmission system designs the equipment required in the offshore transformer substation will be incorporated into the offshore converter substation. It may also be beneficial to co-locate the offshore transformer substations with wind turbines so that a substation and a turbine may share a single foundation structure.

3.4.43 The high voltage equipment on the offshore transformer substations is expected to be rated between 220 kV and 400 kV. The substation unit is pre-fabricated in the form of a multi-layered cube and will be mounted on a jacket foundation some distance above the sea surface.

3.4.44 Up to 12 separate offshore transformer substations are required. All offshore transformer substations will be located within the wind farm array area.

3.4.45 The Design Envelope for offshore transformer substation is shown in Table 3.13.

Table 3.13 Design Envelope: offshore transformer substations.

Parameter	Maximum Design Envelope
Number of offshore transformer substations	12
Topside – main structure length and width (m)	90
Topside – ancillary structure length and width (m)	100
Topside – height (excluding helideck or lightning protection) (LAT) (m)	70
Height of lightning protection above topside (LAT) (m)	90

Offshore converter substations

3.4.46 Offshore converter substations are required in HVDC transmission systems only; they are not required in HVAC transmission systems.

3.4.47 Offshore converter substations convert the three-phase alternating current (AC) power generated at the turbines into direct current (DC) power. This is then transmitted to the onshore substation via the export cables.

3.4.48 As for the offshore transformer substations, the offshore converter substation unit is pre-fabricated in the form of a multi-layered cube. The offshore converter substation is expected to be larger than the offshore transformer substations. The structure will most likely be mounted on a jacket or gravity base foundation some distance above the sea surface. Up to four separate offshore converter substations. The Design Envelope for this can be seen in Table 3.14.

Table 3.14 Design Envelope: offshore converter substations.

Parameter	Maximum Design Envelope
Number of offshore converter substations	4
Length of Topside (m)	180
Width of Topside (m)	90
Topside - height (excluding helideck or lightning protection) (LAT)	100
Height of lightning protection above topside (LAT)	110

3.4.49 Hornsea Three requires flexibility in location and foundation choice of the offshore convertor substations to ensure that anticipated changes in available technology and project economics can be accommodated within the Hornsea Three design.

3.4.50 It is possible that the design approach for offshore converter substations will move towards multiple smaller units, rather than fewer large units. In this case the Design Envelope for the smaller offshore transformer substations (as in Table 3.13) should be used, however the total number of offshore transformer substations would be up to 12 and up to four offshore converter substations, not exceeding 16 in total.

Offshore HVAC booster station(s)

3.4.51 Offshore HVAC booster station(s) are required in HVAC transmission systems only; they are not required in HVDC transmission systems.

3.4.52 Long distance, large capacity HVAC transmission systems require reactive compensation equipment along the Hornsea Three offshore ECR to reduce the reactive power generated by the capacitance of the export cable in order to allow the power delivered to the National Grid to be useable. The electrical equipment required to provide the reactive compensation can be located onshore, on an offshore platform, or within a subsea structure. If required offshore, this infrastructure is more likely to be located in the Hornsea Three offshore ECR corridor, rather than in the array area.

Surface

3.4.53 The design of a surface offshore HVAC booster station will be very similar to the offshore transformer substations. The Design Envelope is shown in Table 3.15.

Table 3.15 Design Envelope: surface offshore HVAC booster

Parameter	Maximum Design Envelope
Number of surface offshore HVAC booster stations	4
Topside – main structure length and width (m)	90
Topside – ancillary structure length and width (m)	100
Topside - height (excluding helideck or lightning protection) (LAT) (m)	70
Height of lightning protection above topside (LAT) (m)	90

Subsea

3.4.54 At the time of writing no subsea offshore HVAC booster station(s) have been constructed for HV power transfer, therefore the details of this type of structure are primarily based on knowledge of surface designs as well as an understanding of subsea structures used in the offshore oil and gas industry. This option is currently retained within the Design Envelope as it may present a more cost effective solution for HVAC booster stations. The structure would likely be a sealed steel or concrete structure fixed to the seabed with piles. It is not expected that this structure would be regularly accessed for operation and maintenance during Hornsea Three's lifetime. The Design Envelope can be seen in Table 3.16.

Table 3.16 Design Envelope: subsea offshore HVAC booster station(s).

Parameter	Maximum Design Envelope
Number of subsea offshore HVAC booster stations	6
Subsea structure: length (m)	30
Subsea structure: width (m)	30
Subsea structure: height above seabed (m)	15
Subsea structure: number of piles	12
Piles: penetration depth (m)	40
Piles: diameter (m)	2

Offshore export cables

3.4.55 Offshore export cables are used for transfer of power from the offshore substations to the landfall point. For HVAC transmission systems offshore export cables will carry electricity from the offshore transformer substation(s) to the HVAC booster station(s) and then on to the landfall. For HVDC transmission systems offshore export cables will carry electricity from the offshore transformer substation(s) to the offshore converter substations and then to the landfall. Up to six offshore export cables, with a voltage of up to 600 kV will be required for the Hornsea Three. If possible, the cables will be buried below the seabed through to landfall.

3.4.56 The length and orientation of the Hornsea Three offshore ECR corridor will be determined once the landfall location is confirmed. The EIA will assess an ECR corridor to allow the final cable route to be microsited around seabed conditions that would make cable installation challenging (including extensive debris, steep gradients, highly mobile sediments, hard bedrock, and protected sites). Detailed geophysical and geotechnical surveys will be needed to confirm the exact route within the Hornsea Three offshore ECR corridor post-consent.

3.4.57 Cable burial will be undertaken by specialist vessels, the burial technique and burial depth will be subject to detailed assessment.

3.4.58 Hornsea Three requires flexibility in type, location, depth of burial and protection measures for export cable to ensure that anticipated physical and technical constraints and changes in available technology and project economics can be accommodated within the Hornsea Three design.

3.4.59 The Design Envelope for offshore export cables is shown in Table 3.17.

Table 3.17 Design Envelope: offshore export cables.

Parameter	Maximum Design Envelope
Number of cables	6
Cable diameter (mm)	300
Burial depth	To be determined via a cable burial assessment
Installation methodology	Trenching, dredging, jetting, ploughing, vertical injection, rock cutting
Total length of cable (km)	1,038*
Width of seabed affected by installation per cable (m)	10
Total seabed disturbed (km^2)	10.38

* Note: The total length of export cables includes ~120 km of offshore ECR corridor from the North Norfolk coast to the Hornsea Three array area boundary. The remaining length (up to 53 km per cable) is required to connect the six cables to the, as yet unconfirmed, location of the offshore substation(s).

Offshore interconnector cables

3.4.60 Hornsea Three may require power cables to interconnect the offshore substations in order to provide redundancy in the case of cable failure elsewhere, or to connect to the offshore accommodation platforms in order to provide power for operation. The cables will have a similar design to either the offshore export cables or array cables depending on the final wind farm design.

3.5 Onshore infrastructure

Onshore export cables

3.5.1 Onshore export cables will be buried and connected to the offshore export cables at a landfall location along the north Norfolk coast (exact location to be confirmed, the search area considers the coast between Salthouse and Weybourne). The cables transfer the power onwards to the onshore substation (potentially via an onshore HVAC booster station in the case of HVAC).

3.5.2 Onshore export cables differ in design to offshore export cables due to the different conditions in which they operate (i.e. marine and terrestrial), as well as the differing installation methods employed. Whereas offshore export cables usually include multiple conductors within a single cable, onshore cables usually contain only a single conductor, and therefore there are more cables.

3.5.3 The offshore and onshore export cables will be jointed together at a location very close to the landfall on the landward side. Site investigations at a possible landfall location (consisting of a borehole and resistivity survey) are due to be undertaken between Quarter 4 2016 and Quarter 1 2017 and will confirm the exact approach to installing export cables at the landfall. At the present time, horizontal directional drilling (HDD), trenching, dredging, jetting, ploughing, rock cutting or vertical injection are being considered as options for laying the cables at the landfall, but will be site dependent.

3.5.4 Up to six export cable circuits will be required. The cables will be buried either in multiple separate trenches (up to six trenches, each containing one circuit), or with some circuits combined in a single larger trench. The cables may be installed directly into open trenches, or pulled through pre-installed ducting. The cables will be installed within an onshore ECR corridor with an expected width of 80 m (this includes both the permanent installation area and temporary working area). The width of the permanent and/or temporary areas may change where obstacles are encountered.

3.5.5 Transition Joint Bays (TJB) will be required for the jointing between the offshore and onshore cables. This is a subsurface concrete box that will be accessed via a manhole. There will be up to eight TJBs with an area of approximately 250 m^2 each. Those TJBs will be located above MHWS and will likely be completely buried, hence the need for manholes for access.

3.5.6 Joint Bays will be required along the onshore route in order to join sections of onshore cable together. They will be similar to the TJB, but with smaller dimensions of approximately 150 m^2. They will be located approximately every 1 to 2.5 km along the onshore ECR. As with the TJBs, these will likely be completely buried, with manholes for access.

3.5.7 The exact onshore ECR corridor will be finalised prior to the EIA being completed once the landfall location is known. The cable routing will consider a wide range of human, biological and physical constraints as well as technical and commercial considerations.

3.5.8 The onshore export cable may need to cross infrastructure and obstacles such as roads, railways and rivers. The detail of how this will be carried out will be explored further when more is known about the onshore ECR corridor, however it is likely that a various methods will be used, including open cut trenching, and HDD, depending on the nature and complexity of each crossing. Hornsea Three will aim to undertake all major crossings, such as major roads, rivers and rail crossings using HDD.

Onshore HVAC booster station

3.5.9 An onshore HVAC booster station is required for the HVAC transmission only; it is not required for HVDC transmission.

The onshore HVAC booster station would have the same purpose as an offshore HVAC booster station(s) and contain similar equipment. The equipment will either be housed within a single or multiple buildings, in an open yard or a combination of the above. The exact location, as well as requirements for landscaping, would be determined based upon a wide range of human, biological and physical constraints as well as technical and commercial considerations.

3.5.10 The Design Envelope for the onshore HVAC booster station can be seen in Table 3.18.

Table 3.18 Design Envelope: onshore HVAC booster station.

Parameter	Maximum Design Envelope
Permanent area of site for all infrastructure* (m^2)	25,000
Single building: length (m)	150
Single building: width (m)	30
Building: height (m)	12.5
Maximum lightning protection height (m)	17.5

* Note – the onshore HVAC booster station may comprise of a single building or multiple buildings on the same site.

Onshore substation

3.5.11 The onshore substation contains the electrical components for transforming the power supplied from the offshore wind farm to 400 kV and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid. If a HVDC system is used it will also house equipment to convert the power from HVDC to HVAC. The equipment will either be housed within a single or multiple buildings, in an open yard or a combination of the above.

3.5.12 The Design Envelope for the onshore substation for both HVAC and HVDC options can be seen in Table 3.19 below. Hornsea Three will connect to the National Grid at the Norwich Main 400 kV substation, located between Swardeston and Stoke Holy Cross, south of Norwich.

Table 3.19 Design Envelope: onshore substation.

Parameter	Maximum Design Envelope
Area of site (m^2)	100,000
Number of main buildings within the substation site	5
Width of each main building (m)	75
Length of each main building (m)	150
Height of each main building(m)	25

Grid connection export cable

3.5.13 A further section of buried onshore export cabling is required to connect the Hornsea Three onshore substation with the National Grid substation. This section of cabling will be similar in design to the onshore export cabling, but must be HVAC at 400 kV.

Construction compounds

3.5.14 The onshore works at the landfall, the onshore HVAC booster station (if required) and onshore substation will require the establishment of temporary construction compounds for the storage of materials and plant, as well as space for small temporary offices, welfare facilities, security and parking.

3.5.15 Construction compounds of various sizes will also be required along the onshore ECR corridor, for laydown and storage of materials, plant and staff, as well as operations such as out drilling works, where there are crossings of other infrastructure.

3.5.16 The construction compounds, if deemed necessary, will be removed and sites restored to their original condition when construction has been completed. The exact number, location and size of the compounds required will be confirmed once a substation location and onshore ECR have been developed. New temporary roads or access tracks for construction traffic are likely to be required at various points along the route, connecting compounds and construction sites to existing nearby roads. All compounds will be reinstated to their former condition following the construction phase, unless it is considered necessary to retain the use of a compound for a longer period post-construction.

3.6 Construction programme

3.6.1 A high-level indicative construction programme is presented in Figure 3.1 below. The programme illustrates the estimated duration of the major installation elements, and how they may relate to one another if built out in a single construction campaign. It covers installation of the major components and does not include elements such as preliminary site preparation, and commissioning of the wind farm post-construction. Onshore construction is currently planned to commence in 2021.

3.6.2 Hornsea Three may also be constructed in two or more phases, including the potential for either an overlap or a gap between the completion of construction of one phase and the start of construction of another.

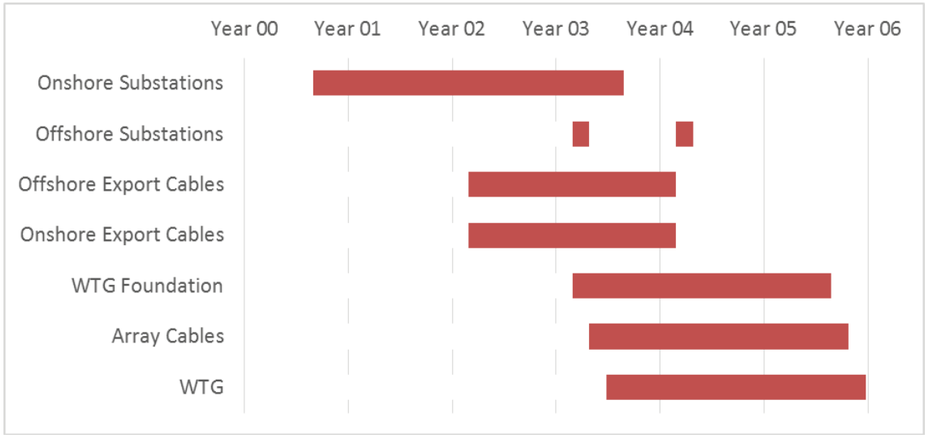

Figure 3.1 Indicative construction programme.

Operation and maintenance and decommissioning phases

3.6.3 The indicative project programme outlined in Figure 3.1 above shows that the operation and maintenance phase will not commence until 2025, based on an onshore construction start date of 2021, with the decommissioning phase following the cessation of Hornsea Three. At this stage the exact activities undertaken during these phases are not known, however they will be further explored as part of the EIA and reported in the final Environmental Statement.

3.6.4 The overall operation and maintenance strategy will be finalised once the operation and maintenance onshore base location and technical specification of Hornsea Three are known, including turbine type, electrical export option and final project layout. The operation and maintenance strategy could include either an onshore operation and maintenance base, or an offshore operation and maintenance base (offshore accommodation platforms), or both. The general operation and maintenance strategy will rely primarily on crew vessels, offshore accommodation, supply vessels, and helicopters for the operation and maintenance services that will be performed at the wind farm.

3.6.5 Maintenance activities can be categorised into two levels: preventive and corrective maintenance. Preventive maintenance is according to scheduled services whereas corrective maintenance covers unexpected repairs, component replacements, retrofit campaigns and breakdowns. Onshore the operation and maintenance requirements will be largely corrective, accompanied by infrequent on-site inspections of the onshore transmission infrastructure. However the onshore infrastructure will be consistently monitored remotely and there may be operation and maintenance staff visiting the onshore substation to undertake works on a regular basis.

3.6.6 At the end of the operational lifetime of the offshore wind farm, it is anticipated that all structures above the seabed or ground level will be completely removed. The decommissioning sequence will take approximately three years and will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. TCE AfL for Hornsea Three requires that the project is decommissioned at the end of its lifetime. Additionally, the Energy Act (2004) requires that a proposed decommissioning plan must be submitted to the Secretary of State for Business, Energy and Industrial Strategy prior to the construction of Hornsea Three. The decommissioning plan and programme will be updated during Hornsea Three's lifespan to take account of changing best practice and new technologies.

4. Environmental Baseline

4.1 Introduction

4.1.1 This section provides an overview of the environmental characteristics relevant to the HRA screening process for Hornsea Three, including:

- Benthic ecology;
- Marine mammals;
- Offshore Ornithology[4]; and
- Onshore Ecology.

4.1.2 Baseline information relevant to the determination of LSE is presented with respect to the Hornsea Three array area for Hornsea Three and the offshore and onshore ECR corridor search areas. Where appropriate, specific reference is made to environmental conditions within the Hornsea Zone. The majority of the information presented here has been derived from the zonal characterisation (ZoC) studies undertaken as part of the Zone Appraisal and Planning (ZAP) process and that presented within the EIA Scoping Report for Project Three (DONG Energy, 2016). Other sources of information are as referenced in the text.

4.2 Benthic ecology

Site investigations

4.2.1 Benthic subtidal surveys to characterise the benthic ecology of the Hornsea Zone were completed in 2010 for the Hornsea ZoC study. Benthic subtidal surveys across the Project One array were completed in 2010/2011 and infill surveys of the Project Two array area were completed in 2012. The Hornsea ZoC subtidal benthic sampling array was based upon a regular grid pattern (approximately 5 km spacing), to optimise coverage of the Zone and to increase the likelihood of encountering as many different habitats as possible. For Project One and Project Two surveys, sampling locations were selected on a stratified random basis to ensure adequate coverage of the different habitats present within the respective benthic ecology study areas. The data acquisition strategies, including the sampling arrays and methodologies, were discussed and agreed with the Marine Management Organisation (MMO) and their advisors (i.e., Cefas and Natural England).

4.2.2 Subtidal benthic habitats were sampled via combined benthic grab and drop down video (DDV) survey and epibenthic beam trawl survey. Sediment chemistry samples were also taken at a number of stations across Project One and Project Two. Figure 4.1 shows the coverage of the Hornsea Zone and summarises the numbers of samples taken across different areas.

4.2.3 As shown in Figure 4.1 and summarised in Table 4.1, a number of samples collected during the ZoC survey coincide with the Hornsea Three array area: 27 of the ZoC benthic grab/DDV sites and, nine epibenthic beam trawls.

[4] For the purposes of this report, offshore ornithology encompasses all those bird populations with the likelihood to interact with Hornsea Three below MHWS. Only a narrow strip of intertidal shingle habitat is present at the Hornsea Three landfall area, rendering a separate topic on intertidal ornithology unnecessary. Those bird populations with a greater propensity to interact with Hornsea Three above MHWS are considered in the onshore ecology section.

Table 4.1 Summary of benthic surveys undertaken within Hornsea Three

Survey	Date of survey	Combined benthic grab sampling and DDV	Epibenthic beam trawls	Sites within Hornsea Three
ZoC Survey	November 2010	122 sites	40 sites	27 grab/DDV 9 epibenthic trawls
Project One Survey	July, September, November 2010 and June, October 2011	161 sites (40 sampled for sediment chemistry)	41 sites	-
Project Two Infill Survey	July 2012	51 sites (8 sampled for sediment chemistry)	21 sites	-

Hornsea Three array area

4.2.4 The results of the previous surveys across the former Hornsea Zone (see paragraphs 4.2.8 to 4.2.10) indicate that the sediments and associated benthic communities present across the eastern half of the former Hornsea Zone, corresponding with the Hornsea Three array area, are similar to those that are present across the Project One and Project Two array areas. The desktop information available for this area (e.g. UK SeaMap), also supports this conclusion. Given the scale of the benthic subtidal surveys conducted to date, and the largely homogeneous nature of the benthos, the subtidal habitats and species present across the former Hornsea Zone are considered to have been well characterised. Further dedicated benthic ecology surveys across the Hornsea Three array area for the purposes of baseline characterisation are therefore not proposed.

4.2.5 However, during geophysical surveys undertaken across the Hornsea Three array area in June 2016, 20 grab samples were collected for the purposes of ground-truthing the geophysical data which were also subsequently processed and analysed for benthic infauna and particle size analysis (PSA). It is therefore intended that the data gathered during the ZoC, Project One and Project Two surveys, together with available benthic data from the Hornsea Three site-specific geophysical survey and the surveys of the Markham's Triangle recommended Marine Conservation Zone (rMCZ) in 2012, will be used to characterise the benthos within the array area for Hornsea Three (see Figure 4.2).

Hornsea Three offshore ECR corridor

4.2.6 There are a number of desktop data sources which cover the Hornsea Three offshore ECR corridor search area including data associated with surveys undertaken within the North Norfolk Sandbanks and Saturn Reef cSAC/SCI and Haisborough, Hammond and Winterton cSAC/SCI as well as from surveys undertaken in support of the designation of the Cromer Shoal Chalk Beds MCZ. These data will be reviewed in order to inform the baseline characterisation of the Hornsea Three offshore ECR corridor and used to inform the HRA Report. However, unlike the Hornsea Three array area, there have been no previous site-specific surveys undertaken within this area for Project One/Project Two/ZoC. Therefore, there has been no ground-truthing/validation of the desktop data. This is particularly pertinent given that the Hornsea Three offshore ECR corridor search area coincides with two SACs, both of which are designated for *S. spinulosa* reef. As such, a benthic subtidal characterisation survey of the Hornsea Three offshore ECR corridor is proposed and it is anticipated that this will comprise the following surveys which will be undertaken by a specialist benthic contractor in line with standard benthic survey methodologies:

- Combined grab and DDV survey with grab samples to be analysed for benthic infauna (abundance and biomass) and PSA; and
- Epibenthic beam trawl survey.

Hornsea Three landfall area

4.2.7 No site-specific data exists for the proposed ECR corridor landfall area. Therefore, a Phase 1 intertidal walkover survey will be undertaken at the preferred landfall, when selected, to include a 250 m buffer zone either side of the ECR corridor.

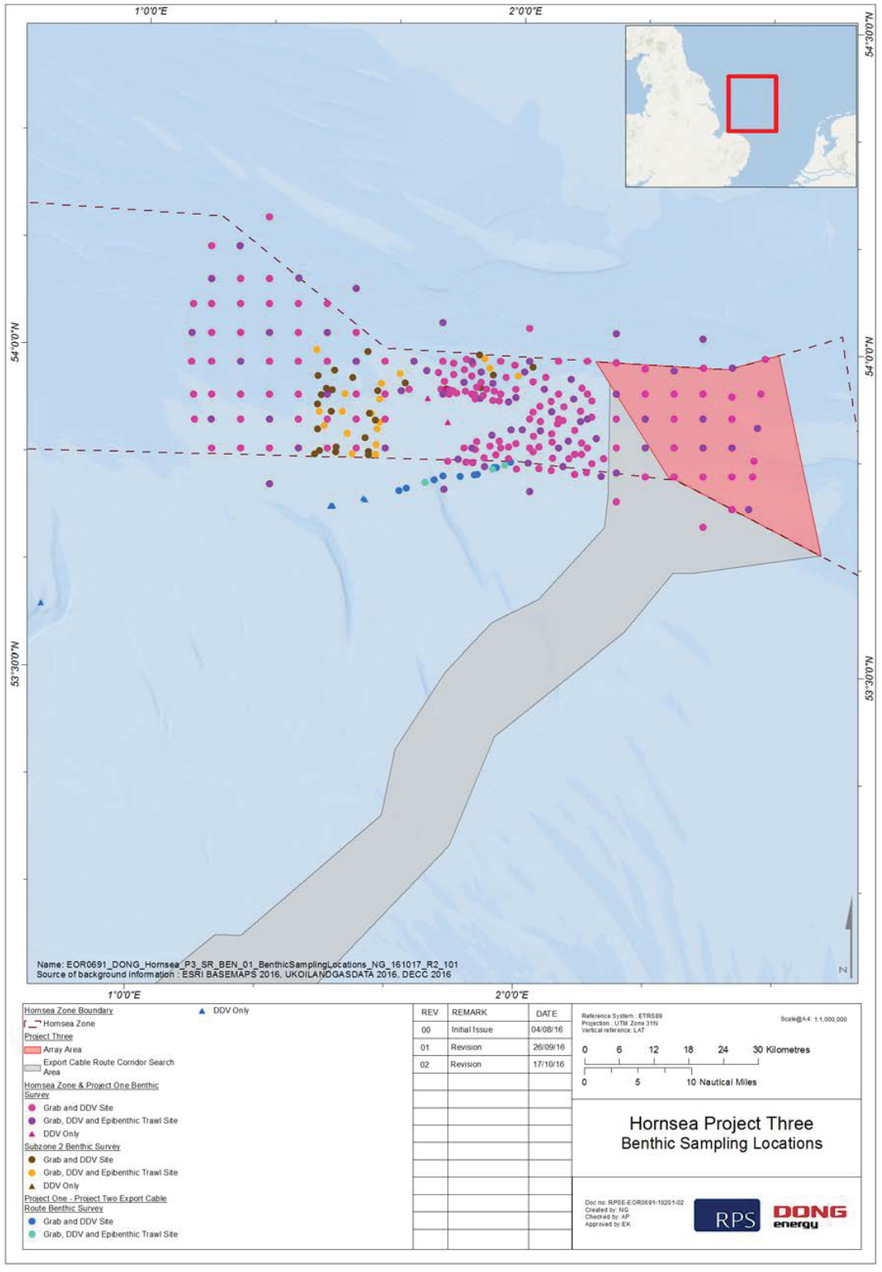

Figure 4.1 Location of subtidal benthic grab, drop down video (DDV) and epibenthic beam trawl locations across Project One, Project Two and the former Hornsea Zone

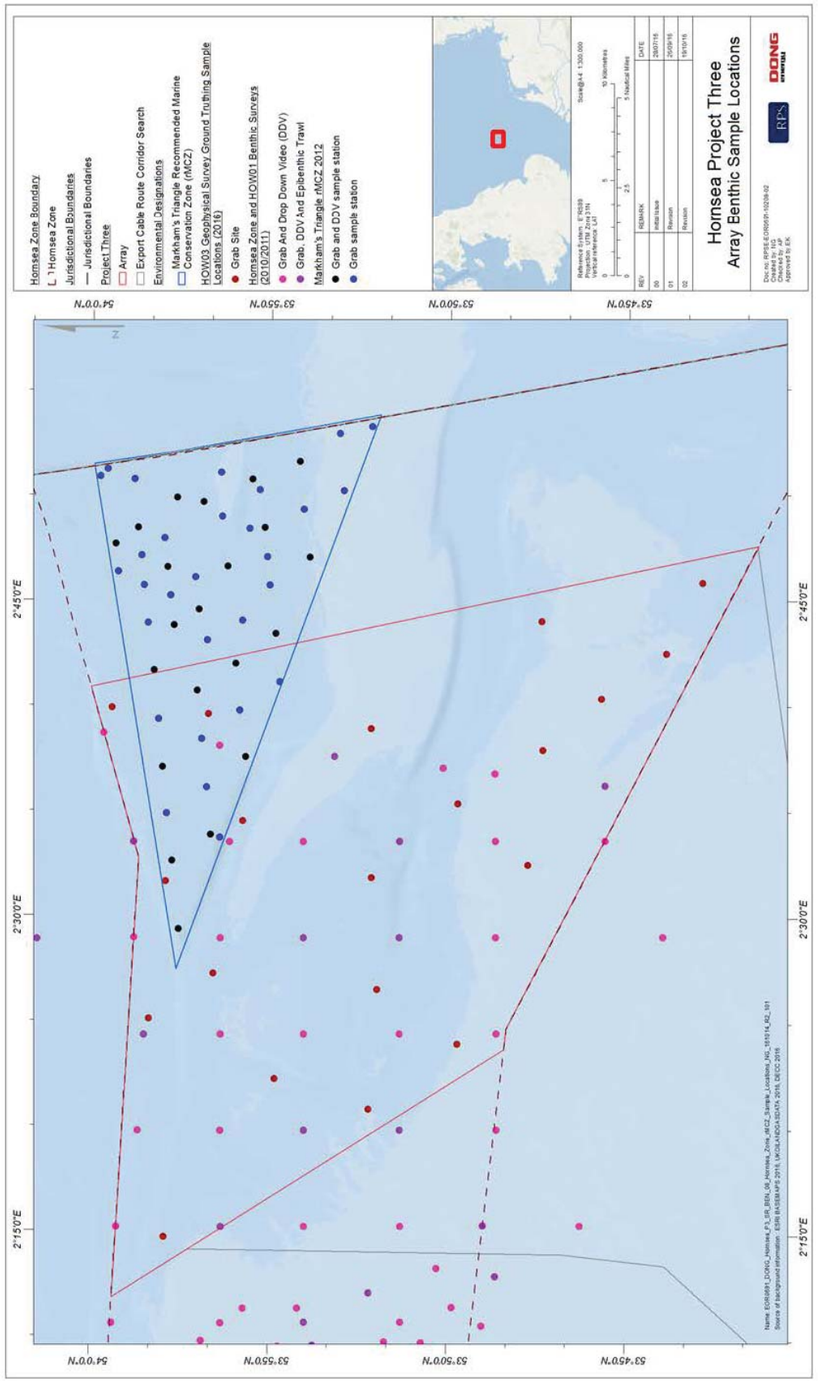

Figure 4.2 Location of benthic samples to characterise the benthic ecology of the Hornsea Three array area

Baseline

Hornsea Three array area

4.2.8 The infaunal species encountered from benthic grab samples collected across the former Hornsea Zone (Figure 4.1) were, in the majority of cases, characteristic of dynamic, predominantly sand habitats, including a number of small-bodied, short-lived species such as the polychaete worms *Nephtys* spp., *Spiophanes bombyx, Aonides paucibranchiata*, *Ophelia borealis* and *Notomastus* sp., Nemertean worms, amphipod crustaceans *Bathypoeria* spp., the pea urchin *Echinocyamus pusillus* and molluscs including *Tellina fabula, Abra* spp. and *Kurtiella bidentata*. Larger and longer lived species (thereby indicative of more stable sediments) were also represented including the bivalve mollusc *Dosinia* sp., and *Chamelea striatula* which can live upwards of 10 years.

4.2.9 Fourteen infaunal biotopes were identified from the previous surveys and mapped across the whole former Hornsea Zone (Figure 4.3). The biotope SS.SSa.IMuSa.FfabMag '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand', was recorded adjacent to, and immediately to the west of, the western boundary of the Hornsea Three array area as well as extensively in the western part of the former Hornsea Zone. Throughout the central section of the Hornsea Three array area this biotope graded into boundary the sandy biotopes SS.SSa.CFiSa.EpusOborApri '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' and SS.SSa.IFiSa.NcirBat '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' in areas of increasing sediment disturbance. Coarser sediments, located along the southern boundary of the Hornsea Three array area, were found to be dominated by the biotope SS.SMx.OMx.PoVen 'Polychaete-rich deep Venus community in offshore mixed sediments'. This biotope also dominated the coarse sediments located to the west of the Hornsea Three array area. Along the northern boundary of the Hornsea Three array area, as well as the wider former Hornsea Zone, the deeper and muddier sediments in these areas were characterised by the SS.SMu.CSaMu.AfilMysAnit '*Amphiura filiformis, Mysella bidentata* and *Abra nitida* in circalittoral sandy mud' biotope.

4.2.10 Epifaunal communities were, on the whole, sparse across the Hornsea Three array area and the former Hornsea Zone, and, where present, typically consisted only of echinoderms including *Asterias rubens*. No potential Annex I *S. spinulosa* reef habitats were identified during the ZoC, Project One or Project Two surveys across the former Hornsea Zone.

Hornsea Three offshore ECR corridor search area

4.2.11 The habitats along the Hornsea Three offshore ECR corridor search area are, on the whole, predicted to be similar to those within the Hornsea Three array area. Broad scale mapping of the habitats provided by the EUSeaMap2 data (EMODnet, 2016), indicates that circalittoral/infralittoral fine sands and infralittoral coarse sediments dominate much of the offshore part of the marine ECR corridor search area. The Humber REC data (Tappin *et al*., 2011), which provides partial coverage of the northern half of the Hornsea Three offshore ECR corridor search area, indicates that these sediments are predominantly characterised by the EUNIS habitat SS.SSa.CFiSa.PoBivAmp 'Infaunal polychaetes with burrowing bivalves and amphipods in circalittoral fine sand'. Similar communities are present in discrete areas of mixed sediment particularly in the area just to the south of the Hornsea Three array area.

4.2.12 Survey work is proposed within the ECR corridor search area, it is anticipated that this will comprise DDV and grab sampling to be analysed for benthic infauna (abundance and biomass) and PSA, and epibenthic beam trawl surveys. The surveys which will be undertaken by a specialist benthic contractor in line with standard benthic survey methodologies.

4.2.13 The landward extent of the Hornsea Three offshore ECR corridor search area is characterised by moderate energy infralittoral rock which corresponds with subtidal chalk beds which are a designated feature of the Cromer Shoal Chalk Beds MCZ (Defra, 2016).

Hornsea Three ECR corridor landfall area

4.2.14 Much of the shoreline at the landfall area, along the coast from Salthouse to Weybourne on the north Norfolk coast, comprises a steep shingle beach, fronting eroding maritime cliffs. To the west, the cliffs give way to a shingle ridge running toward Blakeney Point and sand/shingle barrier island features fronting the low lying coastal fringe with tidal inlets and saltmarsh. According to the EMODnet portal for Seabed Habitats (http://www.emodnet-seabedhabitats.eu/), the intertidal sediments correspond with the EUNIS habitat type A2.1 "Littoral coarse sediment" and comprise predominantly mobile shingle beaches. In the eastern half of the landfall area the intertidal sediments broadly correspond with the EUNIS habitat type A2.4 "Littoral mixed sediments" and comprise sand and shingle beaches.

4.2.15 No site-specific benthic data exists for the proposed ECR corridor landfall area. Therefore, a Phase 1 intertidal walkover survey will be undertaken at the preferred landfall location, when selected, to include a 250 m buffer zone either side of the ECR corridor. Survey to be undertaken according to standard intertidal survey methodologies as outlined in the Marine Monitoring Handbook (Davies *et al*., 2001) within procedural guidance No 3-1 (Wyn and Brazier, 2001) and The Handbook for Marine Intertidal Phase 1 Biotope Mapping Survey (Wyn *et al*., 2006).

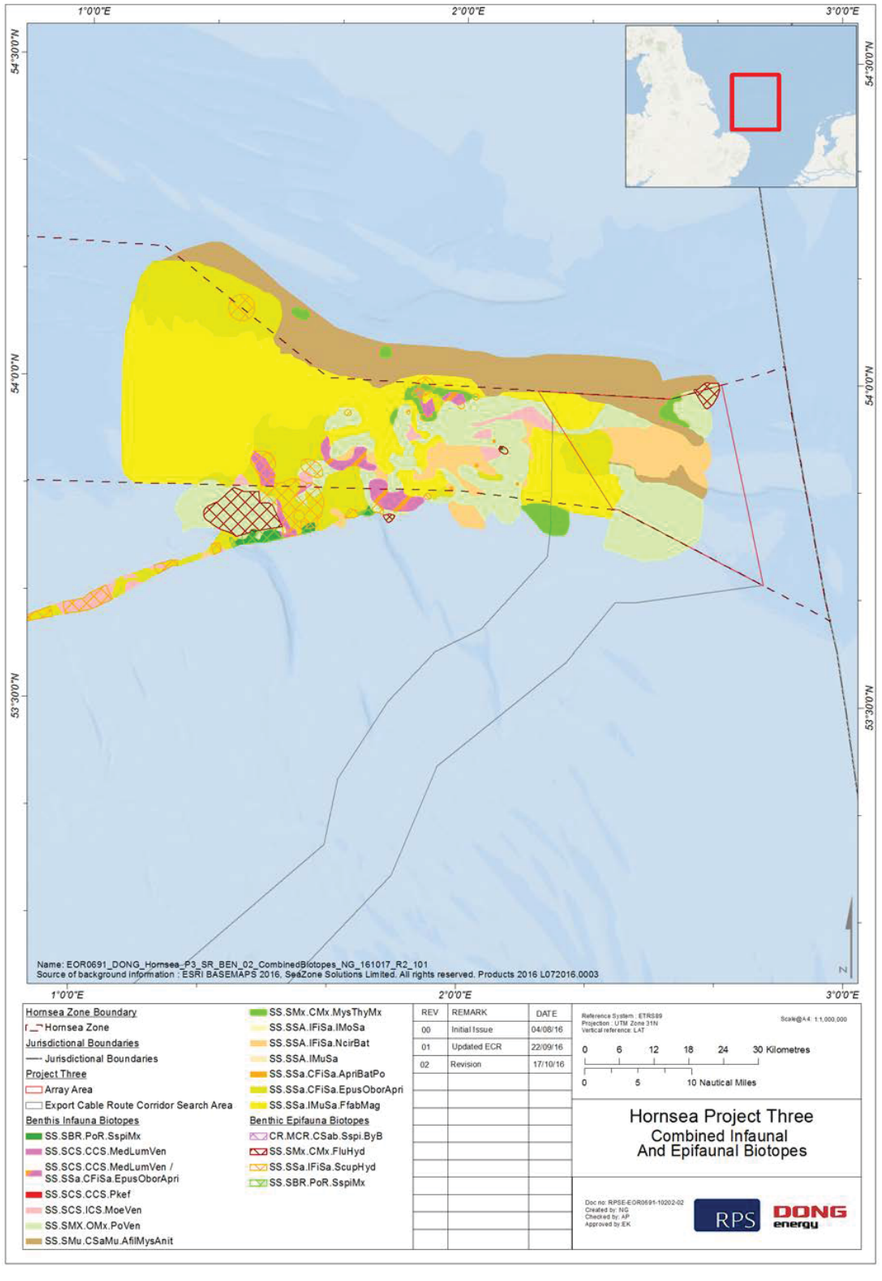

Figure 4.3 Combined infaunal and epifaunal biotope map of Project One, Project Two, Hornsea Three and the former Hornsea Zone

4.3 Marine mammals

Site investigations

4.3.1 Information on marine mammals is available for the Hornsea Three array area from site-specific field surveys undertaken across the former Hornsea Zone for Project One and Project Two between March 2010 to February 2013.

4.3.2 The area surveyed during these boat-based surveys included the array areas for Project One and Project Two plus a 4 km buffer and the former Hornsea Zone plus a 10 km buffer (see Figure 4.4). Visual surveys for marine mammals were conducted along transect lines spaced 2 km apart within the Project One and Project Two array areas and 6 km apart within the former Hornsea Zone. The surveys followed the standard Joint Nature Conservation Committee (JNCC) European Seabirds at Sea (ESAS) survey methodology (Webb and Durinck, 1992), and complied with Collaborative Offshore Wind Research into the Environment (COWRIE) recommendations (Camphuysen *et al.,* 2004).

4.3.3 The visual marine mammal data was augmented by acoustic data from surveys carried out in order to detect any cetacean vocalisations from either harbour porpoise *Phocoena phocoena* or dolphin species where surface activity may not have been recorded due to poor sea state. Acoustic surveys consisted of a towed hydrophone (see Figure 4.4) and on-board recording station and were undertaken monthly from March 2011 to February 2013. For the first six months of acoustic survey, the hydrophone was deployed continuously during surveys. However, following discussion with fisherman in the former Hornsea Zone in January 2011, the hydrophone was not towed south of 53º50.0000' N (Figure 4.4).

Hornsea Three array area

4.3.4 The site-specific marine mammal boat based surveys undertaken across the former Hornsea Zone plus 10 km buffer, between 2010 to 2013, provide a considerable body of marine mammal data and will form the basis for the marine mammal baseline for the key species across the Hornsea Three array area. These baseline data will be enhanced for specific species, namely harbour porpoise, grey seal and harbour seal, with the outputs of the Hornsea Three site-specific aerial surveys. The existing boat based survey data will, however, be reanalysed for Hornsea Three to provide information on spatial variability in mean densities of, and seasonal patterns in, key marine mammal species within the Hornsea Three array area plus 4 km buffer. The main objectives of this exercise are:

- To map the mean surface densities of key species within the Hornsea Three array area plus 4 km buffer, corrected for g(0) (detection probability) where possible;
- To compare mean densities for the Hornsea Three array area with mean densities for the wider Hornsea Zone plus 10 km buffer; and
- To investigate seasonal patterns in encounter rate/density/group size for the Hornsea Three array area plus 4 km buffer and compare to seasonality for the wider former Hornsea Zone plus 10 km buffer.

4.3.5 The outcomes of this exercise will also be used to determine if/how the existing boat-based dataset can be integrated with the aerial survey data being collected for Hornsea Three to provide further baseline information.

4.3.6 The Hornsea Three site-specific marine mammal aerial surveys consist of monthly flights, which commenced in April 2016, along 20 parallel transects aligned north to south within the Hornsea Three array area and a 4 km buffer. Footage from two high-resolution digital video cameras is analysed to achieve 10% coverage of the Hornsea Three array area plus buffer. The aerial survey methodology has been agreed with the SNCBs.

4.3.7 The aerial survey will be used to provide additional baseline information, primarily for harbour porpoise, grey seal and harbour seal. Where the aerial data can be corrected for detection probability, g(0) (i.e. for harbour porpoise and grey seal), it may be possible to use the aerial data for comparison with the site-specific boat-based data.

Hornsea Three offshore ECR

4.3.8 Data from Hornsea Three site-specific aerial/boat-based surveys for key species (i.e. harbour porpoise) will be extrapolated to inform the offshore ECR baseline together with published datasets (e.g. SCOS, SCANS-III, WWT).

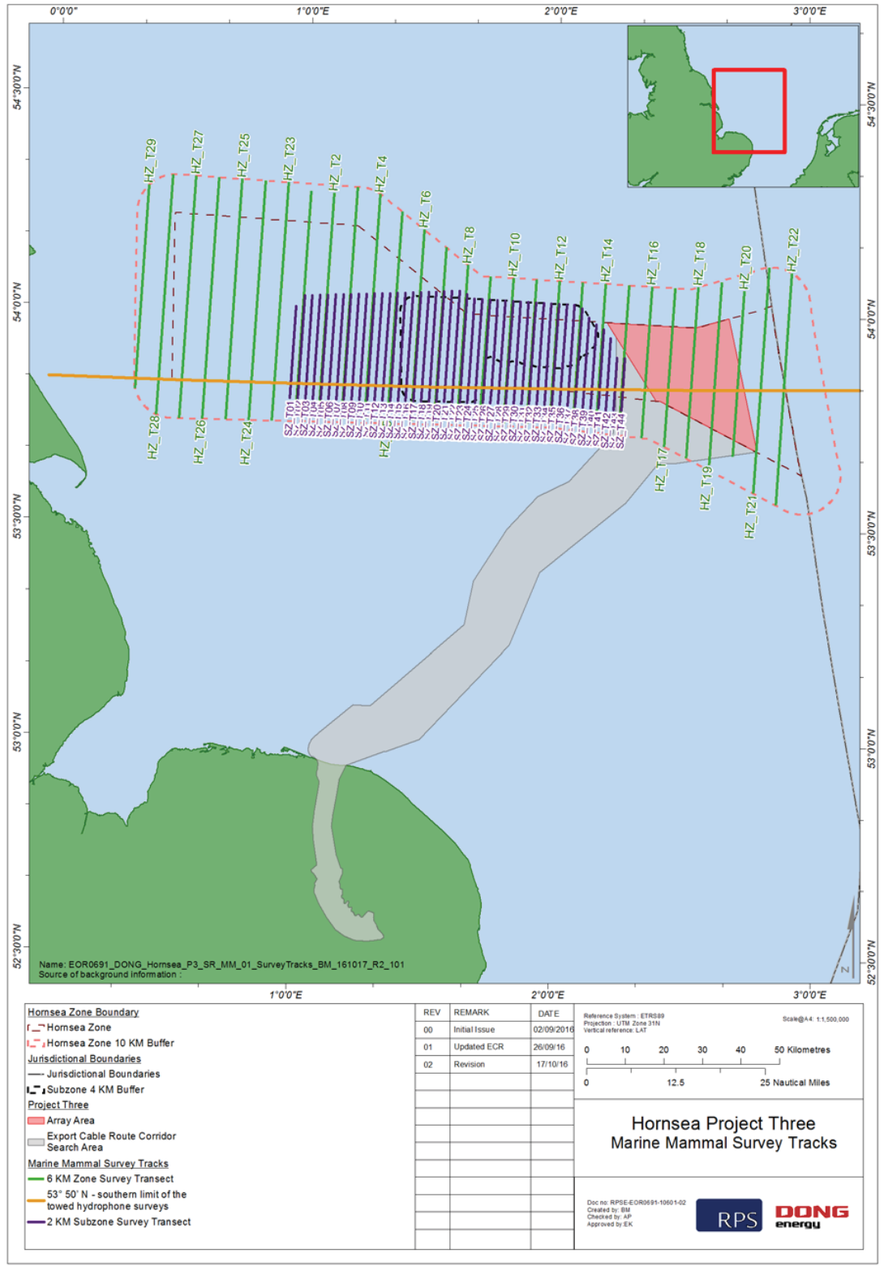

Figure 4.4 Transect lines for boat-based marine mammal surveys across Project One, Project Two and the former Hornsea Zone

Baseline environment

Introduction

4.3.9 Eight marine mammal species occur regularly throughout the North Sea. Two pinniped species; grey seal *Halichoerus grypus* and harbour (common) seal *Phoca vitulina*, and six cetacean species; harbour porpoise *Phocoena phocoena*, bottlenose dolphin *Tursiops truncatus*, white-beaked dolphin *Lagenorhynchus albirostris*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, minke whale *Balaenoptera acutorostrata* and killer whale *Orcinus orca* (Hammond *et al.,* 2001). Land-based sightings records (1990 to 2013) held by the Greater Lincolnshire Nature Partnership (GLNP) and the Norfolk Biodiversity Information Service (NBIS) identify six other cetacean species recorded along the Lincolnshire and North Norfolk coastlines, including: northern bottlenose whale *Hyperoodon ampullatus*, Cuvier's beaked whale *Ziphius cavirostris*, fin whale *Balaenoptera physalus*, long-finned pilot whale *Globicephala melas*, sperm whale *Physeter macrocephalus*, and short-beaked common dolphin *Delphinus delphis*, however, sightings of these species are relatively rare in the North Sea.

4.3.10 Based on the records of marine mammals in the southern North Sea and site-specific surveys for Project One and Project Two the following five marine mammal species were identified as important receptors (in terms of conservation importance) as part of the Hornsea Three EIA scoping exercise (DONG Energy, 2016): harbour porpoise, white-beaked dolphin, minke whale, harbour seal and grey seal.

4.3.11 Note that of these, it is only harbour porpoise, harbour seal and grey seal that are Habitats Directive Annex II species and therefore require consideration in HRA terms. As such the marine mammals baseline characterisation provided in the following sections within this report is only focused on these three species.

Harbour porpoise

Hornsea Three array area

4.3.12 Harbour porpoise are the most abundant cetacean species in UK waters and the entirety of the North Sea and North Atlantic coastlines are considered to be key habitats for this species (Reid *et al*., 2003). Harbour porpoise was the most common marine mammal in the site-specific Project One and Project Two surveys. A total of 6,504 observations were recorded within the former Hornsea Zone plus 10 km buffer over the three years of monthly boat based visual surveys accounting for approximately 87% of all marine mammals recorded during the surveys. This species was distributed widely across the former Hornsea Zone and analysis of the site-specific data for Project One and Project Two estimated that approximately 15,955 animals, based on visual data, or 20,599 animals, based on acoustic data, may be present within the former Hornsea Zone plus 10 km buffer.

4.3.13 Mean absolute densities for the former Hornsea Zone plus 10 km buffer were estimated at 1.718 to 2.218 animals km^{-2} for visual and acoustic data (Figure 4.5), respectively. In comparison, the SCANS Block U average density estimate is 0.598 animals km^{-2} (Figure 4.6). The mean encounter rate for the former Hornsea Zone plus 10 km buffer showed a peak from May to July and was lowest during the winter months.

Hornsea Three offshore ECR corridor

4.3.14 Modelled abundance data from the SCANS-II project (SCANS-II, 2006) (Figure 4.6), as well as historical data from the WWT aerial surveys (Figure 4.7; WWT Consulting, 2009), show that harbour porpoise are regularly sighted along inshore areas and therefore are likely to occur within the proposed Hornsea Three offshore ECR corridor search area.

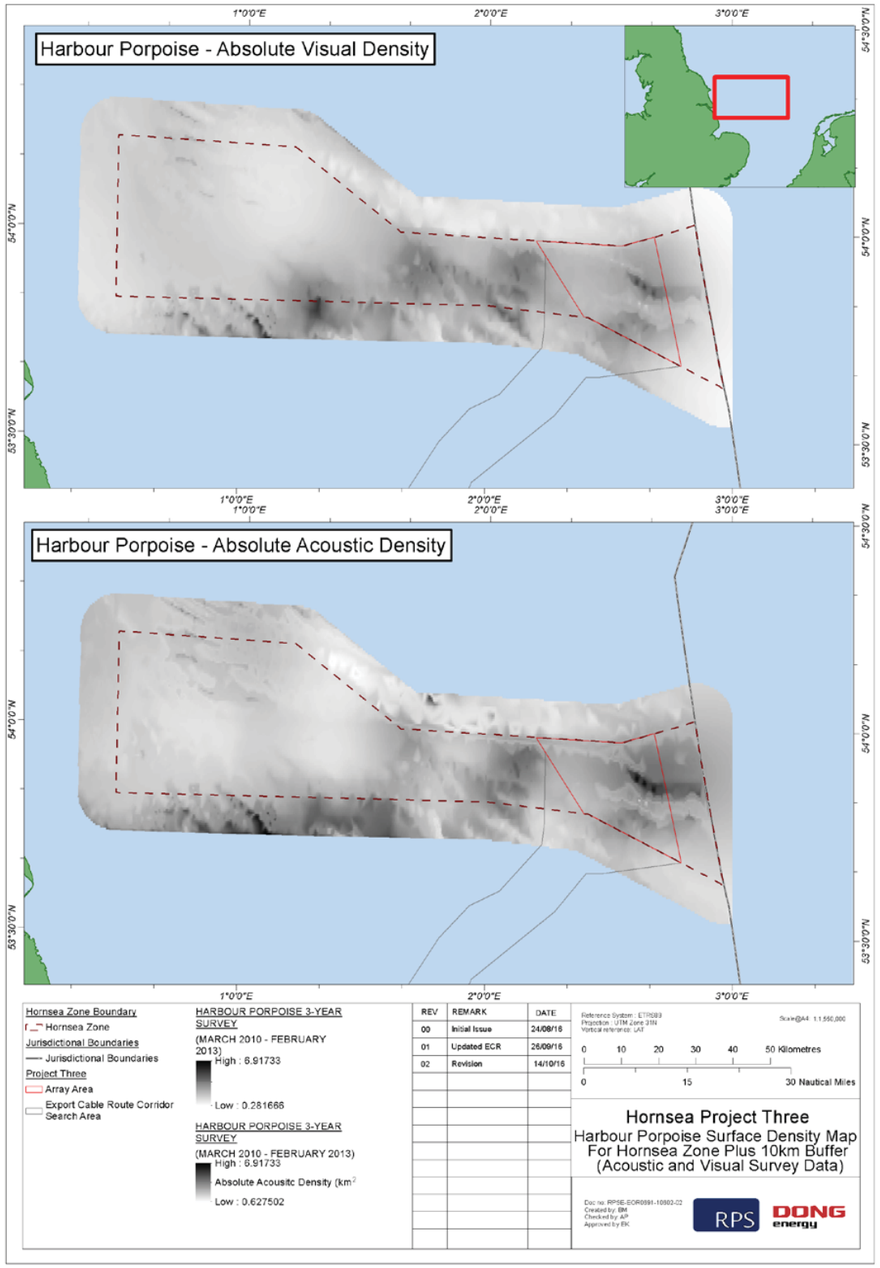

Figure 4.5 Modelled surface density estimates (absolute density) for harbour porpoise across the former Hornsea Zone plus 10 km buffer using three years of visual survey data

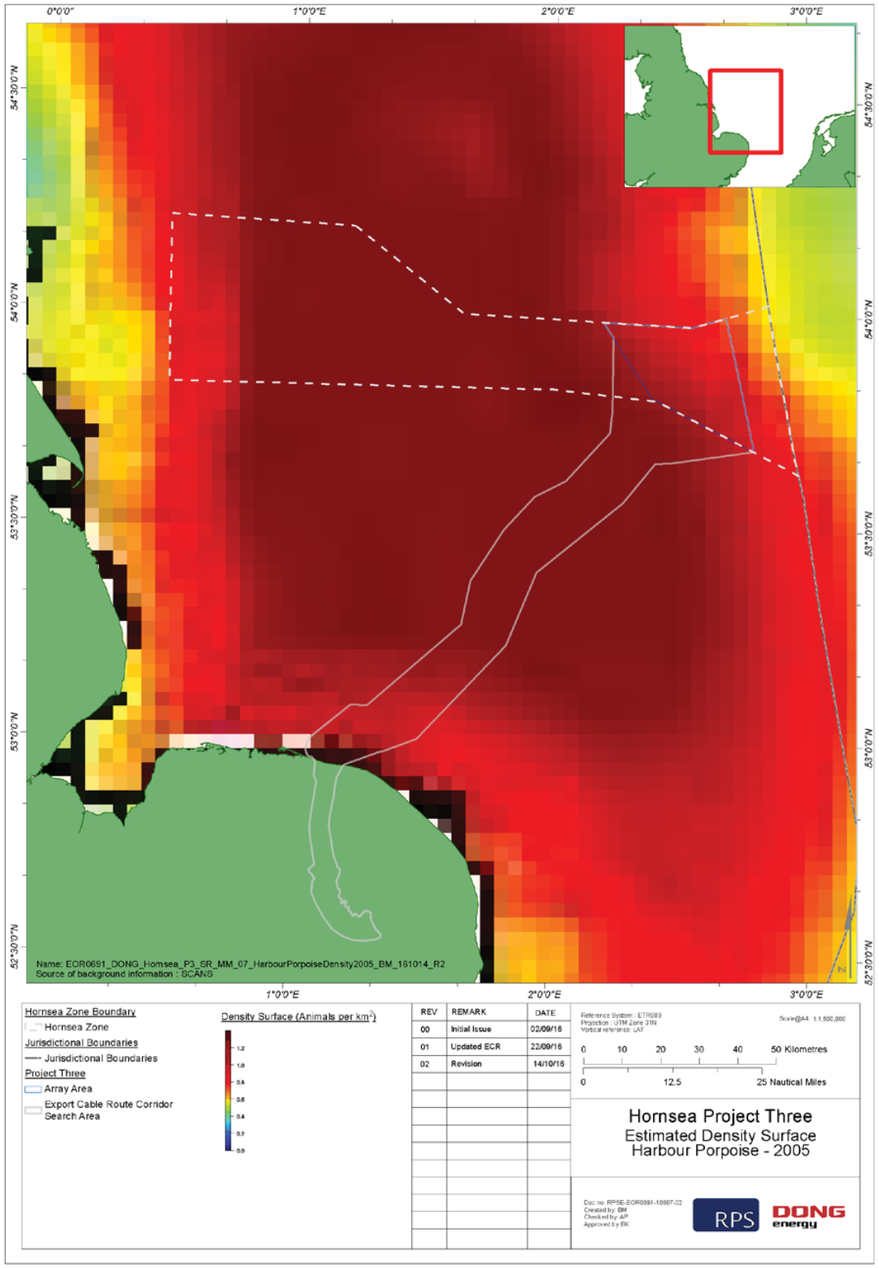

Figure 4.6 Harbour porpoise estimated density surface (animals km^{-2}) in 2005, data from SCANS-II survey

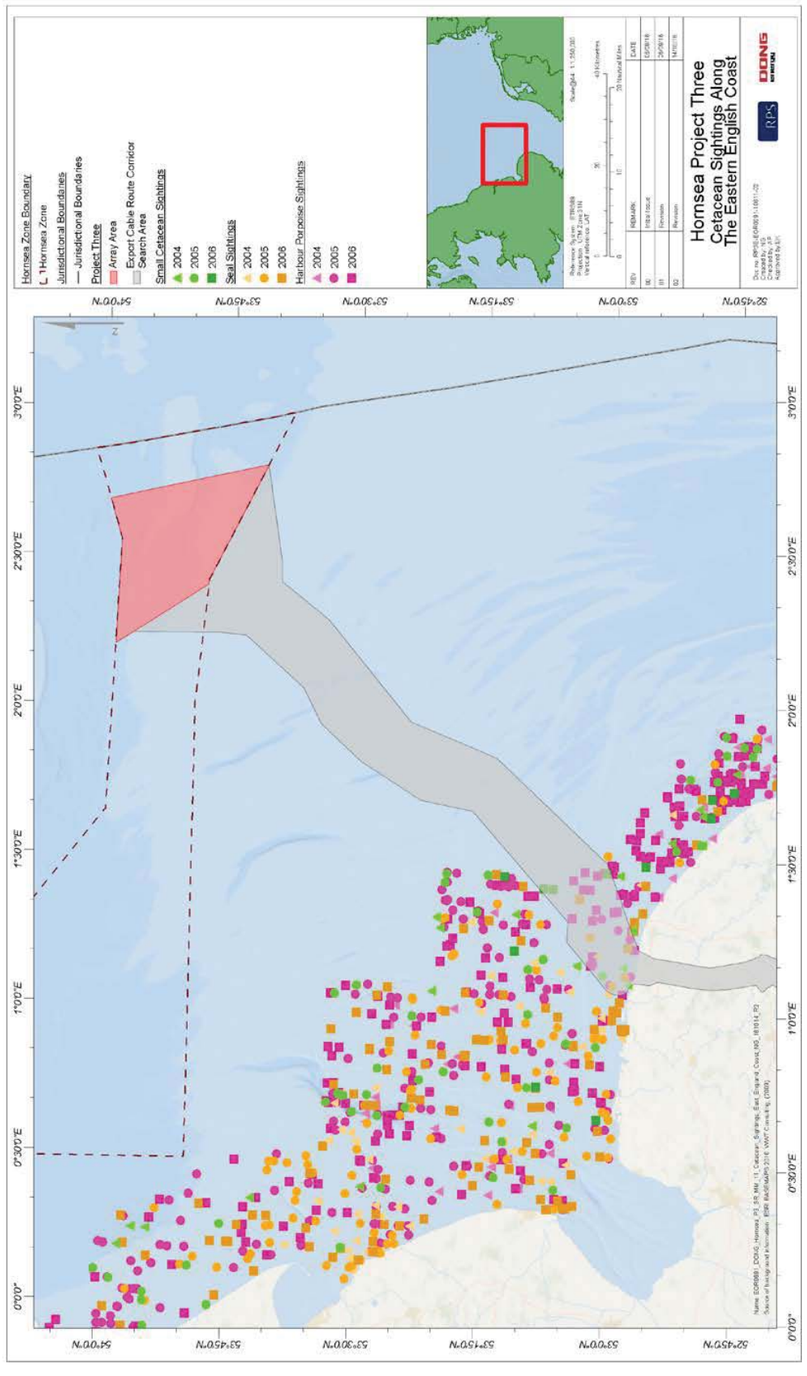

Figure 4.7 Aerial sightings of harbour porpoise (and other small cetaceans and pinnipeds) along the east coast between 2004 and 2006 (source: WWT Consulting, 2009)

Harbour seal

Hornsea Three array area

4.3.15 The majority of the harbour seal population in the UK is found in Scottish waters although the densest concentration of haul-out sites along the North Sea UK coastline is found at The Wash in East Anglia (SMRU, 2004). In the Wash, harbour seals haul out during June and July to give birth to pups and breed, and during August to undergo their annual moult. The Wash and North Norfolk Coast SAC is home to the largest breeding colony of harbour seal in the UK, and hosts 7% of the total UK population of this species.

4.3.16 A total of 147 harbour seal were recorded during the three years of monthly boat-based Project One and Project Two surveys, accounting for 2.0% of marine mammals across all surveys. The mean encounter rate showed that, generally, there were sightings of harbour seal in most months, however, numbers were reduced in November and December.

4.3.17 Modelled surface density estimates for harbour seal are shown in Figure 4.8. The highest harbour seal densities were in the southwest region of the former Hornsea Zone and no animals were recorded in the northeast region of the former Hornsea Zone (i.e. in the area coinciding with the Hornsea Three array area). The relative mean densities within the former Hornsea Zone plus 10 km buffer were 0.018 animals km^{-2}. The mean number of animals estimated to occur offshore within the former Hornsea Zone plus 10 km buffer, based on site-specific Project One and Project Two data, was 167.2 individuals. Telemetry data (SMRU, 2011) for tagged seals at east coast haul-outs shows that individuals regularly travel to areas along the southern edge of the former Hornsea Zone plus 10 km buffer (Figure 4.9).

Hornsea Three offshore ECR corridor

4.3.18 The historical WWT aerial survey data (WWT, 2009) also recorded seals along the coastline to the north and south of The Wash and in the area coinciding with the Hornsea Three offshore ECR corridor search area (Figure 4.7). Given the proximity of known breeding colonies in the region, as well as the telemetry data for harbour seal tagged in The Wash (Figure 4.9) it is considered likely that harbour seal will regularly occur within the proposed Hornsea Three offshore ECR corridor search area.

Grey seal

Hornsea Three array area

4.3.19 Grey seal is commonly found around the entirety of the British Isles coastline, although its distribution is centred in the north of Scotland. The most important haul-out sites in the southern North Sea are those at Donna Nook on the Lincolnshire coastline, The Wash, Blakeney Point, Horsey Gap and Scroby Sands. At these sites, grey seal haul-out during September to December for the pupping and breeding season. After weaning, the pups moult their natal coat and subsequently the adult moulting season occurs early in the new year.

4.3.20 A total of 247 grey seal were recorded during the three years of monthly boat-based Project One and Project Two surveys accounting for 3.3% of marine mammals across all surveys. The majority of sightings of grey seal were in the southwest corner of the former Hornsea Zone.

4.3.21 The average absolute abundance of individuals occurring offshore within the former Hornsea Zone plus 10 km buffer based on site-specific surveys for Project One and Project Two was estimated as 372 individuals. Offshore abundances varied seasonally: the mean encounter rate decreased considerably during September to December, coinciding with the main haul-out period, and peaked in July and February for all three survey years.

4.3.22 The mean absolute density for the former Hornsea Zone plus 10 km buffer was 0.04 animals km^{-2} (Figure 4.8).

Hornsea Three offshore ECR corridor

4.3.23 The historical WWT aerial survey data (WWT, 2009) also recorded seals along the coastline to the north and south of The Wash and in the area coinciding with the Hornsea Three offshore ECR corridor search area (Figure 4.7). Given the proximity of known breeding colonies in the region it is considered likely that grey seal will regularly occur within the proposed Hornsea Three offshore ECR corridor search area.

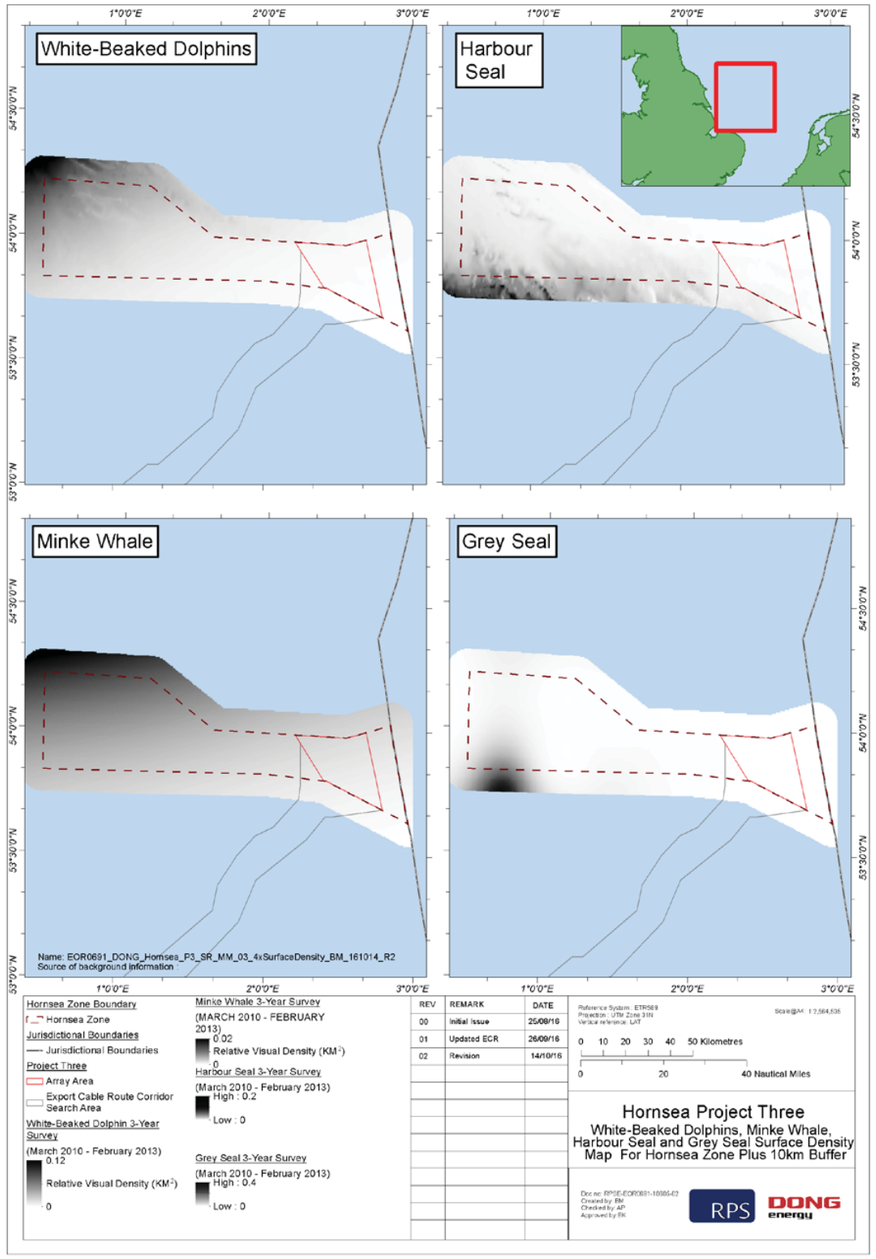

Figure 4.8 Modelled surface density estimates (relative densities) for harbour seal, grey seal, white-beaked dolphin and minke whale, across the former Hornsea Zone plus 10 km buffer using three years of survey data

Note - The density scales for each of the species are different (see legend) and should not be compared.

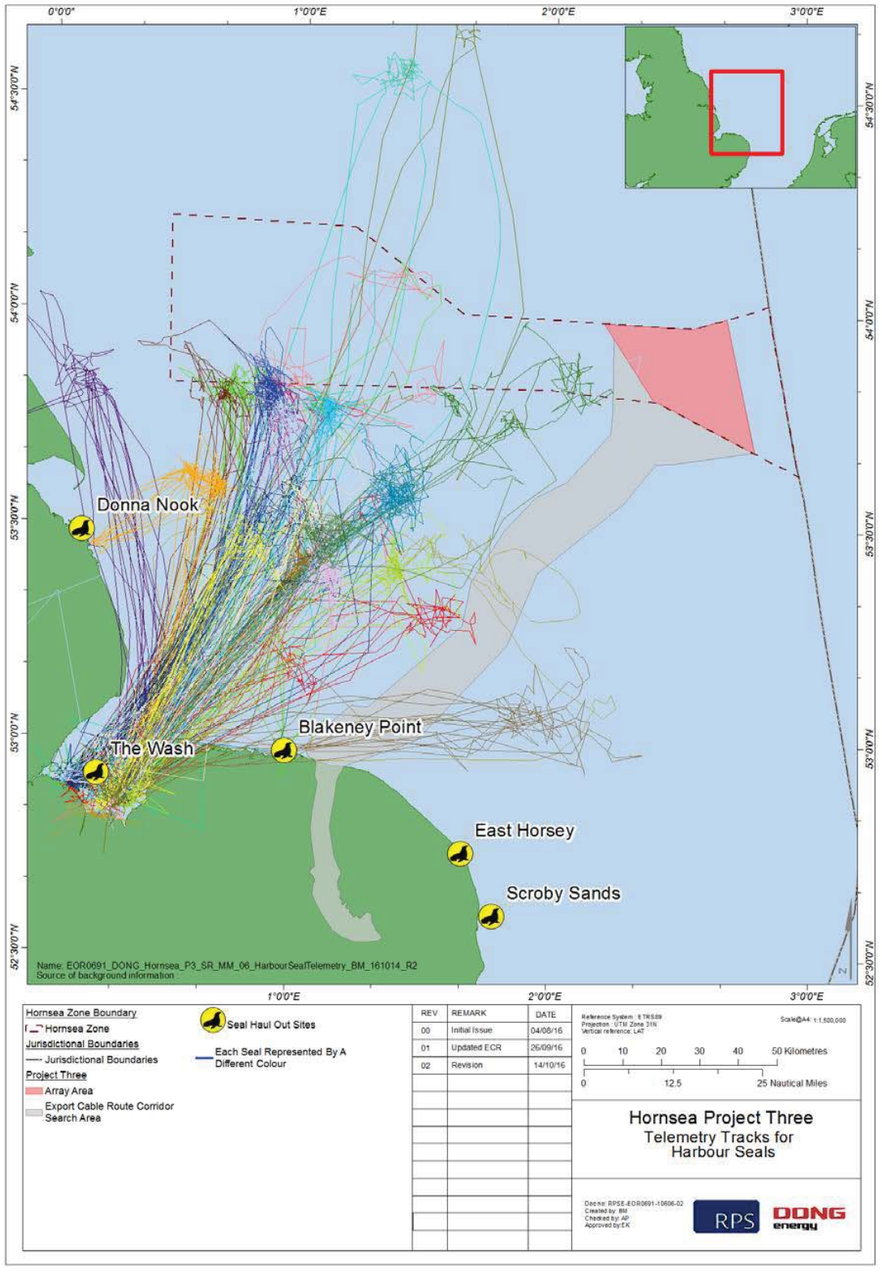

Figure 4.9 Tracks of the 24 harbour seal which were tagged in The Wash (SMRU, 2011)

4.4 Offshore Ornithology

Site investigations

4.4.1 Site-specific offshore ornithology surveys were carried out between 2010 and 2013 to characterise the bird communities across the former Hornsea Zone, as well as the Project One and Project Two array areas. Table 4.2 summarises seabird population estimates recorded within the former Hornsea Zone and 10km buffer, in particular between 2011 and 2012. Those two survey years (Year 1 March 2011 to February 2012; Year 2 March 2012 to February 2013) are when two previously unsurveyed transects in the east of the former Hornsea Zone were included in the survey area so as to entirely capture the Hornsea Three array area and buffer. The survey extensions also included six previously unsurveyed transects in the west of the former Hornsea Zone. This wider area is also useful for providing greater context for determining changes in distribution and abundance within and between years and also increases the probability of capturing migratory movements for relatively rare species. This overview of the data indicates that Hornsea Three does not represent an area of significant importance for breeding, passage or wintering seabirds.

Table 4.2 Population estimates of species in the former Hornsea Zone[5] plus 10 km buffer recorded by monthly boat-based surveys in Project Two Year 1 (March 2011 – February 2012) and Year 2 (March 2012 – February 2013) (SMart Wind Ltd, 2015)

	Survey	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Red-throated diver	Year 1	0	298	0	0	0	0	#	#	+ (0)	#	#	#
	Year 2	40	+ (104)	0	0	0	0	+ (0)	+ (0)	#	#	+ (0)	#
Fulmar	Year 1	3,546	792	11,732	5,116	3,403	1,864	#	#	+ (377)	#	#	#
	Year 2	1,637	+ (2,154)	25,357	4,364	7,733	3,118	+ (7,104)	+ (1,108)	#	#	+ (2,344)	#
Manx shearwater	Year 1	0	0	0	117	332	80	#	#	+ (0)	#	#	#
	Year 2	0	+ (0)	0	37	27	130	+ (0)	+ (0)	#	#	+ (0)	#
European storm petrel	Year 1	0	0	0	0	0	62	#	#	+ (155)	#	#	#
	Year 2	0	+ (0)	0	0	0	0	+ (0)	+ (0)	#	#	+ (0)	#
Gannet	Year 1	3,275	1,143	874	2,884	2,287	2,998	#	#	+ (6,306)	#	#	#
	Year 2	2,680	+ (856)	2,073	4,987	4,998	5,250	+ (2,704)	+ (6,259)	#	#	+ (2,896)	#
Arctic skua	Year 1	0	0	76	0	104	107	#	#	+ (0)	#	#	#
	Year 2	0	+ (140)	47	0	80	133	+ (0)	+ (0)	#	#	+ (0)	#
Great skua	Year 1	0	128	0	0	55	45	#	#	+ (0)	#	#	#
	Year 2	0	+ (60)	0	26	66	19	+ (248)	97	#	#	+ (0)	#
Little gull	Year 1	0	0	0	33	36	61	#	#	+ (0)	#	#	#
	Year 2	0	+ (0)	0	0	582	2,404	+ (0)	+ (0)	#	#	+ (0)	#
Lesser black-backed gull	Year 1	302	4,917	1,528	346	391	78	#	#	+ (0)	#	#	#
	Year 2	413	+ (3,600)	261	178	670	354	+ (248)	+ (0)	#	#	+ (0)	#
Herring gull	Year 1	746	777	509	281	0	29	#	#	+ (178)	#	#	#
	Year 2	43	+ (0)	39	26	286	14	+ (0)	+ (0)	#	#	+ (916)	#
Great black-backed gull	Year 1	3,341	4,507	602	311	825	169	#	#	+ (5,984)	#	#	#
	Year 2	2,772	+ (1,066)	623	824	4,684	500	+ (2,018)	+ (2,373)	#	#	+ (11,104)	#
Kittiwake	Year 1	16,571	12,217	8,625	19,608	17,625	12,058	#	#	+ (1,912)	#	#	#
	Year 2	17,972	+ (13,333)	12,392	24,703	20,409	14,418	+ (5,942)	+ (6,954)	#	#	+ (4,312)	#
Common tern	Year 1	0	0	56	38	101	3,168	#	#	+ (0)	#	#	#
	Year 2	0	+ (0)	0	0	87	6,993	+ (0)	+ (0)	#	#	+ (0)	#
Arctic tern	Year 1	0	111	0	0	2,154	135	#	#	+ (0)	#	#	#
	Year 2	0	+ (60)	0	0	488	412	+ (0)	+ (0)	#	#	+ (0)	#
Guillemot	Year 1	23,593	77,140	31,951	63,183	98,316	155,392	#	#	+ (6,641)	#	#	#
	Year 2	66,084	+ (51,745)	70,624	66,574	84,937	173,412	+ (66,652)	+ (23,966)	#	#	+ (43,393)	#

[5] Hornsea Zone is 4,735 km^2 in area.

	Survey	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Razorbill	Year 1	9,655	17,678	4,775	22,810	43,866	59,276	#	#	+ (983)	#	#	#
	Year 2	22,085	+ (12,622)	9,312	18,574	18,103	44,810	+ (5,970)	+ (414)	#	#	+ (2,718)	#
Puffin	Year 1	2,147	3,533	1,494	2,314	5,635	22,150	#	#	+ (13,476)	#	#	#
	Year 2	10,771	+ (5,246)	5,086	419	5,940	16,607	+ (11,188)	+ (3,249)	#	#	+ (3,497)	#

Notes:

Coloured shading represents the biological seasons used by Project Two which were informed by Furness (2015) (Green = Pre-breeding, red = breeding, orange = post-breeding, blue = non-breeding). The biological seasons for each seabird species to be used for Hornsea Three will be agreed in consultation with the statutory consultees and Expert Working Group offshore ornithology.

No survey coverage

+ (nnnn) Limited survey coverage

Data processing

4.4.2 The Distance-adjusted population estimate was derived by extrapolating bird density from the survey transect. The raw counts of birds on the water and in flight were adjusted to account for the decline in detection probability with the increase in distance from the survey vessel. Camphuysen *et al.* (2004) recommends only using data recorded in sea states less than 5.

Proposed data collection for Hornsea Three array area

4.4.3 Detailed site-specific bird surveys at the scale of Hornsea Three are required to allow the potential impacts of Hornsea Three to be assessed. Dedicated monthly digital video aerial seabird surveys commenced in April 2016 and are planned to cover at least two breeding seasons (20016 and 2017). Parallel transects aligned south to north orientation, are surveyed across the Hornsea Three array and a 4 km buffer around it. The transect orientation crosses the principal habitat gradient of bathymetry for all species which improves the precision of abundance estimates as sampling across the key depth contours reduces the amount of variability in animal abundance between the individual transect. The variation in transect distance from the breeding colony is relatively unimportant at this distance offshore for most seabird species (Hornsea Three is indicatively 160 km from the Yorkshire coast and 120 km from the Norfolk coast).

4.4.4 High-resolution digital video cameras are operated from an aircraft at a survey altitude of 550 m and speed of 220 km per hour. At this altitude, two strips of approximately 125 m (i.e. 250 m combined) are surveyed with a ground sample distance ("GSD") resolution of 2 cm. Parallax is used to measure bird flight height above sea (calculated to the nearest 1 metre). Surveys are completed in about 2½ hours for which a limitation on operating conditions is Beaufort Scale 6 wind speed; this compares with a limitation set of Beaufort Scale 4 wind speed for boat-based bird surveys (Camphuysen *et al.,* 2004). The survey provides 10% coverage by area per month and with a 4 km buffer is considered appropriate for site characterisation and to deliver sufficient precision for abundance estimates.

4.4.5 The aerial survey design was discussed and agreed with the statutory consultees as part of the Evidence Plan process. The survey results will provide the baseline data to inform the EIA and HRA assessment of ornithological impacts of Hornsea Three. To further inform the assessment there will be a review of the ornithological data gathered from the Hornsea Three array site from the boat surveys undertaken between 2010 and 2013. Included within this work will be an assessment of the potential to combine boat and aerial data to provide a single baseline data set.

Landfall zone surveys

4.4.6 A site visit to the landfall zone was completed in July 2016 in order to provide supporting evidence to the determination of whether an intertidal ornithological impact assessment was required and/or whether baseline surveys were necessary to inform such an impact assessment.

4.4.7 The landfall zone encompasses a small section of the North Norfolk Coast SPA which includes in its designation a series of qualifying features that are overwintering and passage shorebirds. The SPA runs to Kelling Hard from the west with the boundary extending inshore beyond mean high water. Despite this, an appraisal of the habitats present in the intertidal zone (a continuous narrow band of coarse shingle), has identified that the landfall zone will not provide notable opportunities for SPA qualifying features that use intertidal habitats for foraging or roosting. This has been discussed with the Expert working Group (offshore ornithology).

4.4.8 The landfall zone was assessed for the potential to support foraging or roosting shorebirds and despite part of the zone being located within the North Norfolk Coast SPA, the intertidal habitat found throughout was found to be, at best, of limited value for intertidal birds. It was therefore considered that a survey programme of winter and passage periods (in respect of intertidal ornithology) is not necessary to inform an impact assessment.

4.4.9 As noted in Section 4.1, for the purposes of this report, offshore ornithology encompasses all those bird populations with the likelihood to interact with Hornsea Three below MHWS. This was on account of only a narrow strip of sub-optimal habitat existing for waterbirds at the Hornsea Three landfall area, rendering a standalone topic on intertidal ornithology unnecessary. Those bird populations with a greater propensity to interact with Hornsea Three above MHWS are considered under the onshore ecology section.

Ornithological importance of the Hornsea Zone

4.4.10 Extensive ornithological surveys (e.g., Carter *et al.,* 1993; Stone *et al.,* 1995), reviews (e.g., Stienen *et al.,* 2007) as well as results documented in Round 1 and 2 offshore wind farm Environmental Statements and monitoring reports have shown that the southern North Sea, extending roughly between the Yorkshire coast and the Straits of Dover and incorporating the Hornsea Zone, is an important area for seabirds. This is particularly the case during passage and in winter months when British breeding birds are joined by birds that have migrated from continental Europe and Fennoscandia. Because of the mix of birds present, it is probable that the Hornsea Zone is used at different times by birds (i) overwintering in the area; (ii) foraging from nearby breeding coastal colonies; and (iii) on post-breeding dispersal, migration and pre-breeding return.

4.4.11 As well as true pelagic seabirds (e.g., gannet, fulmars and auks), other species that spend part of their annual life cycle at sea (e.g., divers, gulls and seaducks) may also be present in particular months, with periodic numbers of non-seabird migrants also present (e.g, wildfowl, waders and passerines).

4.4.12 Stienen *et al.* (2007) demonstrated that the southern North Sea area is an important corridor for migration of some seabird species in particular. For instance, the great majority (40-100%) of the flyway population of great skua use the Strait of Dover to leave the North Sea, as well as 30-70% of the lesser black-backed gull population. Use of the Strait by widely distributed pelagic species, such as kittiwake, is difficult to be accurately assessed, but is estimated to be less than 3% of the total flyway population.

4.4.13 Based on divisions according to geographic, hydrographic and physical differences within the North Sea in Stone *et al*. (1995), the Hornsea Zone potentially falls within three sectors; (i) the Western North Sea sector, which stretches along a relatively coastal strip from northeast Scotland to the Greater Wash; (ii) the Central and Northern North Sea sector which is mainly marine in nature, although encompasses the western coastline of Norway; and (iii) the South and East North Sea sector, which stretches from Kent, across the English Channel and northwards to Norfolk, and includes much of coastal Netherlands, Belgium and Denmark, including the Kattegat, Wadden Sea and German Bight.

4.4.14 The Western North Sea sector contains breeding colonies such as at Flamborough Head and the Farne Islands and was characterised by Stone *et al.* (1995) as being important for auks throughout the year. The area was also used in winter by gulls and eider, with gulls and terns abundant in summer. Skuas, among other species, pass through the area on autumn passage.

4.4.15 The Central and North Sea sector was characterised as being important for guillemots, although less so during the breeding season, when birds are constrained to coastal colonies. Fulmars, gannets and kittiwakes were also found throughout the year, with other gulls more widespread during winter. Water depth in this sector is mostly shallow, with the exception of the Rinne off the coast of Norway.

4.4.16 The South and East North Sea sector is characterised as being a shallow area of low salinity which forms a distinct zone of distribution for many species. During winter, it was described by Stone *et al.* (1995) as being the most important area in north-west European waters for divers, grebes and seaduck. Gulls are common throughout the year, with common gulls and great black-backed gulls most abundant in winter, lesser black-backed gulls in summer, and herring gulls throughout the year. Little gulls are abundant during migration peaks. The area is also important for terns in summer and for auks in winter.

Species accounts [6]

Red-throated diver

4.4.17 Due to the low sample size in the Hornsea Zone it was not possible to conduct Distance analysis for red-throated diver. Population estimates were calculated using the correction factors in Stone *et al.* (1995), which produced peak estimates of 298 in Year 1 (April), and 104 in Year 2 (April) in the Hornsea Zone.

4.4.18 Red-throated diver is most abundant in UK waters during winter months when survey coverage of the Hornsea Zone was low. However, as few red-throated divers were recorded in corresponding surveys of Project Two transects, it is considered unlikely that significant numbers of red-throated diver are present in the Hornsea Zone. This assumption will be tested by reference to the aerial survey currently underway for the Hornsea Three array site and 4km buffer area.

4.4.19 Data are available (Lawson et al, 2015) to support the designation of the Greater Wash pSPA for which red-throated diver are a qualifying feature, see section 6.2.

[6] Species accounts are presented only for those species that are included as qualifying or assemblage components of Special Protection Areas.

4.4.20 Direct observations of red-throated diver from existing data in the Hornsea Zone indicate no defined spatial distribution, with occasional sightings scattered throughout the survey area.

Fulmar

4.4.21 Population estimates for fulmar in the Hornsea Zone were calculated using Distance analysis. Population estimates in the Hornsea Zone peaked in May/June and were comparatively much lower during the non-breeding season.

4.4.22 In Year 1 in the breeding season (April to August), the peak population estimate of fulmar in the Hornsea Zone occurred in May with 11,732 fulmars estimated present in the Hornsea Zone. In Year 2, the peak population estimate also occurred in May with 25,357 fulmars present.

4.4.23 Survey coverage of the Hornsea Zone was relatively low in the post-breeding (September to October), non-breeding (November) and pre-breeding (December to March) seasons in both Years 1 and 2 meaning it is not possible to draw robust inferences on seasonal abundance of fulmar within the Hornsea zone. However, as fulmar abundance was low in surveys of Project Two and 4 km buffer it is considered unlikely that significant numbers of fulmar were present in the Hornsea Zone. This assumption will be tested by reference to the data generated from the aerial survey currently underway for the Hornsea Three array site and 4km buffer area.

Manx shearwater

4.4.24 Due to the low sample size of Manx shearwaters recorded in all surveys, it was not possible to conduct Distance analysis on the data. Population estimates were therefore calculated using the correction factors in Stone et al. (1995). This produced peak population estimates of 332 in Year 1 (July), and 130 in Year 2 (August) of Hornsea Zone surveys.

4.4.25 Survey coverage of the Hornsea Zone was low in winter months in both Years 1 and 2. However, Manx shearwater is rare in UK waters during winter months when birds are wintering off the eastern coast of South America. As such, it is considered unlikely that significant numbers of Manx shearwater occur in the Hornsea Zone during the period in which there was low boat survey coverage. This assumption will be tested by reference to the data generated from the aerial survey currently underway for the Hornsea Three array site and 4km buffer area.

European storm-petrel

4.4.26 Due to the low sample size of European storm-petrels recorded in all surveys (Table 4.2), it was not possible to conduct Distance analysis on the data. Indeed, this species was recorded on a single survey only (August Year 1). Population estimates were therefore calculated using the correction factors in Stone *et al.* (1995). This produced peak population estimates of 155 in Year 1 (November) of Hornsea Zone surveys. Population estimates were not calculable for European storm petrel in Year 2 of Hornsea Zone surveys due to the complete absence of any records.

4.4.27 It is considered unlikely that significant numbers of European storm-petrel will have been present in the Hornsea Zone in those months in which survey coverage was low. This assumption will be tested by reference to the data generated from the aerial survey currently underway for the Hornsea Three array site and 4km buffer area.

Gannet

4.4.28 Population estimates for gannet in the Hornsea Zone were calculated using Distance analysis.

4.4.29 During the breeding season in Year 1 (April to August), the peak estimate of gannet occurred in August (2,998 birds). In the Year 2 breeding season the peak estimate of gannet again occurred in August (5,250 birds).

4.4.30 Low survey coverage in the Hornsea Zone means it is difficult to analyse seasonal trends in population estimate data in the post-breeding and pre-breeding seasons for gannet in the Hornsea Zone. However, it is likely that trends within the Hornsea Zone will be similar to those within the Project Two and 4 km buffer. Population estimates for the Hornsea Zone in November of Year 1 and October of Year 2 indicate high numbers of gannet within the Hornsea Zone during the post-breeding season.

Common scoter

4.4.31 Due to the low sample size of common scoter recorded in all surveys, it was not possible to conduct Distance analysis for common scoter. Population estimates were therefore calculated using the correction factors in Stone *et al.* (1995).

4.4.32 It is considered unlikely that significant numbers of common scoter will have been present in the Hornsea Zone in those months in which survey coverage was low as common scoter abundance was relatively low in corresponding surveys in Project Two transects.

4.4.33 Direct observations were distributed across the Hornsea Zone and, as this species does not show a distinct pattern of spatial or temporal distribution within the survey area, it is unlikely that the Hornsea Three is an important habitat for common scoter.

Arctic skua

4.4.34 Due to the low sample size of Arctic skuas recorded in all surveys, it was not possible to conduct Distance analysis on the data. Population estimates were therefore calculated using the correction factors in Stone *et al.* (1995). Population estimates were calculable in the breeding season (June to July), post-breeding season (August to October) and pre-breeding season (April to May). However, those individuals recorded in the breeding season are again not considered to represent breeding individuals. In Year 1, the estimated peak of Arctic skua in the Hornsea Zone was 107 birds in August. In Year 2, the estimated peak was higher with 140 birds in April.

Great skua

4.4.35 Due to the low sample size of great skuas recorded in all surveys, it was not possible to conduct Distance analysis on the data. Population estimates were therefore calculated using the correction factors in Stone *et al.* (1995).

4.4.36 In the breeding season (May to July) population estimates were calculable for July in Year 1 and June and July in Year 2, with peak breeding estimates of 55 birds and 66 birds occurring in July of both years. In Year 2, the highest populations of great skua in the Hornsea Zone were estimated for passage seasons.

Little gull

4.4.37 Population estimates for little gull in the Hornsea Zone were calculated using Distance analysis. This produced peak estimates of 61 little gulls in August of Year 1 and 2,404 little gulls in August of Year 2.

4.4.38 It is likely that the low survey coverage in the Hornsea Zone will have affected the total number of little gulls recorded during surveys of the Hornsea Zone, especially in Year 1 when survey coverage was low in September and October. This assumption will be tested by reference to the data generated from the aerial survey currently underway for the Hornsea Three array site and 4km buffer area.

4.4.39 The abundance of birds recorded during the autumn indicates regular use by individuals on passage.

Lesser black-backed gull

4.4.40 Population estimates of lesser black-backed gulls were calculated using Distance analysis. In the breeding season in Year 1, a peak estimate of 1,528 lesser black-backed gulls occurred in May in the Hornsea Zone. In Year 2, the peak estimate was lower (670 birds) and occurred in July.

4.4.41 In the pre-breeding season of both survey years, peak population estimates in the Hornsea Zone occurred in April with 4,917 birds estimated in Year 1 and 3,600 birds in Year 2.

4.4.42 Survey coverage in the breeding season (May to August) and between March and April was considered good in Year 1 (Table 4.2). In this period, population estimates of over 1,000 birds occurred in April and May of Year 1.

Herring gull

4.4.43 Due to the low sample size of herring gulls recorded across all survey areas, it was not possible to conduct Distance analysis on the data. It is likely that the low survey coverage in the Hornsea Zone will have affected the total number of herring gulls recorded during surveys of the Zone.

4.4.44 Survey coverage of the Hornsea Zone is considered to be good between March and August of both survey years (with the exception of April in Year 2) (Table 4.2). This encompasses the breeding season (May to July) and three months of the non-breeding season (March, April and August) for herring gull. Within this time period in Year 1, estimates of over 200 birds occurred between March and June. In Year 2, population estimates were lower with estimates of over 200 birds only occurring in July.

Great black-backed gull

4.4.45 Population estimates of great black-backed gull were calculated using Distance analysis.

4.4.46 Survey coverage of the Hornsea Zone is considered to be good between March and August of both survey years (with the exception of April in Year 2) (Table 4.2). This encompasses the breeding season (May to July) and three months of the non-breeding season (March, April and August) for great black-backed gull. Within this time period, the highest estimates of great black-backed gull occurred in April in Year 1 (4,507 birds) and July of Year 2 (4,684 birds).

Kittiwake

4.4.47 Population estimates of kittiwake were calculated using Distance analysis. Survey coverage was considered to be good (Table 4.2) in the breeding season (May to July) of both years and March to April of Year 1. Within the breeding season in Year 1, population estimates of kittiwake were above 10,000 birds in all months except May. In the breeding season of Year 2, population estimates were above 10,000 birds in all months, with population estimates of above 20,000 birds in June and July.

4.4.48 Direct observations of kittiwake were distributed throughout the Hornsea Zone, with no discernible pattern of site use.

Common tern

4.4.49 Population estimates have been calculated using correction factors presented in Stone *et al*. (1995).

4.4.50 Survey coverage was considered to be good in the breeding season (June to July) and in some months of the post-breeding and pre-breeding seasons of both survey years (Table 4.2). In both years the peak population estimate occurred in August with 3,168 common terns in Year 1 and 6,993 common terns in Year 2. Common terns were concentrated in the western half of the former Hornsea Zone in both Years 1 and 2 of survey. The species was decidedly scarce in the vicinity of Hornsea Three in both years (Smart Wind 2015).

Arctic tern

4.4.51 Due to the low sample size of Arctic tern recorded in all surveys, population estimates were calculated using the correction factors presented in Stone *et al.* (1995).

4.4.52 Survey coverage was considered to be good in the breeding season (June to July) of both survey years. In Year 1, a peak estimate of 2,154 Arctic terns occurred in July with the peak estimate in Year 2 of 488 Arctic terns also occurring in July (Table 4.2).

4.4.53 Direct observations of Arctic tern are throughout the Hornsea Zone, with no discernible patterns of site use.

Guillemot

4.4.54 Population estimates of guillemot within the Hornsea Zone were calculated using Distance analysis.

4.4.55 Survey coverage was considered to be good between March and August of Year 1 incorporating the breeding season (March to July) and part of the non-breeding season (August) (Table 4.2). Peak populations in the breeding season in the Hornsea Zone occurred in July of both years with 98,316 birds in Year 1 and 84,937 birds in Year 2. In August of Year 1, 155,392 birds were present in the Hornsea Zone with 173,412 birds in August of Year 2. Guillemots were widespread across the former Hornsea Zone in both years of survey, although highest densities occurred in the western half of the zone (Smart Wind 2015).

Razorbill

4.4.56 Population estimates of razorbill within the Hornsea Zone were calculated using Distance analysis.

4.4.57 Survey coverage was considered to be good between March and August of Year 1 and May to August of Year 2 (Table 4.2). This time period covers one month of the pre-breeding season (March), the breeding season (April to July) and part of the post-breeding season (August). Over 20,000 razorbills were present in the Hornsea Zone in June, July and August of Year 1 and in August of Year 2. Razorbills were distinctly concentrated in the western half of the Hornsea Zone during both years of survey. Few records were made in the vicinity of Hornsea Three including breeding and post-breeding months (Smart Wind 2015).

Puffin

4.4.58 Population estimates of puffin within the Hornsea Zone were calculated using Distance analysis.

4.4.59 Survey coverage was considered to be good between March and August of Year 1 and March and May to August of Year 2 (Table 4.2). In Year 1, this covers the breeding season (April to July) and parts of the non-breeding season (March and August) and most of the breeding season and part of the post-breeding season in Year 2. In both survey years over 1,000 birds were estimated for each month with good survey coverage (with the exception of June of Year 2) with peak estimates occurring in August of both years (22,150 and 16,607 puffins respectively). Puffins were distinctly concentrated in the western half of the former Hornsea Zone during both years of survey. Few records were made in the vicinity of Hornsea Three including breeding months (Smart Wind, 2015).

4.5 Onshore ecology

Sources of information

4.5.1 Key data sources used to inform the onshore component of this report include SAC and SPA citations and Natura 2000 standard data forms as well as Information sheets on Ramsar wetlands.

4.5.2 It should be noted that a number of onshore site specific surveys are underway or proposed and the results of these will help further inform the baseline of the HRA report as it evolves prior to the submission of the DCO application. Those surveys relevant to the HRA include the following:

- Preliminary Ecological Appraisal – comprising a desk study from the sources listed above and an Extended Phase 1 Habitat Survey;
- Wintering bird survey (subject to results of Preliminary Ecological Appraisal);
- Otter survey (subject to results of Preliminary Ecological Appraisal);
- Breeding birds survey (subject to results of Preliminary Ecological Appraisal); and
- Bat survey - bat roosts and emergence/activity surveys - (subject to results of Preliminary Ecological Appraisal).

4.5.3 The Preliminary Ecological Appraisal will help refine the scope and extent of the detailed ecological surveys for the onshore ECR corridor, which in turn will help define the onshore baseline.

Baseline

4.5.4 Preliminary baseline information is given in Table 4.3. This is based on information on European (and Ramsar) sites which lie within the onshore ECR corridor search area or are located immediately adjacent to it (Figure 5.3 and Figure 5.4). The percentage of the area of the sites that overlap with the onshore ECR corridor search area is also shown in Table 4.3. Note that in all cases the onshore ECR only overlaps with a relatively small area of these sites. In the particular case of the Norfolk Valley Fens SAC, the onshore ECR corridor search area only overlaps with two discrete sections of the SAC. These correspond to two Sites of Special Scientific Interest (SSSIs), the Holt Lowes SSSI and the Booton Common SSSI.

4.5.5 Further consideration of sites that lie outside of the onshore ECR corridor search area is detailed in Section 5 where information on European sites potentially affected by Hornsea Three, and the criteria used to identify them, is presented.

Table 4.3 European (and Ramsar) sites which overlap with the Hornsea Three onshore ECR corridor search area

Site	Within Hornsea Three onshore ECR corridor search area	Area of the site covered by the onshore ECR corridor search area (km^2) and percentage of total area of the site	Description
River Wensum SAC	Yes	0.2 km^2 (6.7%)	The River Wensum provides an Annex I habitat – water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation. It also supports various Annex II species, including white-clawed crayfish, Desmoulin's whorl snail, brook lamprey and bullhead.
Norfolk Valley Fens SAC	Yes	0.3 km^2 (7.7%)	This site comprises a series of valley-head spring-fed fens. Such spring-fed flush fens are very rare in the lowlands. Most of the vegetation at this site is of the small sedge fen type, but there are transitions to reedswamp and other fen and wet grassland types. The individual fens vary in their structure according to intensity of management and provide a wide range of variation. There is a rich flora associated with these fens, including species such as grass-of-Parnassus, common butterwort, marsh and narrow-leaved marsh-orchid. In addition to containing various Annex I habitats, the site supports Annex II species, including narrow- mouthed whorl snail and Desmoulin's whorl snail. The onshore ECR corridor search area overlaps with two discrete section of this SAC which correspond with the Holt Lowest SSSi and the Booton Common SSSI. The Holt Lowes SSSi component of the site comprises an area of dry sandy heathland that grades into flushed slopes along the valley of the River Glaven and it provides an important example of mixed mire communities within a small tributary valley bisecting a heath. The habitat supports a rich invertebrate fauna particularly in the wet boggy areas.

Site	Within Hornsea Three onshore ECR corridor search area	Area of the site covered by the onshore ECR corridor search area (km^2) and percentage of total area of the site	Description
			The Booton Common SSSI lies in the valley of a tributary of the River Wensum, approximately a mile east of Reepham. The main interest of the site is associated with a mosaic of wet calcareous fen grassland and acid heath communities which have developed. In additional to the floristic value, the site also supports a variety of breeding birds including Snipe, Woodcock, Grasshopper Warbler and Lesser Whitethroat.
The Wash and North Norfolk Coast SAC	No (but immediately adjacent)	0 km^2 (0%)	The extensive intertidal flats of the Wash and on the North Norfolk Coast provide ideal conditions for Harbour seal *Phoca vitulina* breeding and hauling-out. This site is the largest colony of common seals in the UK, with some 7% of the total UK population. Subtidal communities cover a diverse range from the shallow to the deeper parts of the embayments and include dense brittlestar beds and areas of an abundant reef-building worm ('ross worm') *Sabellaria spinulosa*. The embayment supports a variety of mobile species, including a range of fish, otter *Lutra lutra* and common seal *Phoca vitulina.* In addition, the site contains the largest single area of saltmarsh in the UK and is one of the few areas in the UK where saltmarshes are generally accreting.
North Norfolk Coast SAC/SPA/Ramsar	Yes	SAC: 0.3 km^2 (0.9%) SPA: 0.5 km2 (0.7%) Ramsar: 0.5 km^2 (0.7%)	The sites encompasse a variety of habitats including intertidal sands and muds, saltmarshes, shingle and sand dunes, together with areas of land-claimed freshwater grazing marsh and reedbed, which is developed in front of rising land. Both freshwater and marine habitats support internationally important numbers of wildfowl in winter and several nationally rare breeding birds. The sandflats, sand dune, saltmarsh, shingle and saline lagoons habitats are of international importance for their fauna, flora and geomorphology.

5. Identification of European Sites and Features

5.1 Introduction

5.1.1 Given the large spatial scale and nature of Hornsea Three and the number of European sites that could potentially be affected, an initial pre-LSE screening stage has been introduced into the process. This stage is essentially a site-identification / selection process, which, while it forms part of the overall LSE determination stage of HRA, has been separated out to allow a subsequent focus (in section 6) on those sites where Hornsea Three is considered to have a potential for a LSE.

5.1.2 The criteria used in this first stage of selection takes account of the location of the European sites (including Ramsar sites) in relation to Hornsea Three, the zone of influence (ZOI) of potential impacts associated with Hornsea Three and the ecology and distribution of qualifying features. These criteria are described in Table 5.1.

Table 5.1 Criteria used for initial identification of relevant European sites.

Criteria used for initial identification of relevant European sites	
1	Hornsea Three boundaries overlap with European site.
2	European site supports mobile populations of qualifying features (e.g., Annex I birds, Annex II marine mammals, migratory fish, bats and otters) that may interact with potential effects associated with Hornsea Three).
3	European site with qualifying features/species whose mean maximum foraging or migratory range overlaps with Hornsea Three.
4	European sites and/or qualifying features located within the potential ZOI[7] of impacts associated with Hornsea Three (e.g., habitat loss/disturbance, increase in suspended sediment and sediment deposition, noise and risk of collision).
5	European sites with primary reasons or qualifying features for site selection recorded during zonal-specific surveys.

5.1.3 This initial screening will exclude sites where Hornsea Three is considered to have no potential for a LSE. Sites not excluded at this stage are taken forward for a detailed determination of LSE in Section 6.

5.2 Potential impacts

5.2.1 The potential impacts arising from the construction, operation and maintenance, and decommissioning of Hornsea Three are summarised in Table 5.2 and Table 5.3.

5.2.2 For the purposes of this report, and given the limited information currently available with respect to decommissioning, potential impacts during this phase have been assumed to be similar to those predicted during construction, for all receptors.

[7] ZOI is defined for relevant features in Section 5.3.

Table 5.2 Anticipated effects of offshore components of Hornsea Three on relevant receptors

Project phase	Receptor type	Effect	Justification
Construction	Benthic habitats	Temporary habitat loss/ disturbance	There is potential for temporary, direct habitat loss and disturbance due to cable laying operations (including anchor placements), spud-can leg impacts from jack-up operations and seabed preparation works for gravity base foundations.
		Temporary increases in suspended sediments / smothering	Sediment disturbance arising from construction activities (e.g. cable and foundation installation) may result in adverse and indirect impacts on benthic communities as a result of temporary increases in suspended sediment concentrations and associated sediment deposition.
		Accidental pollution	There is a risk of accidental pollution from sources including construction and installation vessels/vehicles, machinery and offshore fuel storage tanks and from the construction process itself. The release of such contaminants may lead to impacts on the benthic communities present, through toxic effects resulting in reduced benthic diversity, abundance and biomass.
	Diadromous fish species	Temporary habitat loss/disturbance	There is potential for temporary, direct habitat loss and disturbance due to cable laying operations (including anchor placements), spud-can leg impacts from jack-up operations and seabed preparation works for gravity base foundations.
		Temporary increases in suspended sediments/deposition	Sediment disturbance arising from construction activities (e.g. cable and foundation installation) may result in adverse and indirect impacts on fish. There is potential for sediment deposition/smothering of fish habitats as a result of sediment plumes generated during construction activities (e.g. cable and foundation installation).
		Underwater noise	Construction activities, in particular the pile-driving of foundations, will result in high levels of underwater noise that may result in mortality, injury and behavioural effects on fish.
		Accidental pollution	There is a risk of accidental pollution from sources including construction and installation vessels/vehicles, machinery and offshore fuel storage tanks and from the construction process itself. The release of such contaminants may adversely affect fish receptors.
	Marine Mammals	Underwater noise	There is the potential for underwater noise arising from percusive piling and other construction activities within the Hornsea Three array and offshore ECR corridor area (e.g.. for the offshore HVAC booster station) to cause physical/auditory injury or disturbance to marine mammals.
		Vessel noise	Increased vessel traffic during construction may result in an increase in noise disturbance to marine mammals.
		Collision risk	Increased vessel traffic during construction may result in an increased collision risk to marine mammals.
		Temporary increase in suspended sediments	There is the potential that increased suspended sediments, arising from construction activities such as cable and foundation installation, may impair the foraging ability of marine mammals.

Project phase	Receptor type	Effect	Justification
		Accidental pollution	There is a risk of accidental pollution from sources including construction and installation vessels/vehicles, machinery and offshore fuel storage tanks and from the construction process itself. The release of such contaminants may lead to impacts on marine mammals.
		Prey availability	Changes in the fish and shellfish community resulting from construction impacts may lead to a loss in prey resources for marine mammals.
	Ornithology	Direct temporary habitat loss/ disturbance	The impact of construction activities such as increased vessel activity, underwater noise, and cable installation may result in direct disturbance or displacement of birds from important feeding and roosting areas.
		Indirect temporary habitat loss/ disturbance	The impact of construction activities such as increased vessel activity, underwater noise, and cable installation may result in disturbance or displacement of prey from important bird feeding areas.
Operation and Maintenance	Benthic ecology	Long-term habitat loss	There is the potential for long-term habitat loss at and around foundation structures and associated scour protection, and at any subsea cables where secondary cable protection is installed.
		Colonisation of hard structures	Man-made structures placed on the seabed (foundations and scour/cable protection) are expected to be colonised by a range of marine organisms leading to localised changes in biodiversity. These structures also have the potential to act as artificial reef serving as a refuge for fish and may facilitate the spread of non-native species.
		Changes in physical processes	The presence of foundation structures, associated scour protection and cable protection may introduce changes to the local hydrodynamic and wave regime, resulting in changes to the sediment transport pathways and associated effects on benthic ecology. Some benthic species and communities may be more vulnerable to reductions in water flow if the decrease is sufficient to reduce the availability of suspended food particles, and consequently inhibit feeding and growth. Scour and increases in flow rates can change the characteristics of the sediment potentially making the habitat less suitable for some species.
		Temporary seabed disturbance	Temporary disturbance/alteration of seabed habitats may occur during the operation and maintenance phase of Hornsea Three as a result of maintenance operations (such as those requiring jack up vessels or cable repair vessels). The impacts associated with these operations are likely to be similar in nature to those associated with the construction phase, localised and of reduced magnitude.
		Accidental pollution	There is a risk of accidential pollution from vessels, vehicles, machinery and offshore fuel storage tanks during the operation and maintenance phase as well as during the turbines and offshore substations themselves. The release of such contaminants may lead to impacts on the benthic communities present, through toxic effects resulting in reduced benthic diversity, abundance and biomass.
	Diadromous fish species	Long-term habitat loss	There is the potential for long-term loss of fish and shellfish habitat directly under all foundation structures and associated scour protection, and any subsea cables, where secondary cable protection is required.

Project phase	Receptor type	Effect	Justification
		Underwater noise	Underwater noise as a result of operational turbines and maintenance vessel traffic has the potential to result in local effects on fish receptors.
		Colonisation of hard structures	The introduction of man-made structures on the seabed (foundations and scour/cable protection) may lead to effects on fish receptors by creating reef habitat.
		EMF	EMF emitted by array and export cables during the operational phase has the potential to result in behavioural responses on fish.
		Temporary seabed disturbance	Temporary disturbance/alteration of seabed habitats may occur during the operation and maintenance phase of Hornsea Three as a result of maintenance operations (i.e. jack-up operations).
		Accidental pollution	There is a risk of accidental pollution released from vessels, vehicles, machinery and offshore fuel storage tanks during the operation and maintenance phase as well as from the turbines and offshore substations themselves.
	Marine mammals	Operational noise	The operating noise of turbines may result in potential effects on marine mammals.
		Vessel noise	Increased vessel traffic during operation and maintenance may result in an increase in noise disturbance to marine mammals.
		Collision risk	Increased vessel traffic during operation and maintenance may result in an increased collision risk to marine mammals.
		EMFs	EMF emitted by array and export cables may potentially affect marine mammal behaviour.
		Accidental pollution	There is a risk of accidental pollution from vessels, vehicles, machinery and offshore fuel storage tanks during the operation and maintenance phase as well as from the turbines and offshore substations themselves. The release of such contaminants may lead to impacts on the marine mammals.
		Prey availability	Changes in the fish and shellfish community resulting from operation and maintenance impacts may lead to a loss in prey resources for marine mammals.
	Ornithology	Permanent habitat loss/disturbance	The impact of displacement from the array site and any offshore structures within the ECR corridor during the operational phase of the development may equate to effective habitat loss and a consequent reduction in species survival rates and fitness. No permanent habitat loss within the intertidal zone is predicted as a result of the presence of buried export power cables.

Project phase	Receptor type	Effect	Justification
		Collision	Collisions with rotating turbine blades will result in direct mortality of an individual. Increased mortality may reduce species' survival rates.
		Barrier effect	Barrier effects caused by the physical presence of turbines and ancillary structures may prevent clear transit of birds between foraging and breeding sites, or on migration. Additional energetic costs incurred may reduce fitness and survival rate of a species.
		Temporary habitat loss/disturbance	Disturbance as a result of activities associated with maintenance or repair of operational turbines, export and array cables and other infrastructure may result in displacement of birds from the array site, areas of the ECR, and intertidal zone.
Decommissioning	Effects are assumed to be similar to those predicted during the construction phase for all receptors		

Table 5.3 Predicted effects of onshore components of Hornsea Three on relevant receptors

Project phase	Receptor type	Effect
Construction	Habitats	Permanent habitat loss from the construction of the onshore substation and HVAC booster station (if constructed onshore).
		Temporary disturbance/damage to habitats from the installation of the onshore elements of the project.
		Potential accidental release of contaminants.
	Species	Permanent loss of habitat from the construction of the onshore substation and onshore HVAC booster station.
		Temporary disturbance/damage to species from the installation of the onshore elements of the project.
		Habitat fragmentation or severance associated with cable route clearsance and trenching (otters and bats).
		Potential accidental release of contaminants.
Operation	Habitats	Temporary / intermittent disturbance/damage to habitats from operation and maintenance activities.
		Potential accidental release of contaminants
	Species	Temporary/intermittent disturbance/damage to species from operation and maintenance activities
		Potential accidental release of contaminants
Decommissioning	Effects are assumed to be similar to those predicted during the construction phase for all receptors	

5.3 Initial identification of sites and features

Introduction

5.3.1 The following section provides a list of sites (and their features) for which there is potentially connectivity with Hornsea Three using the criteria in Table 5.1.

5.3.2 An overview of the SACs, SCIs, cSACs, pSACs, SPAs, pSPAs, potential Ramsar sites and Ramsar sites surrounding Hornsea Three in relation to the array area, the offshore ECR corridor search area and the onshore ECR corridor search area is given in Figure 5.1 to Figure 5.4 below.

5.3.3 The European sites shown in Figure 5.1 to Figure 5.4 are listed in Table 5.4 to Table 5.7. Note that some coastal sites (for example North Norfolk Coast SAC and Humber Estuary SAC) are shown on both the figure covering the North Sea (Figure 5.1) and the figure covering the onshore ECR search area (Figure 5.3) but are numbered differently in the accompanying tables (Table 5.4 and Table 5.6). Refer to the appropriate table for each figure.

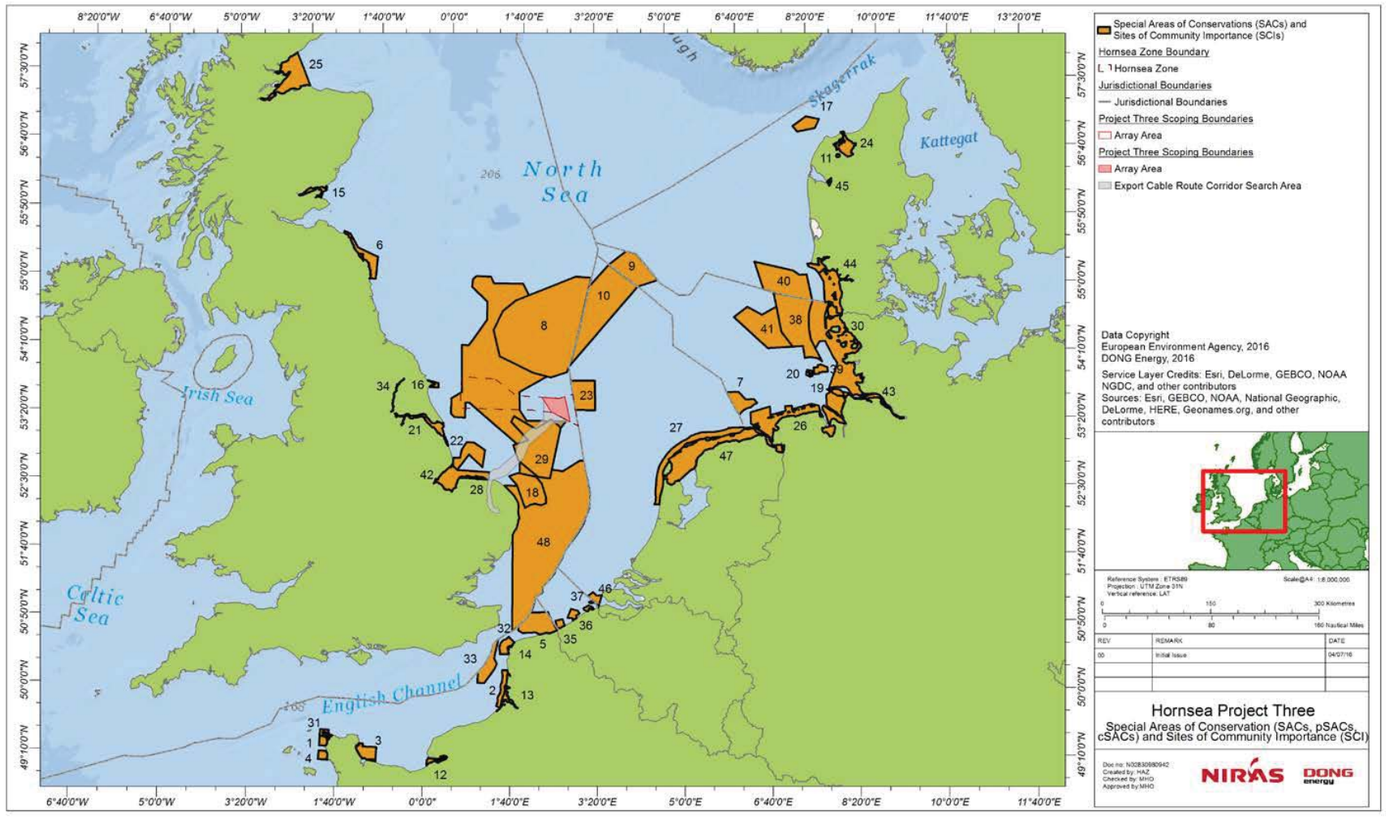

Figure 5.1 Location of SACs, pSACs, cSACs and SCIs in the North Sea potentially relevant to Hornsea Three

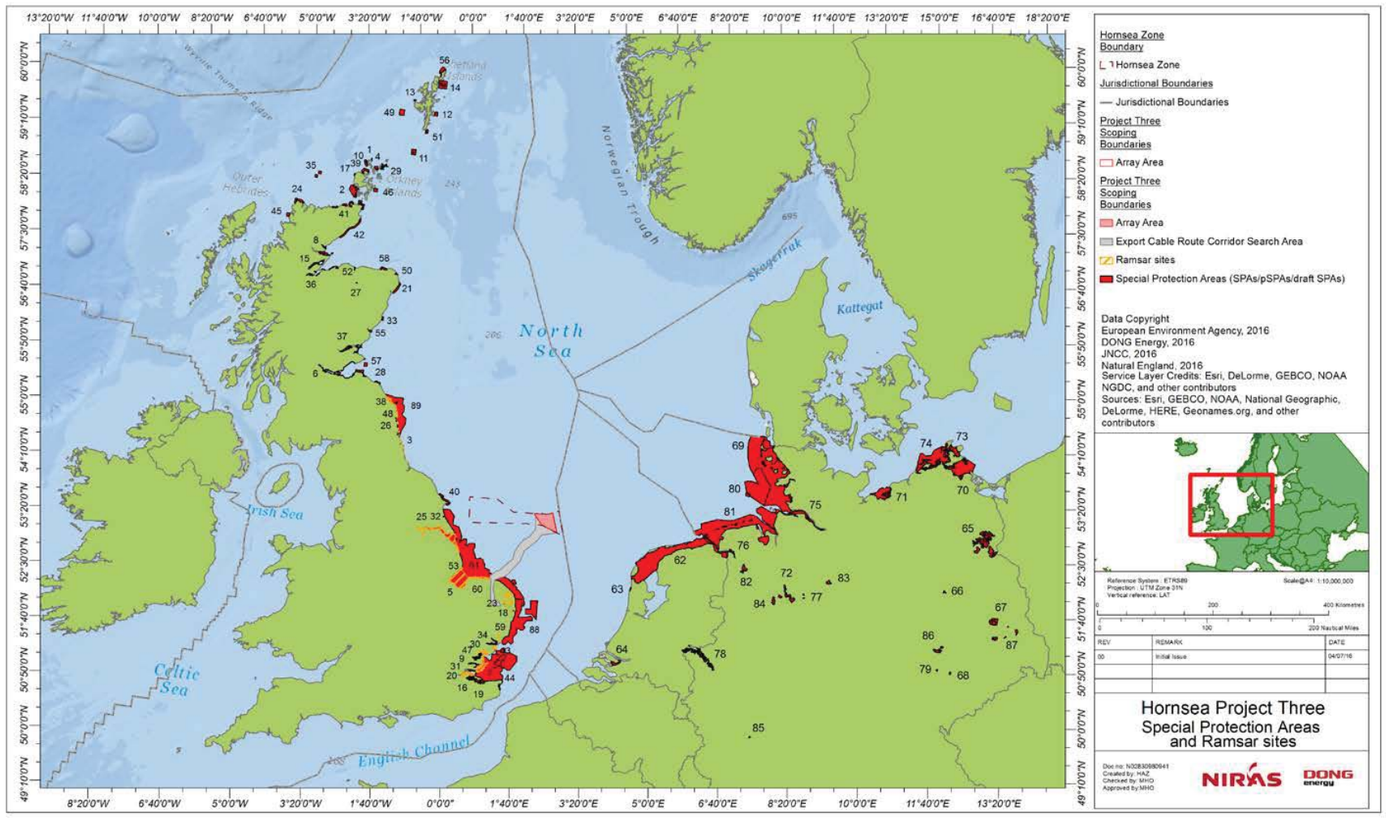

Figure 5.2 Location of SPAs, pSPAs and Ramsar sites in the North Sea potentially relevant to Hornsea Three

Table 5.4 SACs, pSACs, cSACs and SCIs in Figure 5.1

Label	Site	Label		Label	
1	Anse de Vauville	20	Helgoland mit Helgoländer Felssockel	39	Steingrund
2	Baie de Canche et couloir des trois estuaires	21	Humber Estuary	40	Sydlige Nordsø
3	Baie de Seine occidentale	22	Inner Dowsing, Race Bank and North Ridge	41	Sylter Außenriff
4	Banc et récifs de Surtainville	23	Klaverbank	42	The Wash and North Norfolk Coast
5	Bancs des Flandres	24	Løgstør Bredning, Vejlerne og Bulbjerg	43	Unterelbe
6	Berwickshire and North Northumberland Coast	25	Moray Firth	44	Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde
7	Borkum-Riffgrund	26	Nationalpark Niedersächsisches Wattenmeer	45	Venø, Venø Sund
8	Dogger Bank (Uk)	27	Noordzeekustzone	46	Vlakte van de Raan
9	Doggerbank (Germany)	28	North Norfolk Coast	47	Waddenzee
10	Doggersbank (Dutch)	29	North Norfolk Sandbanks and Saturn Reef	48	Southern North Sea
11	Dråby Vig	30	NTP S-H Wattenmeer und angrenzende Küstengebiete		
12	Estuaire de la Seine	31	Récifs et landes de la Hague		
13	Estuaires et littoral picards (baies de Somme et d'Authie)	32	Récifs Gris-Nez Blanc-Nez		
14	Falaises du Cran aux Oeufs et du Cap Gris-Nez, Dunes du Chatelet, Marais de Tardinghen et Dunes de Wissant	33	Ridens et dunes hydrauliques du détroit du Pas-de-Calais		
15	Firth of Tay and Eden Estuary	34	River Derwent		
16	Flamborough Head	35	SBZ 1 / ZPS 1		
17	Gule Rev	36	SBZ 2 / ZPS 2		
18	Haisborough, Hammond and Winterton	37	SBZ 3 / ZPS 3		
19	Hamburgisches Wattenmeer	38	SPA Östliche Deutsche Bucht		

Table 5.5 SPAs, pSPAs and Ramsar sites in Figure 5.2

Label	Site	Label		Label	
1	Papa Westray (North Hill and Holm)	31	Benfleet and Southend Marshes	61	Greater Wash potential SPA
2	Hoy	32	Hornsea Mere	62	Waddenzee
3	Northumbria Coast	33	Fowlsheugh	63	Zwanenwater & Pettemerduinen
4	Calf of Eday	34	Stour and Orwell Estuaries	64	Krammer-Volkerak
5	The Wash	35	Sule Skerry and Sule Stack	65	Schorfheide-Chorin
6	Firth of Forth	36	Inner Moray Firth	66	Rietzer See
7	Foulness (Mid-Essex Coast Phase 5)	37	Firth of Tay & Eden Estuary	67	Luckauer Becken
8	Dornoch Firth and Loch Fleet	38	Farne Islands	68	Bergbaufolgelandschaft Bockwitz
9	Crouch and Roach Estuaries (Mid-Essex Coast Phase 3)	39	Rousay	69	Ramsar-Gebiet S-H Wattenmeer und angrenzende Küstengebiete
10	West Westray	40	Flamborough and Filey Coast pSPA	70	Greifswalder Bodden und südlicher Strelasund
11	Fair Isle	41	North Caithness Cliffs	71	Wismarbucht und Salzhaff
12	Noss	42	East Caithness Cliffs	72	Diepholzer Moorniederung
13	Papa Stour	43	Hamford Water	73	Binnenbodden von Rügen
14	Fetlar	44	Thanet Coast and Sandwich Bay	74	Vorpommersche Boddenlandschaft und nördlicher Strelasund
15	Cromarty Firth	45	Handa	75	Unterelbe
16	Medway Estuary and Marshes	46	Copinsay	76	Emsmarsch von Leer bis Emden
17	Marwick Head	47	Colne Estuary (Mid-Essex Coast Phase 2)	77	Wesertalaue bei Landesbergen
18	Breydon Water	48	Lindisfarne	78	Vogelschutzgebiet 'Unterer Niederrhein'

Label	Site	Label		Label	
19	The Swale	49	Foula	79	Bergbaufolgelandschaft Werben
20	Thames Estuary and Marshes	50	Loch of Strathbeg	80	Seevogelschutzgebiet Helgoland
21	Buchan Ness to Collieston Coast	51	Sumburgh Head	81	Niedersächsisches Wattenmeer und angrenzendes Küstenmeer
22	Dengie (Mid-Essex Coast Phase 1)	52	Moray and Nairn Coast	82	Esterweger Dose
23	Broadland	53	Gibraltar Point	83	Ostenholzer Moor und Meißendorfer Teiche
24	Cape Wrath	54	Blackwater Estuary (Mid-Essex Coast Phase 4)	84	Dümmer
25	Humber Estuary	55	Montrose Basin	85	Engerser Feld
26	Coquet Island	56	Hermaness, Saxa Vord and Valla Field	86	Agrarraum und Bergbaufolgelandschaft bei Delitzsch
27	Tips of Corsemaul and Tom Mor	57	Forth Islands	87	Lausitzer Bergbaufolgelandschaft
28	St Abb`s Head to Fast Castle	58	Troup, Pennan and Lion`s Heads	88	Outer Thames Estuary
29	East Sanday Coast	59	Deben Estuary	89	Northumberland Marine potential SPA
30	Abberton Reservoir	60	North Norfolk Coast		

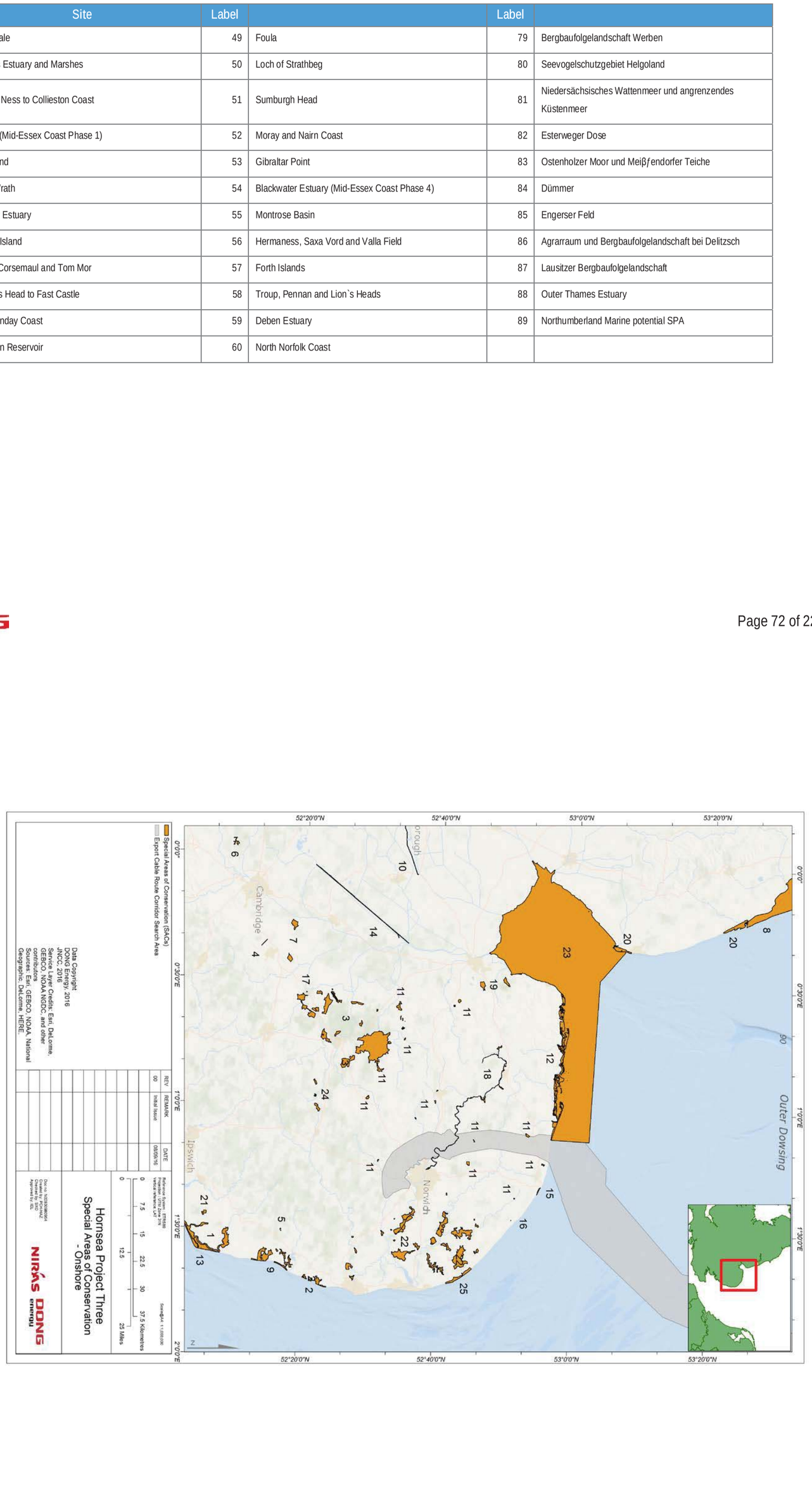

Figure 5.3 Location of SACs around the onshore ECR corridor search area

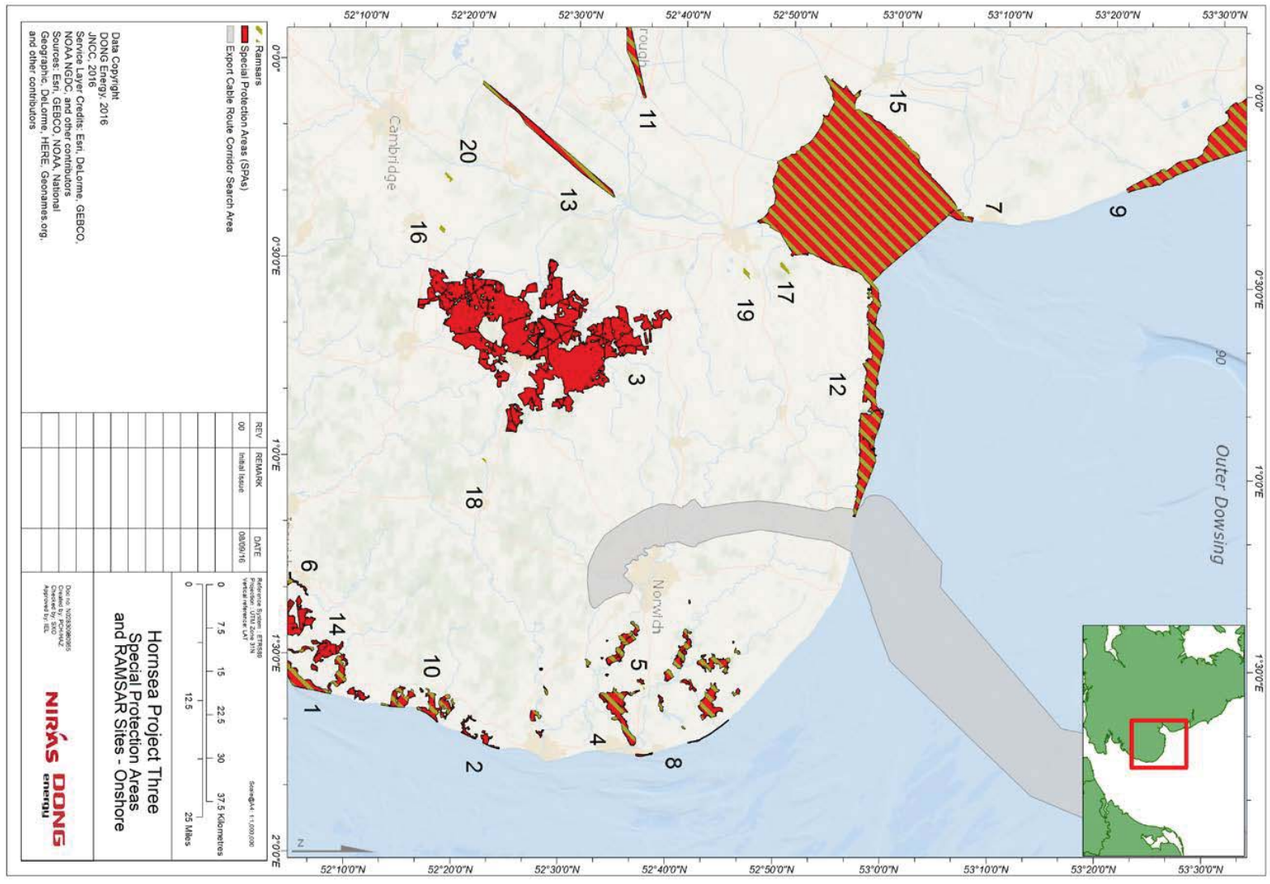

Figure 5.4 Location of SPAs and Ramsar Sites around the onshore ECR corridor search area

Table 5.6 SACs in Figure 5.3

Label	Site	Label		Label	
1	Alde, Ore and Butley Estuaries	10	Nene Washes	19	Roydon Common and Dersingham Bog
2	Benacre to Easton Bavents Lagoons	11	Norfolk Valley Fens	20	Saltfleetby-Theddlethorpe Dunes and Gibraltar Point
3	Breckland	12	North Norfolk Coast	21	Staverton Park and The Thicks, Wantisden
4	Devil`s Dyke	13	Orfordness - Shingle Street	22	The Broads
5	Dew`s Ponds	14	Ouse Washes	23	The Wash and North Norfolk Coast
6	Eversden and Wimpole Woods	15	Overstrand Cliffs	24	Waveney and Little Ouse Valley Fens
7	Fenland	16	Paston Great Barn	25	Winterton - Horsey Dunes
8	Humber Estuary	17	Rex Graham Reserve		
9	Minsmere to Walberswick Heaths and Marshes	18	River Wensum		

Table 5.7 SPAs and Ramsar sites in Figure 5.4

Label	Site	Label	
1	Alde-Ore Estuary SPA and Ramsar	11	Nene Washes SPA and Ramsar
2	Benacre to Easton Bavents SPA	12	North Norfolk Coast SPA and Ramsar
3	Breckland SPA	13	Ouse Washes SPA and Ramsar
4	Breydon Water SPA and Ramsar	14	Sandlings SPA
5	Broadland SPA and Ramsar	15	The Wash SPA and Ramsar
6	Deben Estuary SPA and Ramsar	16	Chippenham Fen Ramsar
7	Gibraltar Point SPA and Ramsar	17	Dersingham Bog Ramsar

Label	Site
8	Great Yarmouth North Denes SPA
9	Humber Estuary SPA and Ramsar
10	Minsmere-Walberswick SPA and Ramsar

Label	Site
18	Redgrave and South Lopham Fens Ramsar
19	Roydon Common Ramsar
20	Wicken Fen Ramsar

OFFSHORE

Sites designated for Annex I habitats (subsea and coastal)

5.3.4 It is assumed there is potential for a LSE on any site which includes Annex I habitats that is directly affected by Hornsea Three. In this instance, 'directly' means where any part of the Hornsea Three array area or the offshore ECR corridor search area is within the European site boundary. For the purposes of this screening exercise it will be assumed that at this stage a LSE on any of the Annex I habitat features for which the site is designated cannot be discounted and further assessment for determination of LSE will be undertaken in Section 6 of this report.

5.3.5 In addition to direct effects, for sites designated for Annex I habitats, there may be potential for indirect effects, due to, for example:

- Changes in the hydrodynamic regime (waves and currents) as result of turbine structures leading to changes in baseline environment and as such on offshore and coastal habitats and non-mobile species; and
- Sediment mobilisation from turbine or cable installation which may be deposited on offshore and coastal habitats and non-mobile species.

5.3.6 The zone of influence (ZOI) for assessment of indirect effects has been determined through a review of the modelled zone of effects associated with increased suspended sediment concentrations during construction produced for Project Two. On this basis, a 16 km buffer around the Hornsea Three array area has been included, based on the evidence base from Project Two which predicted suspended sediment dispersal of up to 2 mg/l extending out to 16 km during seabed preparation works. A buffer of one tidal excursion[8] (approximately 12 km) from the Hornsea Three offshore ECR corridor search area has also been included to capture the zone of likely impacts from cable installation works. This ensures that all sites potentially affected by changes in water quality (e.g. increased suspended sediment concentrations) and potential changes to the hydrodynamic regime are included in the assessment.

5.3.7 Based on the criteria above, Table 5.8 shows the European sites designated for Annex I habitats (subsea and coastal) that overlap with the Hornsea Three array area, offshore ECR corridor search area and associate ZOI buffers. These are illustrated in Figure 5.5.

[8] Distance of one (mean) spring tidal excursion derived from the underlying tidal current data used in the the Atlas of UK Marine Renewable Energy Resources (ABPmer, *et al.,* 2008)

Table 5.8 European sites designated for Annex I habitats (subsea and coastal) for which a LSE cannot currently be discounted

European site	Annex I feature	Distance to array area (km)	Distance to offshore ECR corridor search area (km)
North Norfolk Sandbanks and Saturn Reef cSAC	• Sandbanks which are slightly covered by seawater all the time • Reefs	9	0
Haisborough, Hammond and Winterton SAC	• Sandbanks which are slightly covered by seawater all the time • Reefs	90	3
The Wash and North Norfolk Coast SAC	• Sandbanks which are slightly covered by sea water all the time • Mudflats and sandlflats not covered by seawater at low tide • Large shallow inlets and bays • Reefs • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadow • Mediterranean and thermo-Atlantic halophilous scrubs • Coastal lagoons	120	0
Inner Dowsing, Race Bank and North Ridge SAC	• Sandbanks which are slightly covered by seawater all the time • Reefs	106	12
Klaverbank SCI	• Reefs	11	18

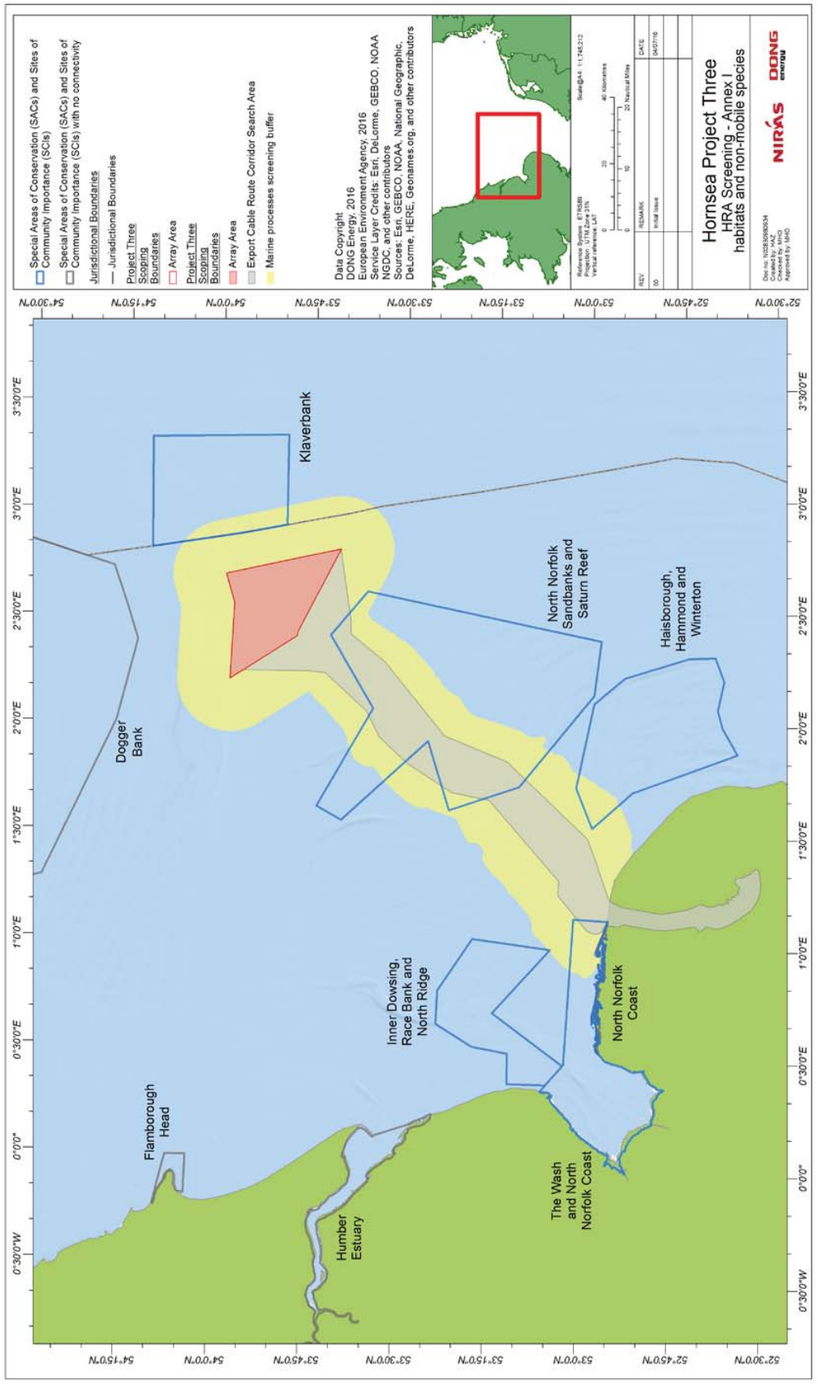

Figure 5.5 European sites designated for Annex I habitats

Sites designated for Annex II diadromous migratory fish

5.3.8 It is assumed there is potential for a LSE on any site which includes Annex II diadromous fish species as a feature that is directly affected by Hornsea Three. In this instance, 'directly' means where any part of the Hornsea Three array area or the offshore ECR corridor search area is within the European site boundary

5.3.9 Annex II diadromous fish species which are features of SACs in the UK are as follows:

- Twaite shad *Alosa fallax*;
- Allis shad *Alosa alosa*;
- Atlantic salmon *Salmo salar*;
- Sea lamprey *Petromyzon mar*inus; and
- River lamprey *Lampetra fluviatilis*.

5.3.10 It should be noted, however, that there are no sites designated for Annex II fish species which overlap with the Hornsea Three array area, nor with the offshore ECR corridor search area and therefore no potential for impacts by direct means on these features are expected to occur as a result of Hornsea Three.

5.3.11 European sites designated for diadromous fish features comprise estuaries through which fish migrate and the freshwater reaches of rivers. Given that these species are mobile and make use of both the freshwater and marine/offshore environments throughout their life cycle, there could be potential, however, for Hornsea Three to result in impacts on Annex II diadromous species at some distance from the sites where they are qualifying features.

5.3.12 Taking a precautionary approach, it has been considered that European sites with Annex II diadromous fish features which are located within 100 km from either the array area or the offshore ECR corridor search area could potentially be affected by Hornsea Three.

5.3.13 Using the screening criteria above, the European sites designated for Annex II diadromous fish species listed in Table 5.9 will be assessed for LSE in Section 6.

Table 5.9 Designated sites included for determination of LSE in respect of Annex II diadromous fish

European site	Annex II feature	Distance to array area (km)	Distance to offshore ECR corridor search area (km)
Humber Estuary SAC	• River lamprey • Sea lamprey	141	67
Humber Estuary Ramsar site	Ramsar criterion 8: • River lamprey • Sea lamprey	141	67

Sites designated for Annex II marine mammals

5.3.14 It is assumed there is potential for a LSE on any site which includes Annex II marine mammals as a feature that is directly affected by Hornsea Three. In this instance, 'directly' means where any part of the Hornsea Three array area or the offshore ECR corridor search area is within the European site boundary.

5.3.15 Given that marine mammals are mobile species which potentially forage over wide areas, they could potentially be affected by activities that occur at some distance from the sites where they are qualifying features.

5.3.16 Taking a precautionary approach, and in order to ensure that that all sites with marine mammal features, potentially affected by noise effects (behavioural impacts) or changes to water quality (e.g. increased suspended sediment concentrations), located within the regional marine mammal study area (as defined in the Hornsea Three Scoping Report (DONG Energy, 2016) will be taken forward for determination of LSE in Section 6.

5.3.17 The regional study area is represented largely by SCANS Block U as the central focus, but extending further east and south (SCANS-II, 2006). The extent of the region and the European sites designated for marine mammals within this area are shown in Figure 5.6. These sites together with their qualifying marine mammal Annex II species are listed in Table 5.10 below.

Table 5.10 European sites with Annex II marine mammal features taken forward for determination of LSE

Site	Features	Distance to array area (km)	Distance to offshore ECR corridor search area (km)
Southern North Sea possible Special Area of Conservation (pSAC)	• Harbour porpoise	2	0
The Wash and North Norfolk Coast SAC	• Harbour seal	120	0
Humber Estuary SAC (and Ramsar site)	• Grey seal	141	67
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal	183	204
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal	42	58
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal	11	18
Noordzeekustzone SAC	• Harbour porpoise • Grey • Harbour seal	138	138
Vadehavet med Ribe Á, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal	383	391
Waddenzee SAC	• Grey seal • Harbour seal	146	146

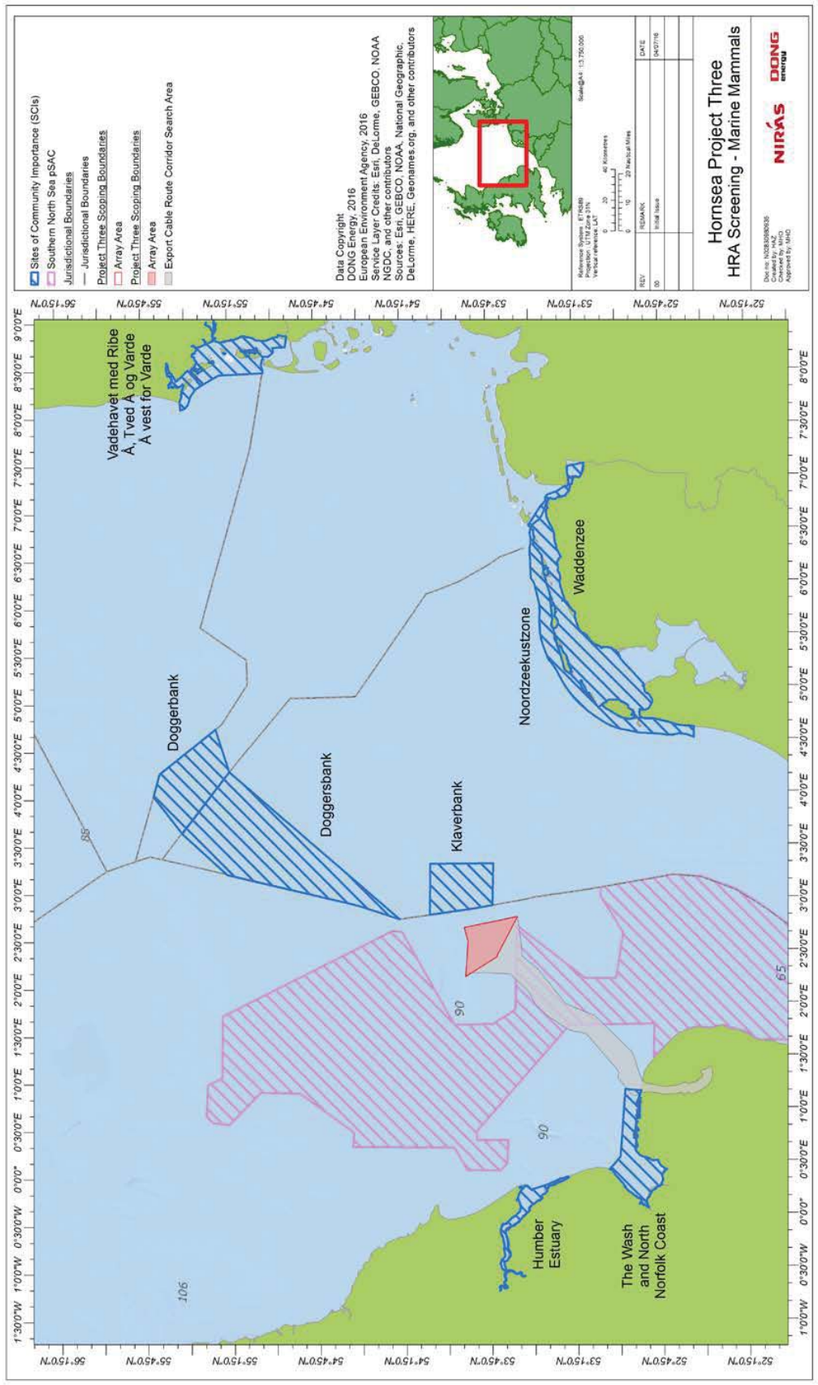

Figure 5.6 European sites designated for Annex II marine mammals

Sites designated for Ornithological features

5.3.18 It is assumed there is potential for a LSE on any site with birds as a qualifying feature that is directly affected by Hornsea Three. In this instance, 'directly' means where any part of the Hornsea Three array area or the offshore ECR corridor search area is within the European site boundary.

5.3.19 The offshore ECR corridor search area runs through the Greater Wash pSPA (see Figure 5.7), as a result the potential for a LSE on the features of this pSPA cannot be discounted. The features include wintering red-throated diver, common scoter and little gull in addition to foraging Sandwich, common and little terns in the breeding season.

5.3.20 The three tern species all breed at the North Norfolk Coast SPA which is adjacent to the proposed landfall and ECR (Figure 5.7). However, the nearest breeding colonies within the SPA are located at Blakeney Point and Scolt Head which are a minimum of 10 kilometres to the west of the offshore ECR corridor search area. Therefore, for the purposes of offshore ornithology, LSEs is only considered to be associated with foraging terns (i.e. within the Greater Wash pSPA).

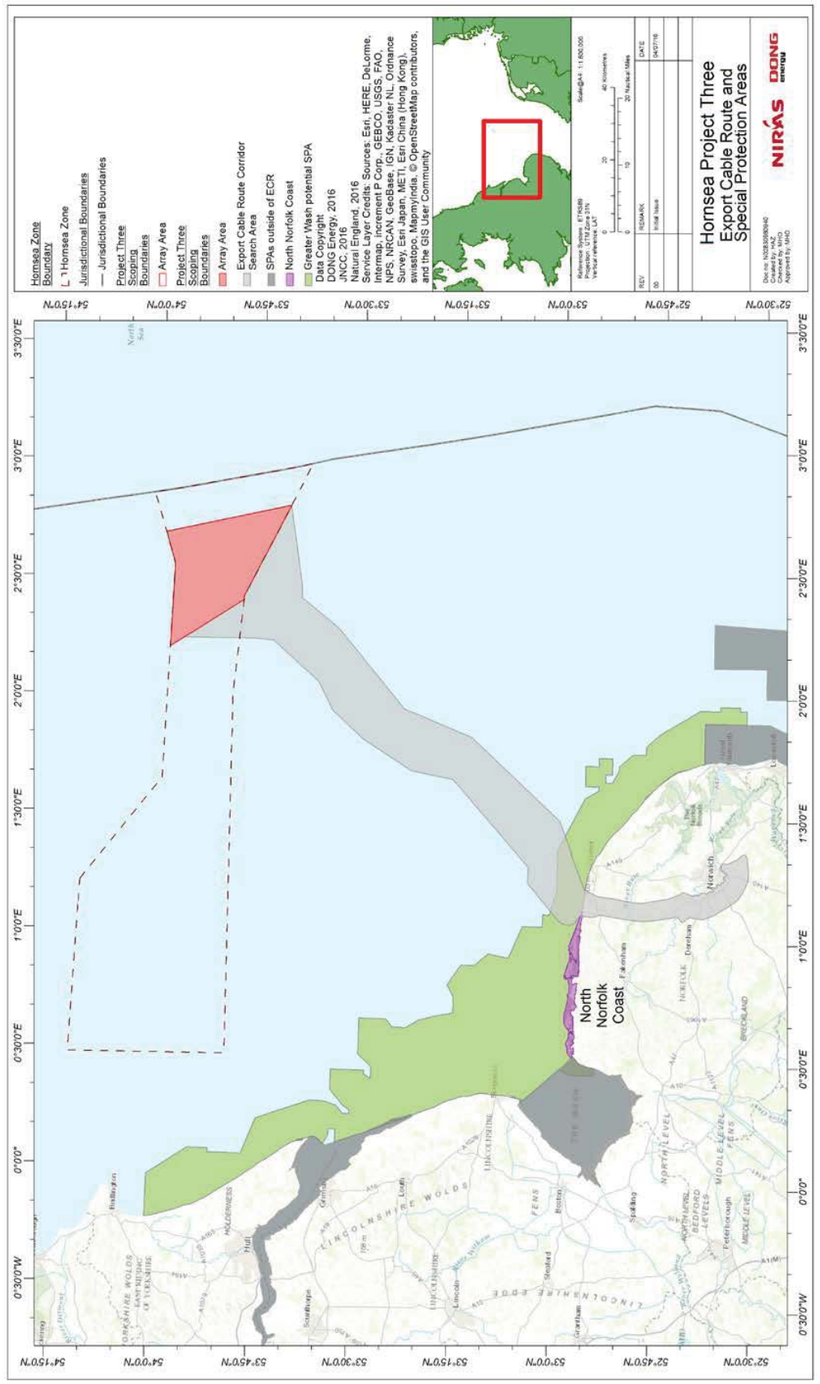

Figure 5.7 Location of the Hornsea Three array and ECR corridor search area and direct overlap with SPAs

5.3.21 In addition to impacts resulting from direct effects (i.e. based on overlap between Hornsea Three and European sites), there may be potential for impacts on ornithological features of sites located further afield, where birds forage and/or migrate through the Hornsea Three array area and/or offshore ECR corridor search area. These features include:

- Breeding birds;
- Migratory seabirds; and
- Waterbirds (waders and wildfowl).

5.3.22 The criteria used for screening of sites with these features are given below by feature type.

Sites designated for breeding ornithological features

5.3.23 During the breeding season foraging birds may travel some distance from their breeding colonies. The information available on the distances that breeding birds will forage depends on the species. Thaxter *et al.* (2012) provide data on recorded foraging ranges for a wide range of species, including the mean and maximum distances travelled. Typically, the mean-maximum range (i.e. the mean average of the maximum foraging trips recorded) has been used as a criterion for establishing whether there is likely to be connectivity (and hence risk of an impact) between an SPA breeding colony and a proposed wind farm array area.

5.3.24 In some cases, more specific information is available from GPS/satellite tracking studies such as, for example, the FAME/STAR initiatives for kittiwake and gannet colonies associated with the Flamborough and Filey Coast (FFC) pSPA.

5.3.25 Mean-maximum foraging ranges as reported by Thaxter *et al*. (2012) have been used to determine potential connectivity with Hornsea Three, unless specific relevant tracking data are available (where the latter is deemed to have priority).

5.3.26 Figure 5.8 to Figure 5.15 present foraging ranges for seven breeding qualifying features of SPAs (fulmar, gannet, kittiwake, herring gull, guillemot, razorbill and puffin). All other breeding seabird qualifying features are disregarded for the purposes of this report, as the Hornsea Three array area is understood to lie considerably beyond mean-maximum (or even maximum) foraging range and there is therefore a lack of connectivity between the SPA and the Hornsea Three during the breeding season.

Fulmar

The mean-maximum foraging range for fulmar from both the FFC pSPA and the Forth Islands SPA overlap with the Hornsea Three array area (Figure 5.8). On this basis, the potential for a LSE on this species cannot be discounted.

Gannet

5.3.27 For gannet, Langston *et al.* (2013) provides the results of three years of tracking data and presents kernel density estimation (KDE) foraging range from FFC pSPA. Two years of the same data set were also used in the work presented by Wakefield *et al.* (2013). Figure 5.9 indicates that although low, there is some level of usage by gannets in the Hornsea Three array area during the breeding season. On this basis, the potential for a LSE on this species cannot be discounted.

Kittiwake

5.3.28 Figure 5.10 shows the mean-maximum foraging range for kittiwake from the Flamborough and Bempton Cliffs SPA (and FFC pSPA) as defined by Thaxter *et al.,* (2012). The foraging range does not overlap with Hornsea Three even assuming 1 standard deviation in range beyond the

mean-maximum value, suggesting no or, at most, limited connectivity with Hornsea Three. Figure 5.11 however shows tracking data from the colony during the breeding season which indicates limited connectivity with the Hornsea Three array area (a single track from a single bird). Whilst it is predicted that only a very small proportion of kittiwakes found in the Hornsea Three array area during the breeding season are foraging adults from the pSPA, the potential for a LSE on this species cannot be discounted.

Guillemot

5.3.29 Figure 5.12 shows the mean maximum foraging ranges plus 1 standard deviation for guillemot from the FFC pSPA. The foraging range falls short of the Hornsea Three array area; there is therefore considered to be no connectivity and therefore no potential for a LSE from Hornsea Three on this feature during the breeding season.

Razorbill

5.3.30 Figure 5.13 presents the mean maximum foraging range plus 1 standard deviation for razorbill from the FFC pSPA. The foraging range falls short of the Hornsea Three array area; there is therefore considered to be no potential for connectivity and no potential for a LSE on this feature during the breeding season.

Puffin

5.3.31 Figure 5.14 presents foraging range for puffin which is a 'non-listed' assemblage feature for the FFC pSPA (as detailed in the Departmental Brief, Natural England, 2014). The mean-maximum foraging range just overlaps with Hornsea Three when 1 standard deviation is taken into account. This strongly suggests that there is very limited likelihood of connectivity between the colony and the Hornsea Three array area. However, in light of the possibility of a small number of individuals occasionally foraging out as far as Hornsea Three a LSE is not discounted at this stage.

Herring gull

5.3.32 Figure 5.15 shows both the mean-maximum foraging range for Herring Gull and the range with 1 standard deviation neither extending as far as Hornsea Three. Smart Wind (2015) presents species distribution maps of Hornsea Zone survey results which indicate that herring gull is at best rare in the vicinity of Hornsea Three in the breeding season. On this basis it is concluded that there is no prospect of a LSE on this species in the breeding season.

Summary of sites with breeding features taken forward for determination of LSE

5.3.33 On the basis of this analysis, the following SPAs (and features) are identified as having potential for connectivity with Hornsea Three during the breeding season and are therefore taken for assessment of LSE in Section 6:

- Flamborough Head and Bempton Cliffs SPA (kittiwake, gannet and puffin); and
- Flamborough and Filey Coast pSPA (kittiwake, gannet, puffin and fulmar[9]).
- Forth Islands SPA (fulmar).

[9] Fulmar is listed as an assemblage component for FFC pSPA while puffin is a 'non-listed' assemblage feature.

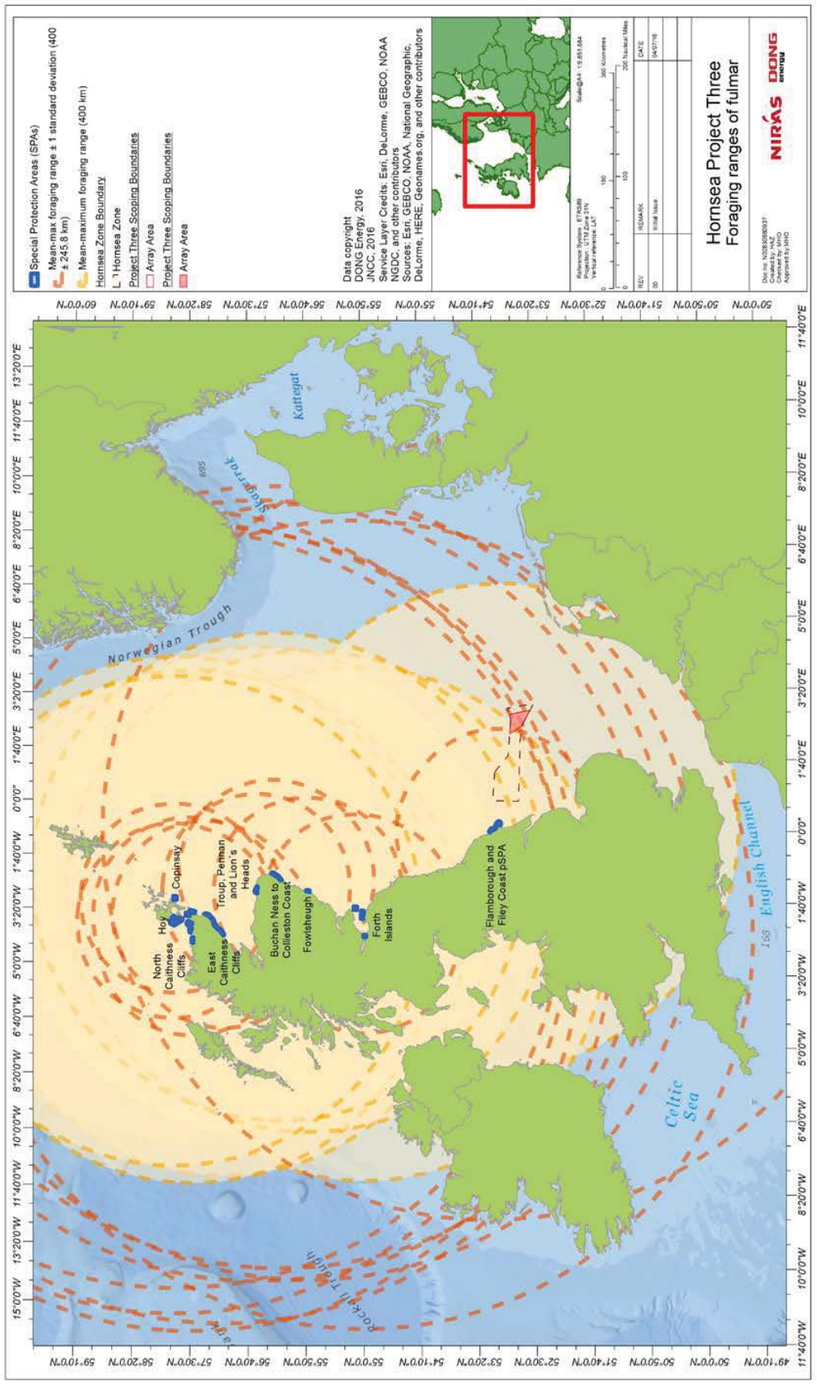

Figure 5.8 Fulmar foraging range (Thaxter *et al.*, 2012)

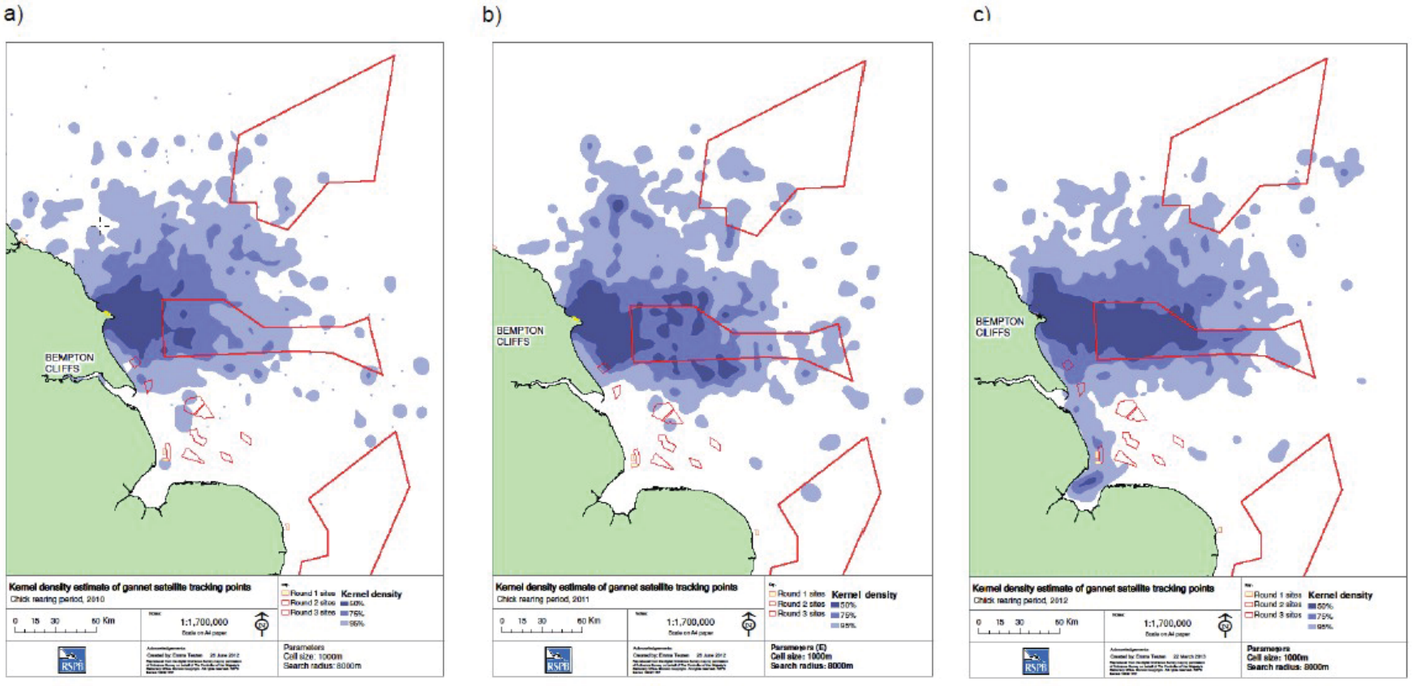

Figure 5.9 Gannet foraging range during chick-rearing seasons 2010-2012, showing 50%, 75% and 95% density contours (taken from Langston *et al.* (2013))

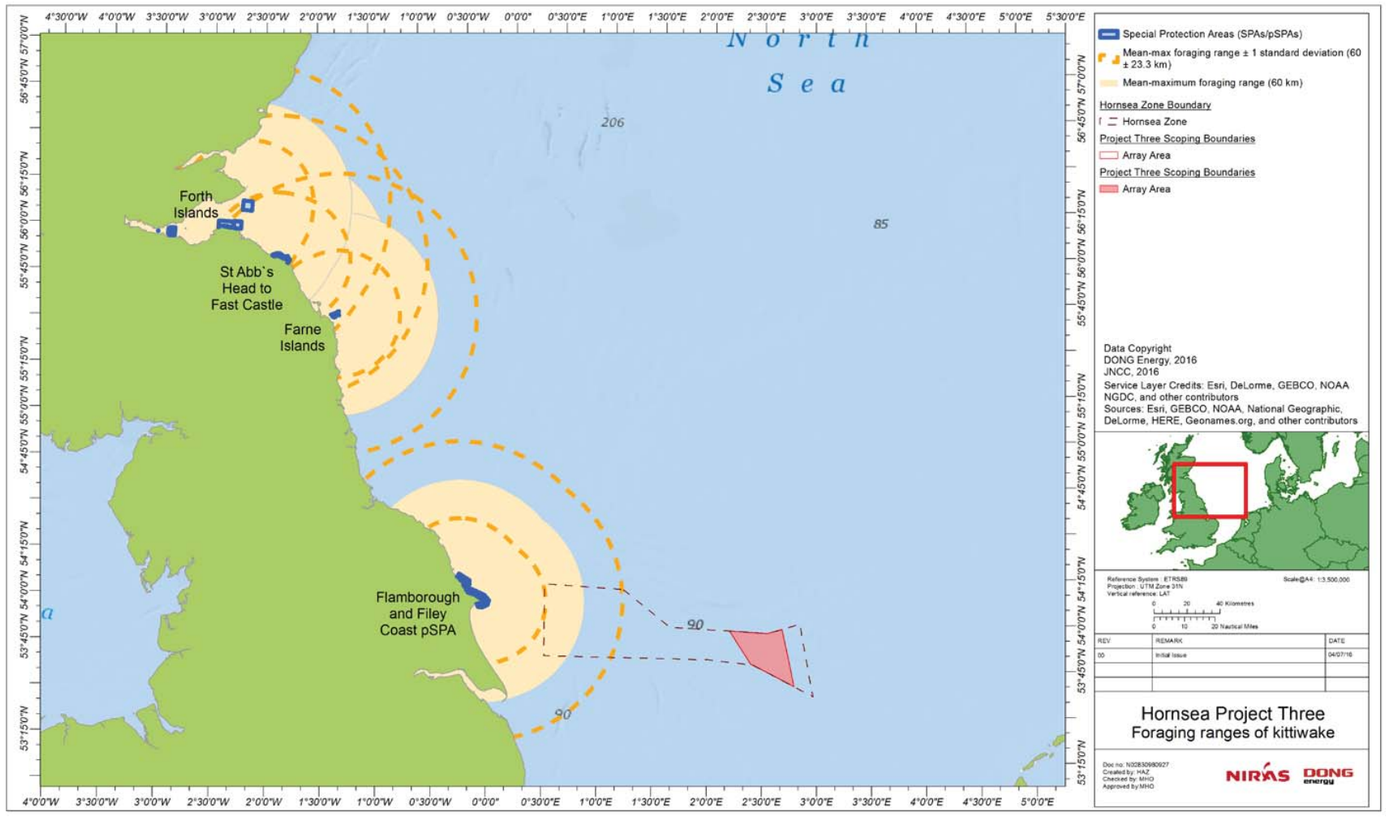

Figure 5.10 Kittiwake foraging range (Thaxter *et al.*, 2012)

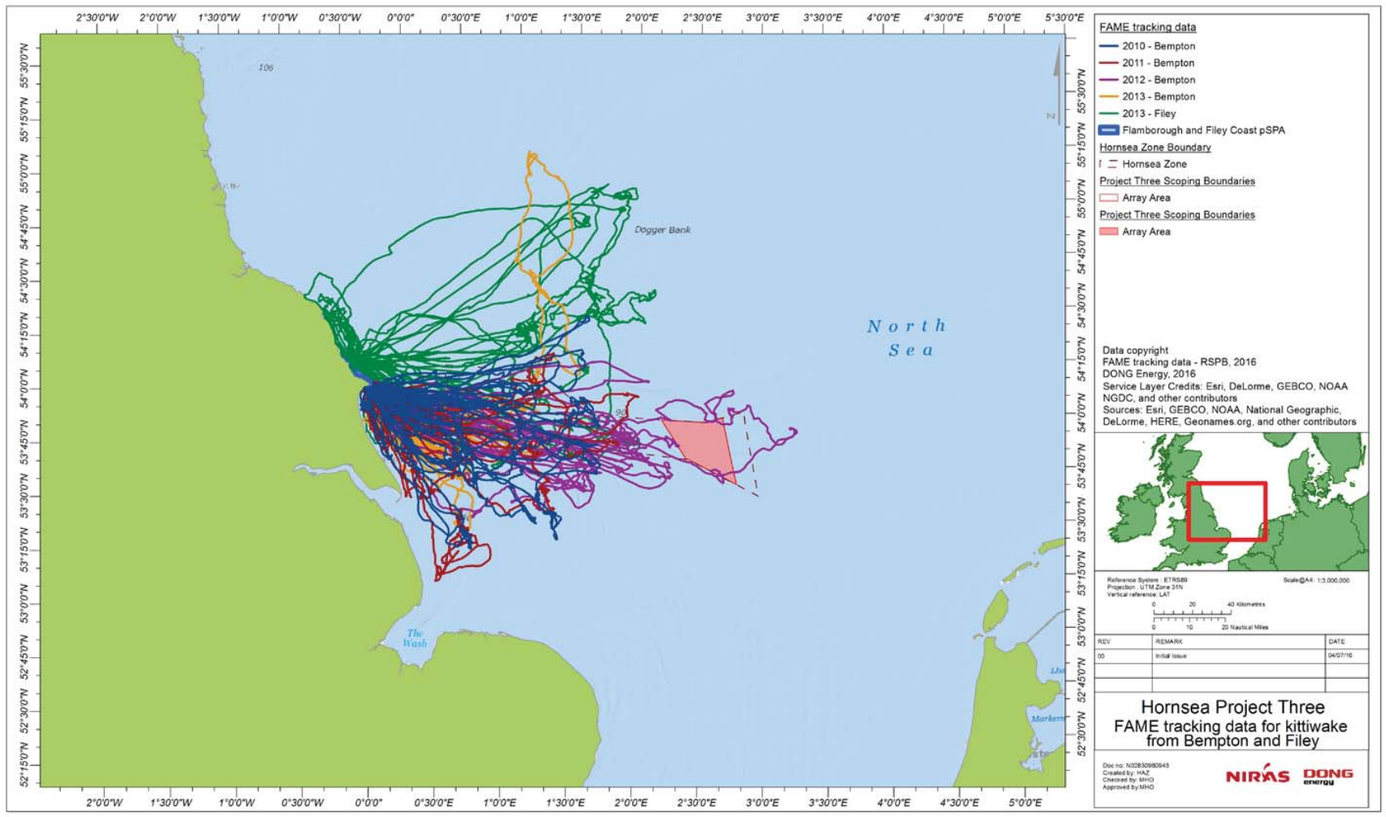

Figure 5.11 Kittiwake tracking data from the Flamborough and Filey Coast pSPA

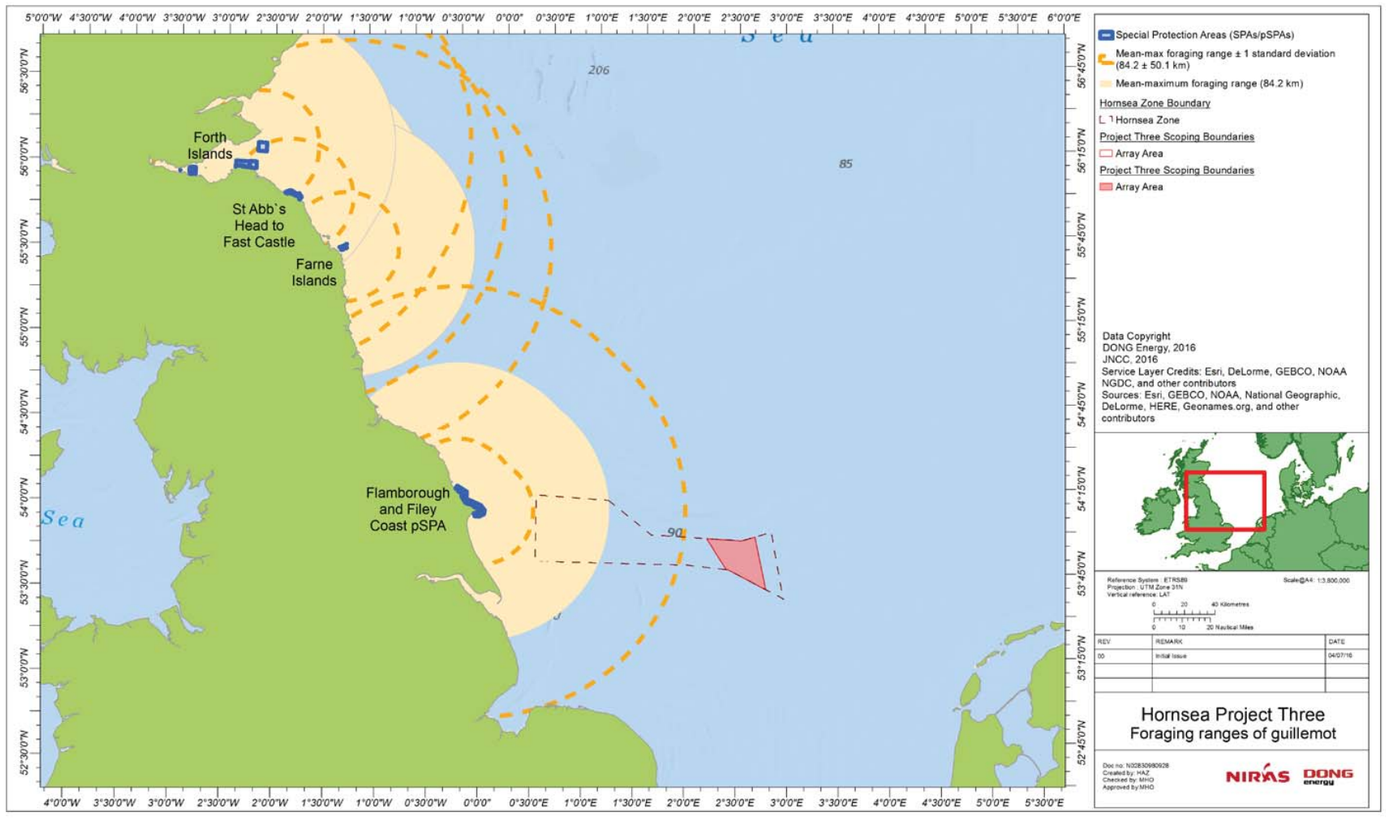

Figure 5.12 Guillemot foraging range (Thaxter *et al.*, 2012)

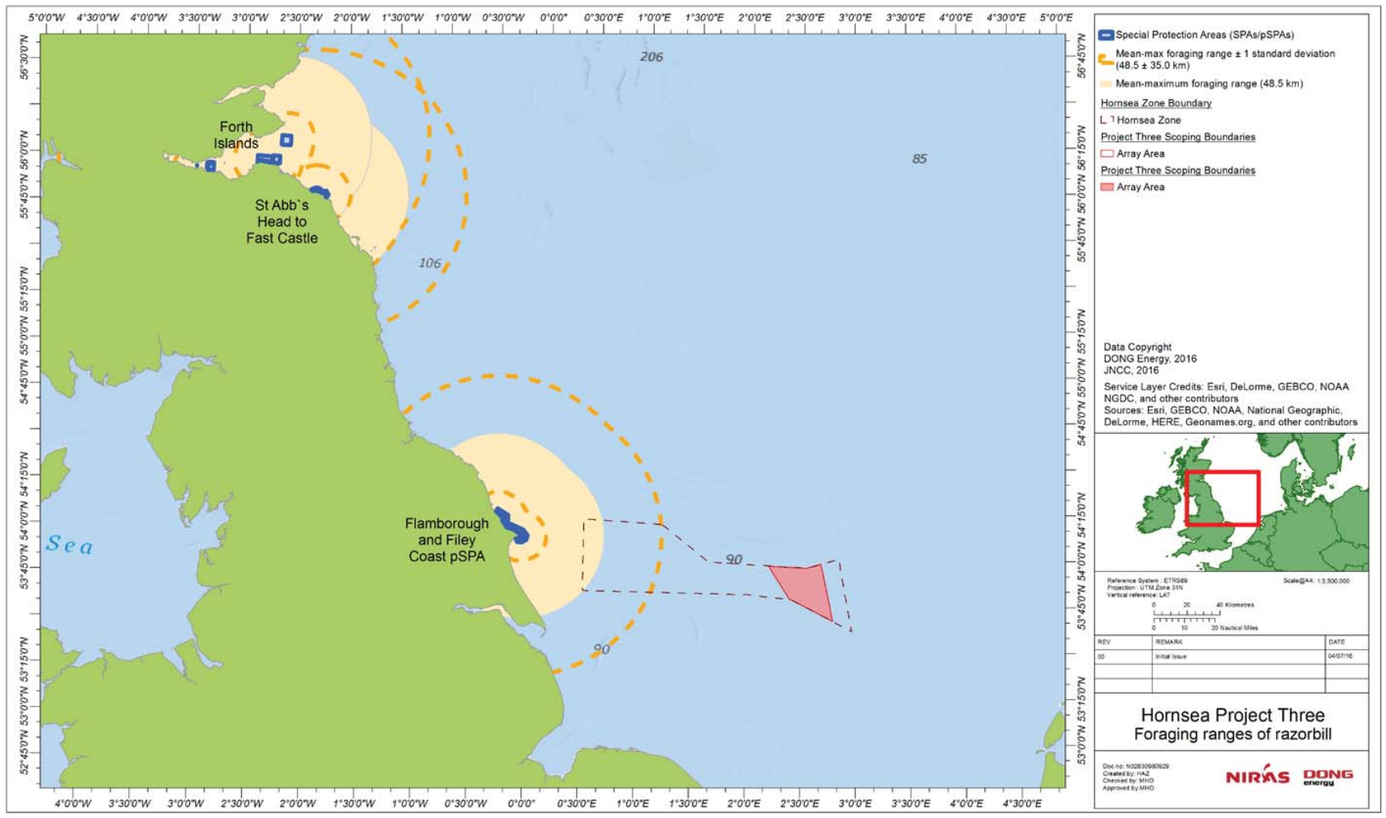

Figure 5.13 Razorbill foraging range (Thaxter *et al.*, 2012)

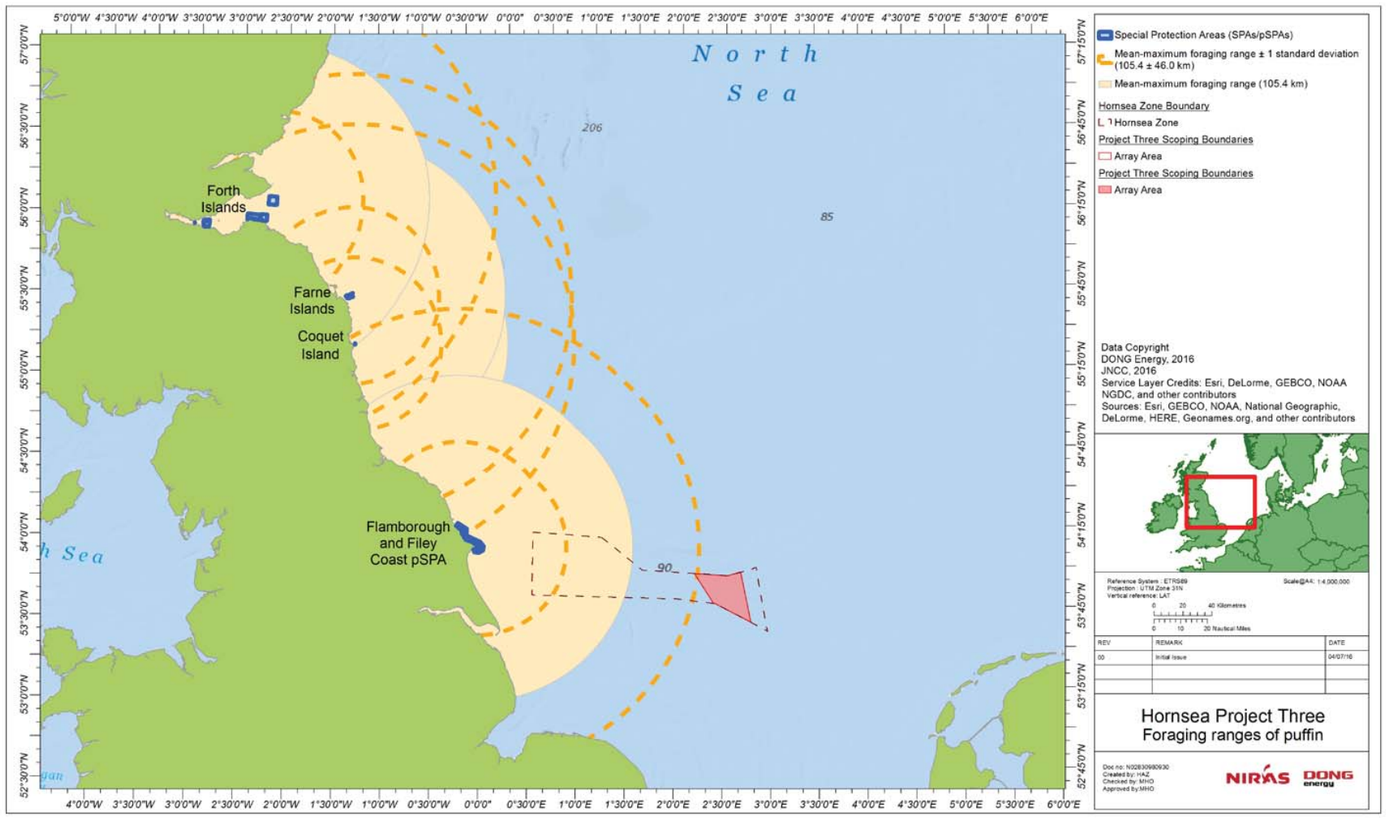

Figure 5.14 Puffin foraging range (Thaxter *et al.*, 2012)

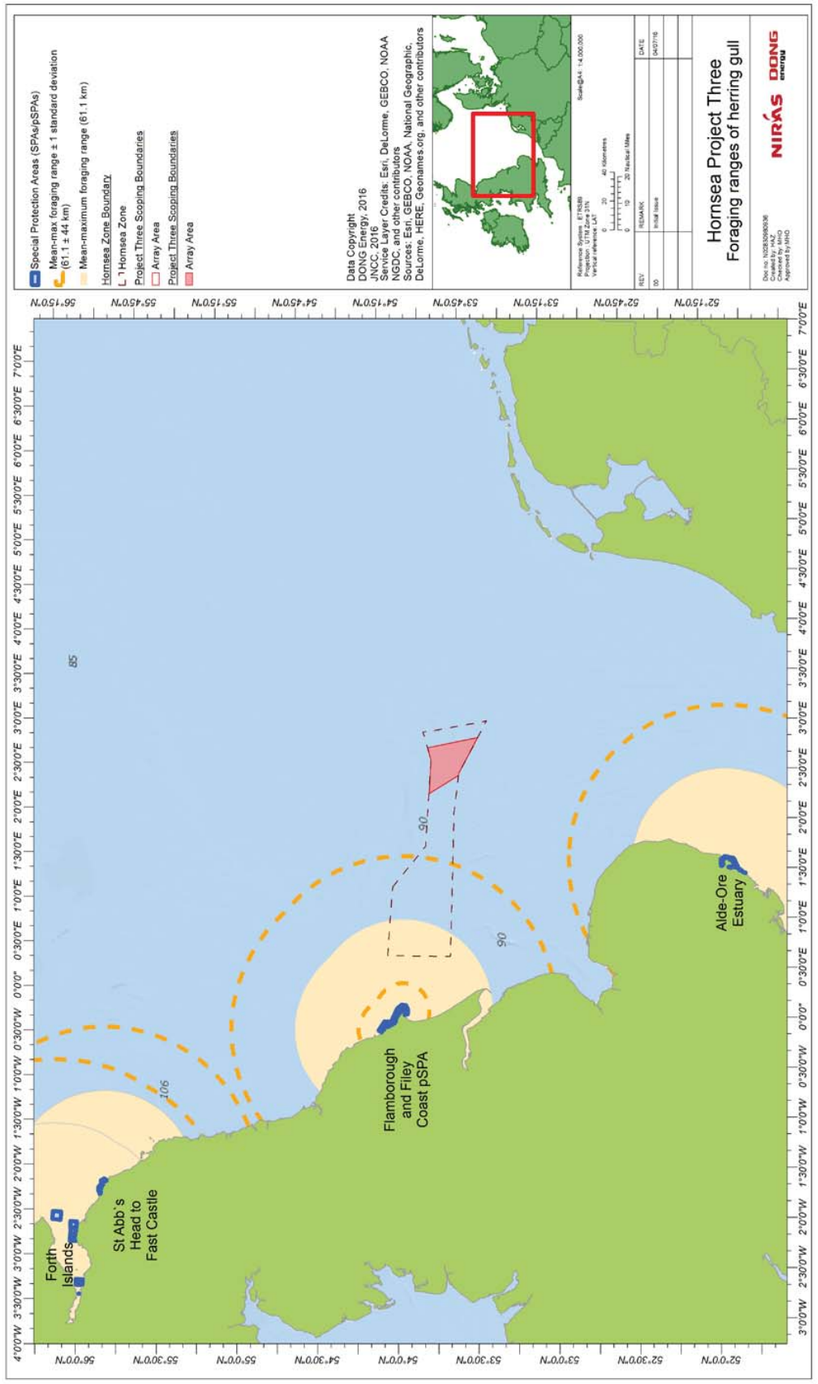

Figure 5.15 Herring gull foraging range (Thaxter *et al.*, 2012)

Breeding seabird features in the non-breeding season

5.3.34 Seabird species in general disperse widely during non-breeding seasons, so that impacts to some degree may be felt on the SPA populations during these seasons. The species are not constrained by extents of central-place foraging so a LSE therefore on all species detailed above that are SPA / pSPA qualifying or non-listed assemblage features (fulmar, gannet, herring gull, kittiwake, guillemot, razorbill and puffin) cannot be discounted. It is however expected that densities of species will be low in the non-breeding seasons (especially in the case of herring gull) or lower apportioning values to the pSPA will be appropriate (compared to the breeding season).

Sites designated for migratory seabirds

5.3.35 Seabirds that breed in sites designated as SPAs in areas of the UK that are distant from the Hornsea Three array area have some potential to interact with the wind farm during bi-annual migratory movements.

5.3.36 Collision risk modelling (CRM) for migratory seabirds was conducted as part of the Environmental Impact Assessment for both Project One and Project Two. These analyses indicated that the number of predicted collisions was negligible when compared to the Great Britain and Ireland (or of individual SPA) populations of each species.

5.3.37 In order to determine whether there is potential for a LSE with respect to Hornsea Three the CRM will be updated (Appendix A within this report illustrates an example CRM assessment) with the aim of showing an extended screening exercise for migratory seabirds. The process involves calculating the proportion of each species' migratory front represented by Hornsea Three which is then incorporated into the CRM.

Sites designated for migratory waterbirds (waders and wildfowl)

5.3.38 The movement of migratory waders and wildfowl is characterised by long distance flights, which occur as a series of flights between discrete wetlands or 'staging areas'. The majority of these movements occur across broad fronts with radar studies showing that waders will migrate at altitudes of 500-4,000 m (e.g. van de Kam *et al.,* 2004). Only when migrating waders encounter unfavourable weather will birds descend to lower heights following landscape features such as coastlines until they reach suitable staging areas.

5.3.39 A total of 40 wader and wildfowl species were recorded during boat-based surveys of the Project One, Project Two and Hornsea Zone areas undertaken between March 2010 and February 2013. The majority of these species were recorded in low numbers with totals of over 100 individuals only recorded across all surveys for three waterbird species (common scoter, golden plover and lapwing).

5.3.40 Collision risk modelling for migratory waders and wildfowl was conducted as part of the Environmental Impact Assessment for both Project One and Project Two, incorporating those species for which a high proportion of birds occurred in regional SPAs close to these projects. Analyses incorporated the Great Britain and Ireland population of relevant species with collision risk estimates calculated based on the proportion of the Great Britain and Ireland population considered to interact with Project One and Project Two. These analyses indicated that the number of predicted collisions was negligible when compared to the Great Britain and Ireland population of each species. It was also considered for Project One and Project Two that the results from these analyses did not indicate potential for a LSE on SPAs at which the species are qualifying features. In order to determine whether there is potential for a LSE with respect to Hornsea Three CRM will be undertaken and reported in the draft HRA and draft ES.

5.3.41 The offshore ECR corridor search area is located adjacent to the North Norfolk Coast SPA and the potential for LSE associated with onshore elements of the proposed development is discussed in the subsequent section of this report.

Summary

5.3.42 A summary of the sites designated for ornithological features for which LSE cannot be discounted and therefore those which are taken forward for determination of LSE in Section 6 is given in Table 5.11.

Table 5.11 European sites designated for ornithological features for which LSE cannot be discounted

European site	Feature	Distance to Hornsea Three array area (km)	Distance to ECR corridor search area (Km)
Flamborough Head and Bempton Cliffs SPA / Flamborough and Filey Coast pSPA	Fulmar Gannet Kittiwake Puffin (Herring Gull)[10] (Guillemot)[10] (Razorbill)[10]	149	149
Greater Wash pSPA	Red-throated diver Common scoter Little gull Sandwich tern Common tern Little tern	108	0
Forth Islands SPA	Fulmar	384	388

ONSHORE

Sites designated for Annex I habitats

5.3.43 Any site that includes Annex I habitats that is directly affected by Hornsea Three has been screened into assessment along with all its interest features.

5.3.44 In this instance, 'directly' means where the onshore ECR corridor search area passes through the European site.

5.3.45 European sites designated for Annex I habitats identified following the criteria above, and therefore taken forward for assessment of LSE in Section 6 are listed in Table 5.12 and illustrated in Figure 5.16 (SACs) and Figure 5.18 (Ramsar sites). Note that some of these sites are also designated for Annex II species features and in the case of Ramsar sites for both Annex II species and ornithological features. The screening process for Annex II species and ornithological features is dealt with in the following sections (paragraphs 5.3.46 to 5.3.52).

[10] LSE not discounted for non-breeding seasons only.

Table 5.12 European sites designated for Annex I habitats for which LSE cannot currently be discounted.

European site	Feature
Norfolk Valley Fens SAC (The onshore ECR corridor search area overlaps with sections of the Holt Lowes and Booton Common SSSIs)	• Alkaline fens (Calcium-rich springwater-fed fens) • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae, Salicion albae*). (Alder woodland on floodplains) * • Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*. (Calcium-rich fen dominated by great fen sedge (saw sedge)) * • European dry heaths • Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*). (Purple moor-grass meadows) • Northern Atlantic wet heaths with *Erica tetralix* (Wet heathland with cross-leaved heath) • Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) (Dry grasslands and scrublands on chalk or limestone)
River Wensum SAC	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; Rivers with floating vegetation often dominated by water-crowfoot
North Norfolk Coast SAC	• Coastal lagoons* • Fixed dunes with herbaceous vegetation (grey dunes). (Dune grassland) * • Embryonic shifting dunes • Humid dune slacks • Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). (Mediterranean saltmarsh scrub) • Perennial vegetation of stony banks. (Coastal shingle vegetation outside the reach of waves) • Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes). (Shifting dunes with marram).
North Norfolk Coast Ramsar Site	Ramsar criterion 1: The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish-water lagoons and extensive areas of freshwater grazing marsh and reed beds.
The Wash and North Norfolk Coast SAC	• Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • Coastal lagoons* • Large shallow inlets and bays • Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). (Mediterranean saltmarsh scrub) • Mudflats and sandflats not covered by seawater at low tide. (Intertidal mudflats and sandflats) • Reefs • Salicornia and other annuals colonising mud and sand (Glasswort and other annuals colonising mud and sand) • Sandbanks which are slightly covered by sea water all the time (Subtidal sandbanks)

Annex I priority habitats are denoted by an asterisk (*)

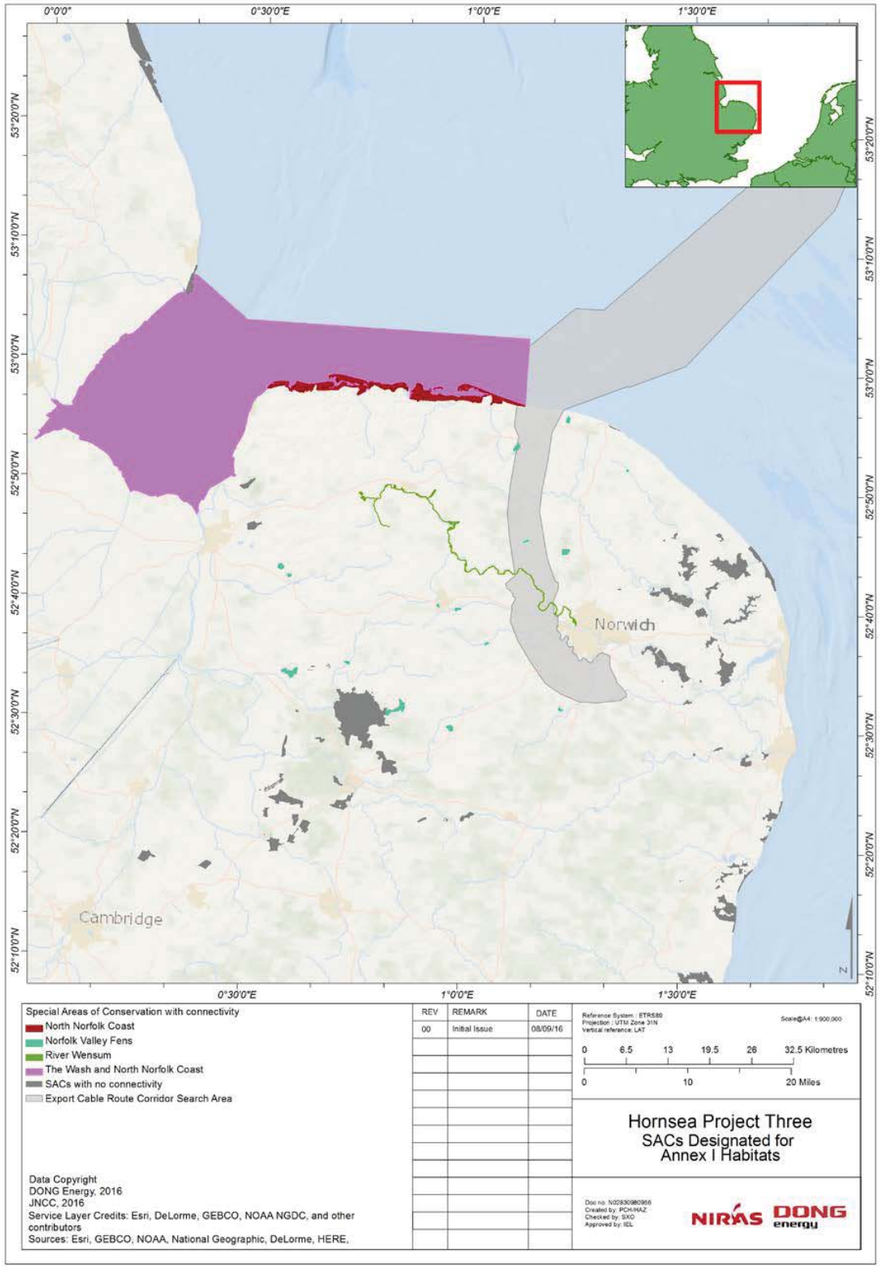

Figure 5.16 Sites designated for Annex I habitats

Sites designated for Annex II species

5.3.46 Any site that includes Annex II species that is directly affected by Hornsea Three has been screened into assessment along with all its Annex II species features.

5.3.47 In this instance, 'directly' means where the onshore ECR corridor search area includes the European site.

5.3.48 In addition, following CIEEM (2016) guidance, specific qualifying features have been included in the assessment, taking account of their distribution and ecology, as follows:

- Otters: Sites within a 5 km buffer around the onshore ECR corridor search area, have also been included for assessment; and
- Bats: Sites within a 10 km buffer around the onshore ECR corridor search area have been considered for inclusion into this assessment. Note however that the closest European site with bats as a qualifying feature (Paston Great Barn SAC) is located 18 km from the onshore ECR corridor area, therefore is outside the potential ZOI in respect to these species. As such, sites designated for bats as qualifying features have been scoped out for further consideration and assessment.

European sites designated for Annex II species taken forward for determination of LSE, following the criteria set out above, are listed in Table 5.13 and illustrated in Figure 5.17 (SACs) and Figure 5.18 (Ramsar Sites). Features of the sites taken forward for assessment are shown in bold.

Table 5.13 European sites designated for Annex II species for which LSE cannot be discounted

European site	Feature	Distance from onshore ECR corridors search area (km)
Norfolk Valley Fens SAC	• Narrow-mouthed whorl snail *Vertigo angustior* • Desmoulin's whorl snail *Vertigo moulinsiana*	0
River Wensum SAC	• Desmoulin`s whorl snail *Vertigo moulinsiana* • White-clawed (or Atlantic stream) crayfish Austropotamobius *pallipes* • Brook lamprey *Lampetra planeri* • Bullhead *Cottus gobio*	0
The Wash and North Norfolk Coast SAC	• Otter *Lutra lutra* • Harbour seal *Phoca vitulina*	0
North Norfolk Coast SAC	• Otter *Lutra lutra* • Petalwort *Petalophyllum ralfsii*	0
The Broads SAC	• Desmoulin's whorl-snail *Vertigo moulinsiana* • Little whirlpool ram's-horn snail *Anisus vorticulus* • Fen orchid *Liparis loeselii* • Otter *Lutra lutra*	5
Broadland Ramsar site	Ramsar criterion 2: The site supports a number of rare species within the biogregraphical zone context, including the following Annex II species: • Desmoulin`s whorl snail *Vertigo moulinsiana* • Otter *Lutra lutra* • Fen orchid *Liparis loeselii*	5

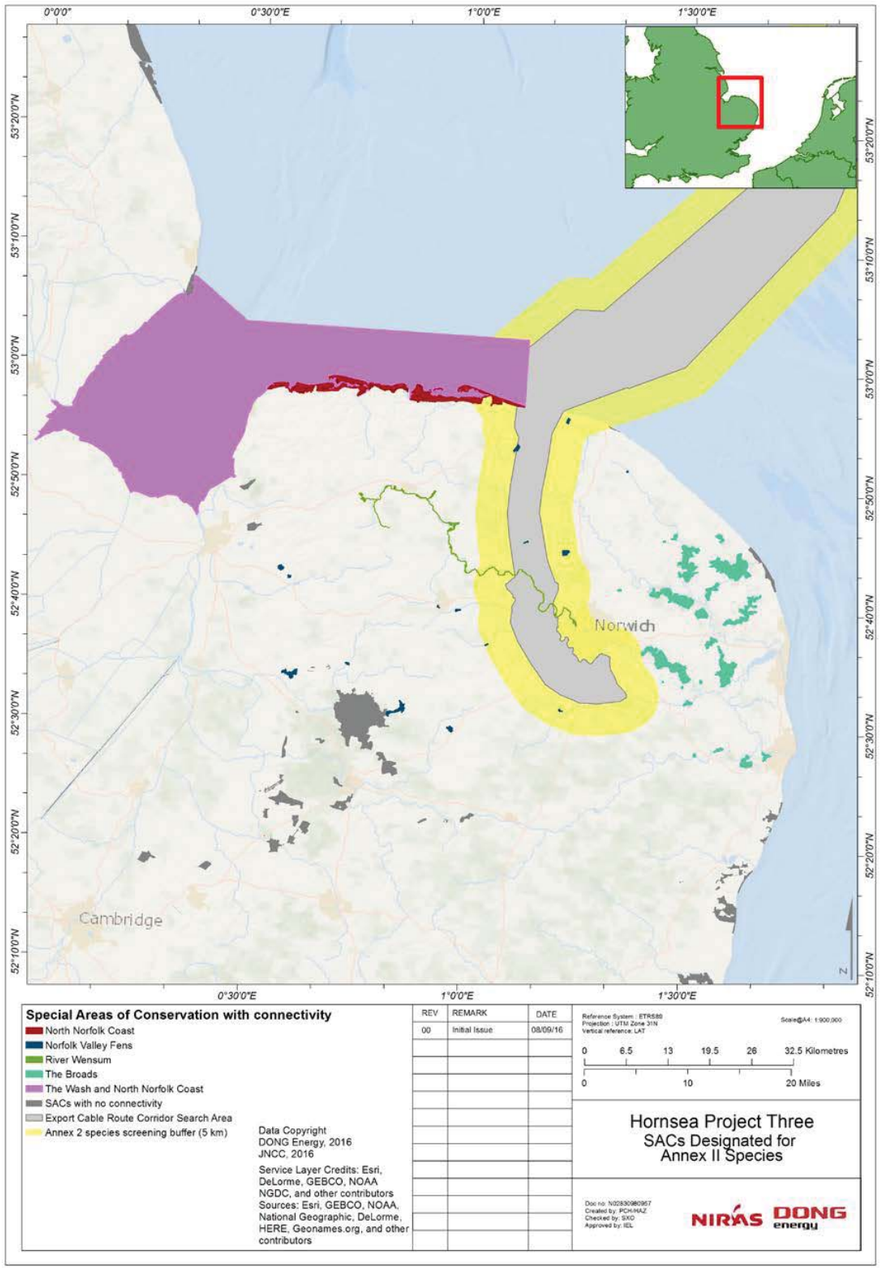

Figure 5.17 Sites designated for Annex II species

Sites designated for ornithological features

5.3.49 Any site which includes ornithological features that is directly affected by Hornsea Three has been screened into assessment along with all its features. In this instance, 'directly' means where the onshore ECR scoping search area includes the European site.

5.3.50 In addition, sites designated for ornithological features which are located within a 5 km buffer area from the onshore ECR corridor search area have also been included for assessment.

5.3.51 European sites designated for ornithological features taken forward for assessment of LSE are listed in Table 5.14 and illustrated in Figure 5.18.

Table 5.14 European sites designated for ornithological features taken forward for determination of LSE

European site	Feature	Distance from onshore ECR corridors search area (km)
North Norfolk Coast SPA	Annex 1 species (qualified under Article 4.1): During the breeding season: • Avocet *Recurvirostra avosetta,* • Bittern *Botaurus stellaris* • Common Tern *Sterna hirundo,* • Little Tern Sterna *albifrons,* • Marsh harrier • Mediterranean Gull *Larus melanocephalus*,* • Roseate Tern Sterna *dougallii** • Sandwich Tern Over winter: • Avocet *Recurvirostra avosetta** • Bar-tailed Godwit *Limosa lapponica** • Bittern *Botaurus stellaris** • Golden Plover *Pluvialis apricaria*,* • Hen Harrier *Circus cyaneus*,* • Ruff *Philomachus pugnax** Migratory species (qualified under Article 4.2): During the breeding season: • Redshank *Tringa tetanus** • Ringed Plover *Charadrius hiaticula** On passage: • Ringed Plover *Charadrius hiaticula *,* Over-winter: • Dark-bellied Brent *Goose Branta bernicla bernicla* • Knot *Calidris canutus* • Pink-footed Goose • Pintail *Anas acuta** • Redshank Tringa *totanus** • Wigeon *Anas penelope* Waterfowl assemblage (qualified under Article 4.2): Over winter, the area regularly supports 91,249 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Shelduck *Tadorna tadorna*, Avocet Golden Plover , Ruff , Bar-tailed Godwit *Limosa lapponica*, Pink-footed Goose *Anser*	0

European site	Feature	Distance from onshore ECR corridors search area (km)
	brachyrhynchus, Dark-bellied Brent *Goose Branta bernicla bernicla*, Wigeon *Anas penelope*, Pintail *Anas acuta*, Knot *Calidris canutus,* Redshank *Tringa totanus*, Bittern *Botaurus stellaris*, White-fronted Goose *Anser albifrons albifrons*, Dunlin *Calidris alpina alpina,* Gadwall *Anas strepera*, Teal *Anas crecca*, Shoveler *Anas clypeata*, Common Scoter *Melanitta nigra*, Velvet Scoter *Melanitta fusca*, Oystercatcher *Haematopus ostralegus*, Ringed Plover *Charadrius hiaticula*, Grey Plover *Pluvialis squatarola*, Lapwing*Vanellus vanellus*, Sanderling *Calidris alba*, Cormorant *Phalacrocorax carbo.*	
North Norfolk Coast Ramsar Site	Ramsar criterion 5: Assemblages of international importance: Species with peak counts in winter: waterfowl Ramsar criterion 6- species populations occurring at levels of international importance: <u>Qualifying species/populations (as identified at designation):</u> *Species regularly supported during the breeding season:* • Sandwich tern, *Sterna sandvicensis* • Common tern, *Sterna hirundo* • Little tern, *Sterna albifrons albifrons*, W Europe *Species with peak counts in spring/autumn:* • Red knot, *Calidris canutus islandica*, W & Southern Africa (wintering) *Species with peak counts in winter:* • Pink-footed goose, *Anser brachyrhynchus*, Greenland, Iceland/UK • Dark-bellied brent goose, *Branta bernicla bernicla* • Eurasian wigeon, *Anas penelope*, NW Europe • Northern pintail, *Anas acuta*, NW Europe <u>Species/populations identified subsequent to designation for possible future consideration under criterion 6:</u> • Species with peak counts in spring/autumn: • Ringed plover, *Charadrius hiaticula*, Europe/Northwest Africa • Sanderling, *Calidris alba*, Eastern Atlantic • Bar-tailed godwit, *Limosa lapponica lapponica*, W Palearctic	0

European site	Feature	Distance from onshore ECR corridors search area (km)
Broadland SPA	Annex 1 Species (qualified under Article 4.1): <u>During the breeding season</u>: • Bittern *Botaurus stellaris* • Marsh harrier *Circus aeruginosus* <u>Over winter</u>: • Bewick's Swan *Cygnus columbianus bewickii* • Bittern *Botaurus stellaris** • Hen harrier *Circus cyaneus* • Ruff *Philomachus pugnax* • Whooper swan *Cygnus Cygnus* Migratory species (qualified under Article 4.2): <u>Over winter:</u> • Gadwall *Anas strepera* • Pink-footed goose *Anser brachyrhynchus* * • Shoveler *Anas clypeata* • Wigeon *Anas penelope* Assemblage of waterfowl (qualified under Article 4.2) *: • Over winter, the area regularly supports 22,603 individual waterfowl (RSPB, Count 99/00) including: cormorant *Phalacrocorax carbo*, Bewick's Swan, whooper swan, ruff, pink-footed goose *Anser brachyrhynchus*, gadwall, bittern, great crested grebe, coot, bean goose *Anser fabalis*, white-fronted goose *Anser albifrons albifrons*, wigeon, teal *Anas crecca*, pochard *Aythya ferina*, tufted duck *Aythya fuligula*, Shoveler	5
Broadland Ramsar site	Ramsar criterion 6: Qualifying species/populations (as identified at designation). <u>Species with peak counts in winter:</u> • Bewick's swan, NW Europe • Wigeon, NW Europe • Gadwall, NW Europe Species populations identified subsequent to designation for possible future consideration under criterion 6. <u>Species with peak counts in winter:</u> • Pink-footed goose, *Anser brachyrhynchus* • Greylag goose, *Anser anser*	5

* *Feature included in the SPA 2001 review but not in the site citation*

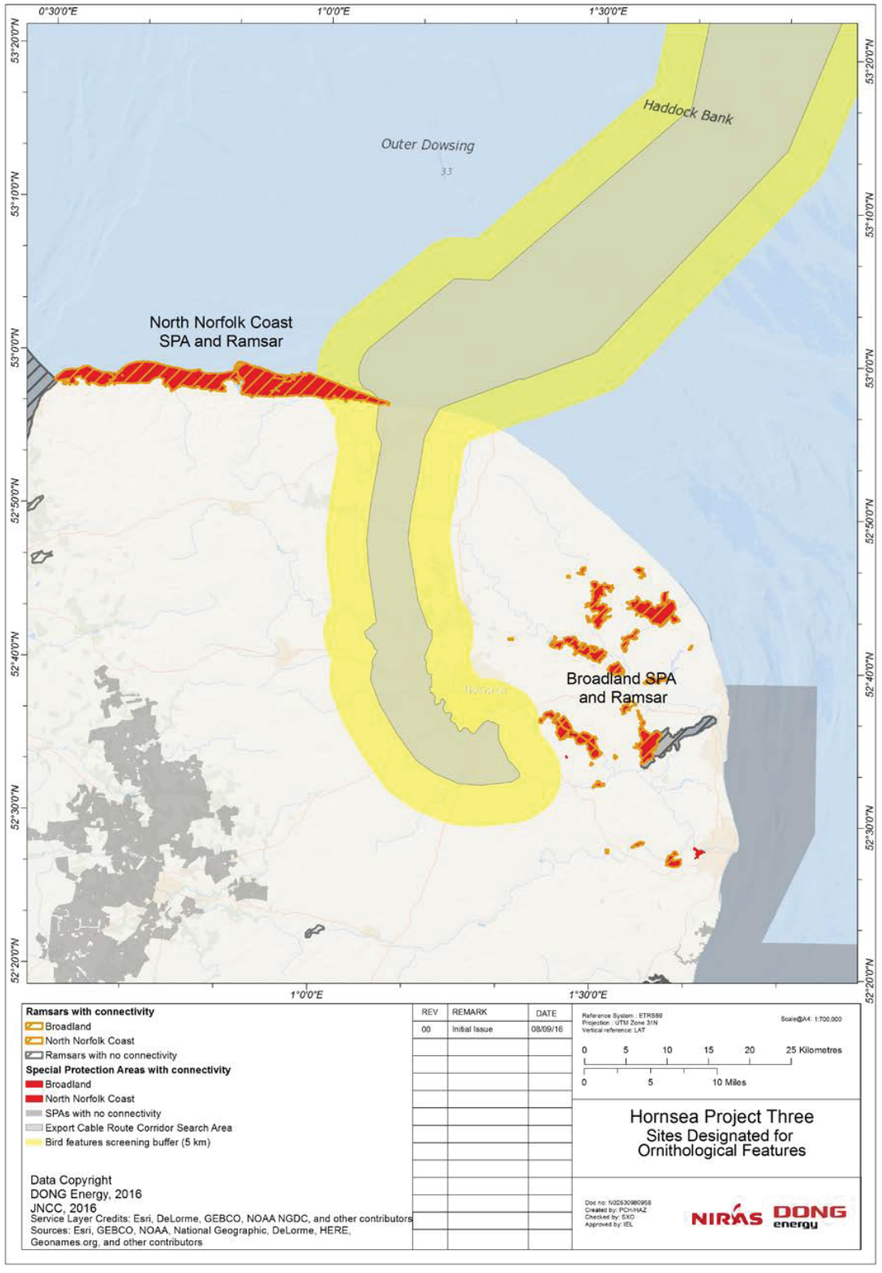

Figure 5.18 Sites designated for Ornithological features (SPAs) and Ramsar sites

Summary of European Sites and features identified for further consideration for LSE

5.3.52 Using the screening criteria identified in Table 5.1, the Zone of Influence for Project impacts and the species specific criteria (such as foraging range for breeding birds) described in section 5.3 a review has been undertaken of those designated sites and qualifying features where there is considered a potential for Hornsea Three to have a likely significant effect.

5.3.53 A summary of the findings is presented in Table 5.15 (offshore) and Table 5.16 (onshore). The tables show those sites and qualifying features for which there is considered to be a potential connectivity with Hornsea Three and therefore those sites which will be taken forward for determination of LSE in Section 6.

Table 5.15 European sites and features taken forward for determination of LSE in Section 6 (offshore)

Site	Feature	
North Norfolk Sandbanks and Saturn Reef cSAC	Annex I habitats	• Sandbanks which are slightly covered by seawater all the time • Reefs
Haisborough, Hammond and Winterton SAC	Annex I habitats	• Sandbanks which are slightly covered by seawater all the time • Reefs
Inner Dowsing, Race Bank and North Ridge SAC	Annex I habitats	• Sandbanks which are slightly covered by seawater all the time • Reefs
The Wash and North Norfolk Coast SAC	Annex I habitats	• Sandbanks which are slightly covered by sea water all the time • Mudflats and sandlflats not covered by seawater at low tide • Large shallow inlets and bays • Reefs • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadow • Mediterranean and thermo-Atlantic halophilous scrubs • Coastal lagoons
	Annex II marine mammals	• Harbour seal
Doggersbank SAC (Dutch designation)	Annex II marine mammals	• Harbour porpoise • Harbour seal • Grey seal
Doggerbank (German designation)	Annex II marine mammals	• Harbour porpoise • Harbour seal
Klaverbank SCI (Dutch designation)	Annex I habitats	• Reef
	Annex II marine mammals	• Harbour seal • Grey seal • Harbour porpoise
Humber Estuary SAC/Ramsar	Annex II fish	• River lamprey • Sea lamprey

Table 5.16 European sites and features taken forward for determination of LSE in Section 6 (onshore)

European site	Feature	
Norfolk Valley Fens SAC	Annex I habitats	• Alkaline fens (Calcium-rich springwater-fed fens) • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae, Salicion albae*). (Alder woodland on floodplains) • Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*. (Calcium-rich fen dominated by great fen sedge (saw sedge)) • European dry heaths • Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*). (Purple moor-grass meadows) • Northern Atlantic wet heaths with *Erica tetralix* (Wet heathland with cross-leaved heath) • Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) (Dry grasslands and scrublands on chalk or limestone)
	Annex II species	• Narrow-mouthed whorl snail • Desmoulin's whorl snail
River Wensum SAC	Annex I habitats	Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; Rivers with floating vegetation often dominated by water-crowfoot
	Annex II species	• Desmoulin`s whorl snail • White-clawed (or Atlantic stream) crayfish • Brook lamprey • Bullhead
North Norfolk Coast SAC	Annex I habitats	• Coastal lagoons • Fixed dunes with herbaceous vegetation (grey dunes). (Dune grassland) • Embryonic shifting dunes • Humid dune slacks • Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). (Mediterranean saltmarsh scrub) • Perennial vegetation of stony banks. (Coastal shingle vegetation outside the reach of waves) • Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes). (Shifting dunes with marram).
	Annex II species	• Otter • Petalwort
North Norfolk Coast Ramsar Site	Annex I habitats	Ramsar criterion 1: The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish-water lagoons and extensive areas of freshwater grazing marsh and reed beds.

European site	Feature	
	Ornithological features	Ramsar criterion 5: Assemblages of international importance: Species with peak counts in winter: waterfowl Ramsar criterion 6- species populations occurring at levels of international importance: Qualifying species/populations (as identified at designation): *Species regularly supported during the breeding season:* • Sandwich tern, *Sterna sandvicensis* • Common tern, *Sterna hirundo* • Little tern, *Sterna albifrons albifrons*, W Europe *Species with peak counts in spring/autumn:* • Red knot, *Calidris canutus islandica*, W & Southern Africa (wintering) *Species with peak counts in winter:* • Pink-footed goose, *Anser brachyrhynchus*, Greenland, Iceland/UK • Dark-bellied brent goose, *Branta bernicla bernicla* • Eurasian wigeon, *Anas penelope*, NW Europe • Northern pintail, *Anas acuta*, NW Europe Species/populations identified subsequent to designation for possible future consideration under criterion 6: • Species with peak counts in spring/autumn: • Ringed plover, *Charadrius hiaticula*, Europe/Northwest Africa • Sanderling, *Calidris alba*, Eastern Atlantic • Bar-tailed godwit, *Limosa lapponica lapponica*, W Palearctic
North Norfolk Coast SPA	Ornithological features	Annex 1 species (qualified under Article 4.1): During the breeding season: • Avocet *Recurvirostra avosetta,* • Bittern *Botaurus stellaris* • Common Tern *Sterna hirundo,* • Little Tern Sterna *albifrons,*

European site	Feature	
		• Marsh harrier • Mediterranean Gull *Larus melanocephalus* • Roseate Tern Sterna *dougallii* • Sandwich Tern Over winter: • Avocet *Recurvirostra avosetta* • Bar-tailed Godwit *Limosa lapponica* • Bittern *Botaurus stellaris* • Golden Plover *Pluvialis apricaria* • Hen Harrier *Circus cyaneus* • Ruff *Philomachus pugnax* Migratory species (qualified under Article 4.2): During the breeding season: • Redshank *Tringa tetanus* • Ringed Plover *Charadrius hiaticula* On passage: • Ringed Plover *Charadrius hiaticula* Over-winter: • Dark-bellied Brent *Goose Branta bernicla bernicla* • Knot *Calidris canutus* • Pink-footed Goose • Pintail *Anas acuta* • Redshank Tringa *totanus* • Wigeon *Anas penelope* Waterfowl assemblage (qualified under Article 4.2): Over winter, the area regularly supports 91,249 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Shelduck *Tadorna tadorna*, Avocet Golden Plover , Ruff , Bar-tailed Godwit *Limosa lapponica*, Pink-footed Goose *Anser brachyrhynchus*, Dark-bellied Brent *Goose Branta bernicla bernicla*, Wigeon *Anas penelope*, Pintail *Anas acuta*, Knot *Calidris canutus,* Redshank *Tringa totanus*, Bittern *Botaurus stellaris*, White-fronted Goose *Anser albifrons albifrons*, Dunlin *Calidris alpina alpina,* Gadwall *Anas strepera*, Teal *Anas crecca*, Shoveler *Anas clypeata*, Common Scoter *Melanitta nigra*, Velvet Scoter *Melanitta fusca*, Oystercatcher *Haematopus ostralegus*, Ringed

European site	Feature	
		Plover *Charadrius hiaticula*, Grey Plover *Pluvialis squatarola*, Lapwing*Vanellus vanellus*, Sanderling *Calidris alba*, Cormorant *Phalacrocorax carbo.*
The Wash and North Norfolk Coast SAC	Annex I habitats	• Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) • Coastal lagoons* • Large shallow inlets and bays • Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). (Mediterranean saltmarsh scrub) • Mudflats and sandflats not covered by seawater at low tide. (Intertidal mudflats and sandflats) • Reefs • Salicornia and other annuals colonising mud and sand (Glasswort and other annuals colonising mud and sand) • Sandbanks which are slightly covered by sea water all the time (Subtidal sandbanks)
	Annex II Species	• Otter
The Broads SAC	Annex II species	• Otter
Broadland SPA	Ornithological features	Annex 1 Species (qualified under Article 4.1): During the breeding season: • Bittern *Botaurus stellaris* • Marsh harrier *Circus aeruginosus* Over winter: • Bewick's Swan *Cygnus columbianus bewickii* • Bittern *Botaurus stellaris* • Hen harrier *Circus cyaneus* • Ruff *Philomachus pugnax* • Whooper swan *Cygnus Cygnus* Migratory species (qualified under Article 4.2): Over winter: • Gadwall *Anas strepera* • Pink-footed goose *Anser brachyrhynchus* • Shoveler *Anas clypeata* • Wigeon *Anas penelope*

European site	Feature	
		Assemblage of waterfowl (qualified under Article 4.2) *: Over winter, the area regularly supports 22,603 individual waterfowl (RSPB, Count 99/00) including: cormorant *Phalacrocorax carbo*, Bewick's Swan, whooper swan, ruff, pink-footed goose *Anser brachyrhynchus*, gadwall, bittern, great crested grebe, coot, bean goose *Anser fabalis*, white-fronted goose *Anser albifrons albifrons*, wigeon, teal *Anas crecca*, pochard *Aythya ferina*, tufted duck *Aythya fuligula*, Shoveler
Broadland Ramsar	Annex II species	• Otter
	Ornithological features	Ramsar criterion 6: Qualifying species/populations (as identified at designation). Species with peak counts in winter: • Bewick's swan, NW Europe • Wigeon, NW Europe • Gadwall, NW Europe Species populations identified subsequent to designation for possible future consideration under criterion 6. Species with peak counts in winter: • Pink-footed goose, *Anser brachyrhynchus* • Greylag goose, *Anser anser*

6. Determination of Likely Significant Effect (LSE)

6.1 Introduction

6.1.1 The initial screening documented in Section 5 generated a list of designated sites and features (Table 5.15 and Table 5.16) in respect of which there is a potential for Hornsea Three to have a LSE. This Section documents the assessment of LSE, Stage 1 of the Habitats Regulations Assessment process. The assessment is provided separately in respect of the offshore and onshore components of Hornsea Three.

6.1.2 The assessment of LSE is based on Hornsea Three's current understanding of the baseline environment and the scope and nature of the proposed project activities. Further environmental survey and assessment work, consultee and advisor responses to this document, and refinements to the project design may change this assessment. These changes will be reflected in the HRA Report to be submitted with the DCO application for Hornsea Three.

6.2 Assessment of Likely Significant Effect (LSE)

OFFSHORE

Annex I Habitats

Introduction

6.2.1 A description of those European sites with Annex I habitats qualifying features identified in Section 5 with the potential of interacting with the Hornsea Three array area and offshore ECR corridor search area is provided in the following sections. These comprise:

- North Norfolk Sandbanks and Saturn Reef cSAC;
- Haisborough, Hammond and Winterton SAC;
- The Wash and North Norfolk Coast SAC;
- Inner Dowsing, Race Bank and North Ridge cSAC; and
- Klaverbank SCI.

6.2.2 The location of these sites together with the distribution of Annex I sandbank and reefs habitat is illustrated in Figure 6.1.

6.2.3 Note that in the particular case of the Klaverbank SCI detailed information on the distribution of Annex I habitat features (reefs) is not available and therefore these are not shown in Figure 6.1.

<u>North Norfolk Sandbanks and Saturn Reef cSAC</u>

6.2.4 The North Norfolk Sandbanks and Saturn Reef SAC is located in the southern North Sea, extending from about 40 km off the north east coast of Norfolk. The SAC encloses a series of ten main sandbanks (Leman, Inner, Ower, Well, Broken, Swarte and four sandbanks collectively known as the 'Indefatigables') and associated fragmented smaller banks, all of which together represent the most extensive example of offshore linear ridge sandbank feature in UK waters (Graham *et al.,* 2001). The SAC also includes areas of Ross worm (*Sabellaria spinulosa*) biogenic reef, which qualify as Annex I habitat. Reefs formed by *S. spinulosa* allow the settlement of other species not found in adjacent habitats leading to a diverse community of epifaunal and infaunal species (Tillin and Marshal, 2015).

<u>Haisborough, Hammond and Winterton SAC</u>

6.2.5 The Haisborough, Hammond and Winterton SAC lies off the north east Norfolk coast and contains a series of sandbanks. The central sandbank ridge in the site is composed of alternating ridge headland associated sandbanks (Dyer & Huntley, 1999). *Sabellaria spinulosa* reefs arise from the seabed to heights of 5 to 10 cm.

<u>The Wash and North Norfolk Coast SAC</u>

6.2.6 The Wash is the largest embayment in the UK. It is connected via sediment transfer systems to the north Norfolk coast. Together, The Wash and North Norfolk Coast SAC forms one of the most important marine areas in the UK and European North Sea coast, and includes extensive areas of varying, but predominantly sandy, sediments subject to a range of conditions. Communities in the intertidal zone include those characterised by large numbers of polychaetes, bivalve and crustaceans. Subtidal communities cover a diverse range from the shallow to the deeper parts of the embayments and include dense brittlestar beds and areas of an abundant reef-building worm ('Ross worm') *Sabellaria spinulosa*. Sandy sediments occupy most of the subtidal area, resulting in one of the largest expanses of subtidal sandbanks in the UK. The subtidal sandbanks vary in composition and include coarse sand through to mixed sediment at the mouth of the embayment.

6.2.7 The site contains the largest single area of saltmarsh in the UK and is one of the few areas in the UK where saltmarsh is generally accreting. The proportion of the total saltmarsh vegetation represented by glasswort Salicornia and other colonising annuals is high because of the extensive historic enclosure of marsh at this site and is also unusual in that it forms a pioneer community with common cord-grass *Spartina anglica*.

6.2.8 Annex I habitats which are qualifying features for this site include:

- Sandbanks which are slightly covered by sea water all the time;
- Mudflats and sandlflats not covered by seawater at low tide;
- Large shallow inlets and bays;
- Reefs;
- Salicornia and other annuals colonizing mud and sand;
- Atlantic salt meadow;
- Mediterranean and thermo-Atlantic halophilous scrubs; and
- Coastal lagoons.

Inner Dowsing, Race Bank and North Ridge cSAC

6.2.9 The Inner Dowsing, Race Bank and North Ridge cSAC is located off the south Lincolnshire coast to the east of Skegness and extending eastwards and north from Burnham Flats on the north Norfolk coast. The site occupies The Wash approaches. Water depths are generally shallow and mostly less than 30m. The area encompasses a wide range of sandbank types and biogenic reef formed by Ross worm *Sabellaria spinulosa*. These features lay almost entirely on the glacial till (sediment deposited by glacial activity) of the Bolders Bank Formation which is responsible for much of the seabed topography.

6.2.10 The group of banks within The Wash approaches are made up of fine to medium sands derived from coastal erosion processes following the last glacial retreat and marine inundation. Inner Dowsing is a sandbank to the west of the site comprising of coarse sand with some areas of gravel, with a distinctive elongate shape maintained by the tidal currents in the area. The Race Bank-North Ridge-Dudgeon Shoal sandbank system is an example of a sinusoidal sandbank that also has a complex pattern of smaller sandbanks associated with it. Together, this site and Haisborough, Hammond and Winterton cSAC provide the only protection to offshore, headland-associated sandbank systems in the southern North Sea.

Klaverbank SCI

6.2.11 The Klaverbank SCI is located in the southern North Sea within Dutch waters in the north-western region of the Exclusive Economic Zone (EEZ) of the Netherlands and lies 160 km north-west of Den Helder on the Dutch coast. The site occupies approximately 1,235 km^2 and is an example of habitat type H1170 'Open-sea reefs' and is characterised by geo-morphological features that are considered to be reef structures. Places where large cobbles or coarse gravel occur are a characteristic feature.

Determination of LSE

6.2.12 The assessment and conclusions with regards to LSEs on Annex I habitats has been carried out taking account of the ZOI of potential impacts, location of the European site under consideration and the distribution of qualifying features within the sites.

6.2.13 The conclusions and rationale of the assessment are described in Table 6.1.

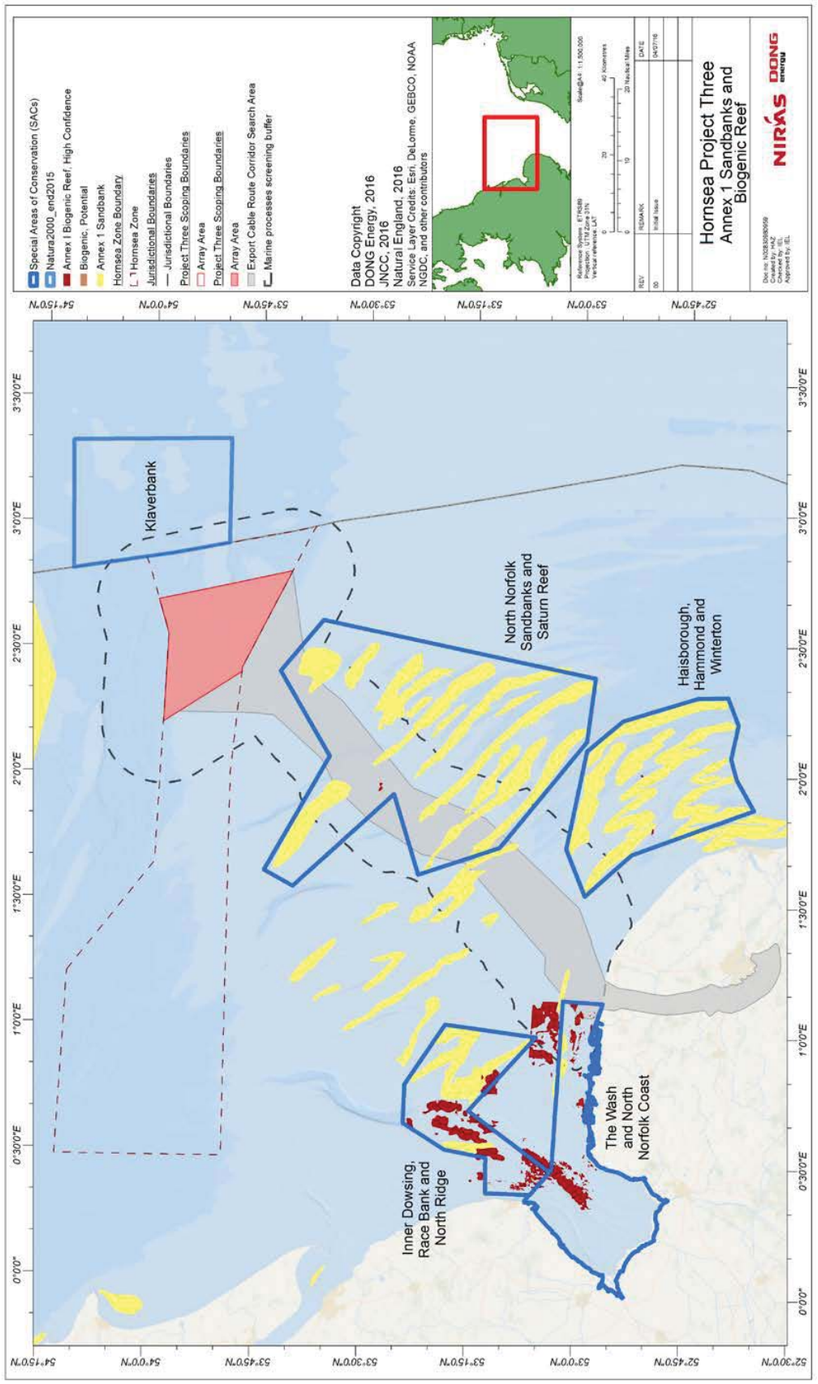

Figure 6.1 European sites designated for Annex I habitats within the ZOI of Hornsea Three and distribution of sandbanks and Annex I reef habitat

Table 6.1 Determination of LSE in respect of European sites with Annex I habitat qualifying features

Impact	Justification	Site	Rationale for determination of LSE	Conclusion
Construction/Decommissioning				
Temporary habitat loss/ disturbance	There is potential for temporary, direct habitat loss and disturbance due to cable laying operations (including anchor placements), spud-can leg impacts from jack-up operations and seabed preparation works for gravity base foundations.	North Norfolk Sandbanks and Saturn Reef cSAC	Significant overlap between European site (and assumed presence of qualifying features) and ECR corridor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Haisborough, Hammond and Winterton SAC	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE
		The Wash and North Norfolk Coast SAC	Some overlap between European site (and assumed presence of qualifying features) and offshore ECR corridor search area. No overlap with the array area (Figure 6.1).	Potential for LSE
		Inner Dowsing, Race Bank and North Ridge cSAC	No overlap between European site and ECR corridor search area or the array area (see Figure 6.1).	No LSE
		Klaverbank SCI	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE
Temporary increases in suspended sediments / smothering	Sediment disturbance arising from construction activities (e.g. cable and foundation installation) may result in adverse and indirect impacts on benthic communities as a result of temporary increases in suspended sediment concentrations and associated sediment deposition. Potential for impact assumed out to 12 km from source of impact along the ECR and 16 km in the array site.	North Norfolk Sandbanks and Saturn Reef SAC	Significant overlap between European site (and assumed presence of qualifying features) and the potential ZOI for suspended sediment in the ECR corriodor search area. Minor overlap with the array area (see Figure 6.1).	Potential for LSE
		Haisborough, Hammond and Winterton SAC	Partial overlap between European site (and assumed presence of qualifying features) and potential ZOI for suspended sediment in the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		The Wash and North Norfolk Coast SAC	Partial overlap between European site (and assumed presence of qualifying features) and potential ZOI for suspended sediment in the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Inner Dowsing, Race Bank and North Ridge cSAC	Minor overlap between European site (and assumed presence of qualifying features) and potential ZOI for suspended sediment in the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Klaverbank SCI	Partial overlap between European site (and assumed presence of qualifying features) and potential ZOI for suspended sediment from the array area. No overlap with the ECR corridor search area (see Figure 6.1).	Potential for LSE

Impact	Justification	Site	Rationale for determination of LSE	Conclusion
Accidental pollution	There is a risk of pollution being accidentally released from sources including construction and installation vessels/vehicles, machinery and offshore fuel storage tanks and from the construction process itself. The release of such contaminants may lead to impacts on the benthic communities present, through toxic effects resulting in reduced benthic diversity, abundance and biomass	North Norfolk Sandbanks and Saturn Reef cSAC	A number of mitigation measures and best practice approaches will be implemented during the construction phase to reduce potential impacts associated with accidental pollution events. This will include the development of a CoCP which will set out measures to follow, published guidelines and best working practice for the prevention of pollution events. By adhering to such approaches significant effects on Annex I habitats are not anticipated.	No LSE
		Haisborough, Hammond and Winterton SAC		No LSE
		The Wash and North Norfolk Coast SAC		No LSE
		Inner Dowsing, Race Bank and North Ridge cSAC		No LSE
		Klaverbank SCI		No LSE
Operation				
Long-term habitat loss	There is the potential for long-term habitat loss to occur directly under installed scour protection at the array site, around foundations within the ECR corridor or along the cable route (cable crossing points or where ground conditions prevent adequate cable burial)	North Norfolk Sandbanks and Saturn Reef cSAC	Significant overlap between European site (and assumed presence of qualifying features) and ECR corridor search area. No overlap with the array site (see Figure 6.1).	Potential for LSE
		Haisborough, Hammond and Winterton SAC	No overlap between European site and ECR corridor search area or array site (see Figure 6.1).	No LSE
		The Wash and North Norfolk Coast SAC	Some overlap between European site (and assumed presence of qualifying features) and offshore ECR corridor search area. No overlap with the array site (Figure 6.1).	Potential for LSE
		Inner Dowsing, Race Bank and North Ridge cSAC	No overlap between European site and ECR corridor search area or the array site (see Figure 6.1).	No LSE
		Klaverbank SCI	No overlap between European site and ECR corridor search area or the array site (see Figure 6.1).	No LSE
Colonisation of hard structures	Man-made structures placed on the seabed (foundations and scour/cable protection) are expected to be colonised by a range of marine organisms leading to localised changes in biodiversity. These structures also have the potential to act as artificial reef serving as a refuge for fish and may facilitate the spread of non-native invasive species	North Norfolk Sandbanks and Saturn Reef cSAC	Significant overlap between European site (and assumed presence of qualifying features) and ECR corridor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Haisborough, Hammond and Winterton SAC	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE
		The Wash and North Norfolk Coast SAC	Partial overlap between European site (and assumed presence of qualifying features) and potential ZOI for suspended sediment in the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Inner Dowsing, Race Bank and North Ridge cSAC	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE

Impact	Justification	Site	Rationale for determination of LSE	Conclusion
		Klaverbank SCI	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE
Changes in physical processes	The presence of foundation structures, associated scour protection and cable protection may introduce changes to the local hydrodynamic and wave regime, resulting in changes to the sediment transport pathways and associated effects on benthic ecology. Some benthic species and communities may be more vulnerable to reductions in water flow if the decrease is sufficient to reduce the availability of suspended food particles, and consequently inhibit feeding and growth. Scour and increases in flow rates can similarly change the characteristics of the sediment potentially making the local habitat less suitable for some species.	North Norfolk Sandbanks and Saturn Reef SAC	Significant overlap between European site (and assumed presence of qualifying features) and the ECR corriodor search area. Minor overlap with the array area (see Figure 6.1).	Potential for LSE
		Haisborough, Hammond and Winterton SAC	Partial overlap between European site (and assumed presence of qualifying features) and the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		The Wash and North Norfolk Coast SAC	Partial overlap between European site (and assumed presence of qualifying features) and the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Inner Dowsing, Race Bank and North Ridge cSAC	Minor overlap between European site (and assumed presence of qualifying features) and the ECR corriodor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Klaverbank SCI	Partial overlap between European site (and assumed presence of qualifying features) and the array area. No overlap with the ECR corridor search area (see Figure 6.1).	Potential for LSE
Temporary seabed disturbance	Temporary disturbance/alteration of seabed habitats may occur during the operation and maintenance phase of Hornsea Three as a result of maintenance operations. The impacts associated with these operations are likely to be similar in nature to those associated with the construction phase although of reduced magnitude.	North Norfolk Sandbanks and Saturn Reef cSAC	Significant overlap between European site (and assumed presence of qualifying features) and ECR corridor search area. Assumes maintenance activity in ECR corridor search area. No overlap with the array area (see Figure 6.1).	Potential for LSE
		Haisborough, Hammond and Winterton SAC	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE
		The Wash and North Norfolk Coast SAC	Some overlap between European site (and assumed presence of qualifying features) and offshore ECR corridor search area. Assumes maintenance activity in ECR corridor search area. No overlap with the array area (Figure 6.1).	Potential for LSE
		Inner Dowsing, Race Bank and North Ridge cSAC	No overlap between European site and ECR corridor search area or the array area (see Figure 6.1).	No LSE
		Klaverbank SCI	No overlap between European site and ECR corridor search area or array area (see Figure 6.1).	No LSE
Accidental pollution	There is a risk of accidental pollution releases from vessels, vehicles, machinery and offshore fuel storage tanks during the operation and maintenance	North Norfolk Sandbanks and Saturn Reef cSAC	A number of mitigation measures and best practice approaches will be implemented during operations and maintenance activities to reduce potential impacts associated with accidental pollution events. This will include reference to published guidelines and best	No LSE
		Haisborough, Hammond and Winterton SAC		No LSE

Impact	Justification	Site	Rationale for determination of LSE	Conclusion
	phase as well as from the turbines and offshore substations themselves. The release of such contaminants may lead to impacts on the benthic communities present, through toxic effects resulting in reduced benthic diversity, abundance and biomass.	The Wash and North Norfolk Coast SAC	working practice for the prevention of and response to pollution events. By adhering to such approaches significant effects on Annex I habitats are not anticipated.	No LSE
		Inner Dowsing, Race Bank and North Ridge cSAC		No LSE
		Klaverbank SCI		No LSE

Annex II diadromous fish species

6.2.14 As noted in in Section 5, based on the high level screening criteria, there may be potential for river lamprey and sea lamprey as Annex II qualifying features of the Humber Estuary SAC (and Ramsar site) to be affected by Hornsea Three activities in the ECR corridor search area.

6.2.15 The information available to date in relation to the distribution and use that these species make of the marine environment is limited. Both species are however most commonly found in coastal and/or estuarine areas whether in transit from and into home rivers and/or engaged in foraging activity.

6.2.16 Taking account of their habitat usage, distance from the Humber SAC (and Ramsar site) to the offshore ECR corridor search area (67 km) and to the array area (141 km) it is therefore considered that there is limited potential for Hornsea Three to result in a detrimental impact on these the diadromous features of this site. As such LSEs on river lamprey and sea lamprey as qualifying features of the Humber Estuary SAC (and Ramsar) are not predicted.

6.2.17 A summary of the assessment is given in Table 6.2 below.

Table 6.2 LSE conclusions for the Humber Estuary (SAC and Ramsar site) in respect of Annex II diadromous fish features

Effect	Assessment rationale	Conclusion
Construction/decommissioning		
Temporary habitat loss/disturbance	Limited potential interaction between the qualifying features and construction works given their preference for estuarine/coastal environments and the distance to both the offshore ECR corridor search area and array area.	No LSE
Temporary increases in suspended sediments/deposition		No LSE
Underwater noise		No LSE
Accidental pollution		No LSE
Operation		
Long-term habitat loss	Limited potential interaction between the qualifying features and construction works given their preference for estuarine/coastal environments and the distance to both the offshore ECR corridor search area and array area.	No LSE
Underwater noise		No LSE
Colonisation of hard structures		No LSE
EMFs		No LSE
Temporary seabed disturbance		No LSE
Accidental pollution		No LSE

Annex II marine mammal species

Introduction

6.2.18 The European sites identified in Section 5 for determination of LSE in respect of Annex II marine mammal species are listed in Table 6.3 below by qualifying feature and site name.

Table 6.3 Marine mammal Annex II features and European sites considered for determination of LSE

Qualifying feature	European site
Harbour porpoise	• Southern North Sea pSAC • Doggerbank (German Doggerbank) SCI • Doggersbank (Dutch Doggerbank) SCI • Klaverbank SCI • Noordzeekustzone SAC • Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC
Harbour seal	• The Wash and North Norfolk Coast SAC • Doggerbank (German Doggerbank) SCI • Doggersbank (Dutch Doggerbank) SCI • Klaverbank SCI • Noordzeekustzone SAC • Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC • Waddenzee SAC
Grey seal	• Humber Estuary SAC • Humber Estuary Ramsar • Doggersbank (Dutch Doggerbank) SCI • Klaverbank SCI • Noordzeekustzone SAC

Southern North Sea pSAC

6.2.19 A potential network of eight SAC sites were identified within UK waters for harbour porpoise with the Southern North Sea pSAC being the largest of the proposed possible SACs. The site extends over 36,958 km^2, extending down the North Sea from the River Tyne to the River Thames, and includes habitats such as sandbanks and gravel beds. Water depths range between 10 m to 75 m.

6.2.20 The Southern North Sea pSAC is an important area for the species, persistently supporting higher numbers of porpoises compared to many other parts of their UK range. The implication is that this site provides good foraging habitat and it may also be used for breeding and calving. However, because the number of harbour porpoise using the site naturally varies, there is not an exact number of animals within the site above which the species is viable or below which it will become unviable. Seasonal differences in the relative use of the site have been identified based on the analyses of Heinänen and Skov (2015) which shows that water depth and hydrodynamic variables provide the greatest influence on the presence and density of harbour porpoise.

6.2.21 The main aim of the designation is to support the maintenance of harbour porpoise populations throughout UK waters.

The Wash and North Norfolk Coast SAC.

6.2.22 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. This site is the largest colony of common seals in the UK, with some 7% of the total UK population. Although not currently a qualifying feature of this SAC Blakeney Point within the SAC is understood to hold the largest breeding colony of grey seal in England.These seals haul out to pup during the winter months here and at Horsey further south along the Norfolk coast.

The Humber Estuary SAC (and Ramsar)

6.2.23 The Humber is the second largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. In this area grey seals come ashore in autumn to form breeding colonies on the sandy shores of the south bank at Donna Nook.

6.2.24 On the Lincolnshire coast grey seal start to aggregate in mid-September to begin breeding. Pupping at Donna Nook commences in late October and runs until December. During these periods the majority of the population will be on land for several weeks. Consequently densities at sea will be much lower at this time when compared to other times of the year.

6.2.25 Thus, grey seal may be more vulnerable to anthropogenic disturbances during their time spent at sea foraging both before and after breeding as opposed to during the breeding season itself, particularly at Donna Nook where breeding seals and pups may be habituated to disturbance.

Doggerbank SCI (Dutch designation)

6.2.26 The Doggerbank is the largest sandbank in UK waters and extends into both Dutch and German waters. It is located in the southern North Sea approximately 150 km from the UK coast. The Doggerbank SCI is an important location for the North Sea harbour porpoise population as well as the grey and harbour seal populations.

Dogger Bank SCI (German designation)

6.2.27 The German part of this unique sandbank covers 1,624 km^2 and comprises the receding flanks from depths of 29 m to about 40 m. The entire site is nominated as a Special Area of Conservation (SAC) under the Habitats Directive in line with the sandbank habitat listed in Annex I of the Directive. It is a characteristic sandbank with mostly fine sands containing many shell fragments and is representative of the open offshore sublittoral zone.

6.2.28 Harbour porpoises and harbour seals have been sighted in the site, although because of lacking data the latter can currently only be considered a visiting species. The harbour porpoises sighted in airborne censuses – some of them even with calves – may be part of the British subpopulation.

Klaverbank SCI

6.2.29 Klaverbank lies in the north-western region of the Exclusive Economic Zone (EEZ) of the Netherlands.

6.2.30 Harbour porpoise are found on Klaverbank and are a designated feature of the SCI. Visual sightings of seals are difficult to make but the animals can be tracked with the help of satellite transmitters. Based on data obtained with such transmitters, density maps have been made, from which it can be deduced that both the harbour seal and the grey seal can occur at Klaverbank (Lindeboom *et al.,* 2008).

Noordzeekustzone SAC

6.2.31 This site lies in the Dutch sector of the North Sea and covers an area of 1,444.75 km^2 stretching from Bergen to north of Schiermonnikoog. It is entirely marine and is characterised by the presence of sea inlets and sandbanks which are slightly covered by sea water all the time. The site provides important habitat to grey seals, harbour seals and harbour porpoise.

Vadehavet med Ribe Á, Tved Å og Varde Å vest for Varde SAC

6.2.32 This SAC is one of the largest in Denmark spanning an area of 1,348 km^2 (55% is formed of marine and sea inlets). The area consists of a large shallow tidal range with sand and mudflats, which are separated by deep channels, as well as individual sandbanks that are not inundated by ordinary tides. The area also includes the peninsula Skallingen, and a number of characteristic tidal lakes – Langli, Fanoe, Mando and Romo. The area is characteristic of the wider Wadden Sea habitat and provides important habitat for harbour seal, grey seal and harbour porpoise.

Waddenzee SAC

6.2.33 The Wadden Sea is the largest European site in the Netherlands. The area includes open water, tidal portions and marshes along the mainland coast and a number of smaller islands. The islands of Griend, Rottumeroog, Rottumerplaat and Zuiderduin lie within the boundary, as well as a number of high, generally dry lying sandbanks.

6.2.34 A large number of birds use the mudflats and salt marshes during migration or nesting on the salt marshes, beaches and dunes. The migratory birds are attracted by the tidal mudflats due to the high density of shrill animals, worms, crustaceans and other foods. The deeper waters are important as a nursery for fish species from the North Sea whilst the site provides important habitat to harbour seal and grey seal.

Determination of LSE

Construction/decommissioning

Underwater noise

6.2.35 There is the potential for underwater noise arising from foundation piling and other construction activities (e.g. drilling of piles, cable laying) within the Hornsea Three array area and the offshore ECR corridor (e.g. for the offshore HVAC booster station) to cause physical/auditory injury or disturbance to marine mammals.

6.2.36 Percusive piling noise is considered the noise generating activity with greatest potential to result in a detrimental impact on marine mammals. Other construction activities (i.e. drilling of piles, cable laying) could also affect marine mammals, however to a much lesser extent.

6.2.37 The behavioural and physiological effects of noise on a particular species depend on its intensity, frequency bandwidth, duration and the heterogeneity of ambient physical and environmental parameters such as water depth, salinity and substrate (see Parvin *et al*. 2006, for a review), as well as the particular species' sensitivity to sound.

6.2.38 Non-lethal and behavioural responses such as avoidance of an area may be significant where the noise source is in the vicinity of important areas such as breeding grounds, migratory routes or key feeding grounds for marine mammal populations.

6.2.39 At this stage the Hornsea Three underwater noise modelling has not yet been completed and therefore cannot yet be used to inform the assessment of LSE. Further, the exact location of the offshore HVAC booster station is also unknown and therefore a precautionary approach has been adopted for determination of LSE at this stage.

6.2.40 An assessment of LSE is given below in respect of underwater noise for each Annex II marine mammal qualifying feature separately.

Harbour porpoise

6.2.41 In 2016 JNCC undertook a consultation on the Southern North Sea pSAC which is designated for harbour porpoise. Within the draft conservation objectives and advice on activities, advice was provided on HRA requirements for pile driving and acoustic surveys (JNCC, 2016) where it is advised that "an HRA will be considered for all new developments (coastal and marine) using pile driving within the site or within 26 km" (JNCC, 2016).

6.2.42 Taking JNCC advice for the pSAC it is assumed at this stage that there is potential for LSEs in relation to percussive piling underwater noise impacts for those European sites located within 26 km of the boundary of the Hornsea Three array area or offshore ECR corridor search area as summarised in Table 6.4.

Table 6.4 Determination of LSE for European sites with harbour porpoise as qualifying feature in respect of underwater noise

European site	Rationale for determination of LSE	Conclusion
Southern North Sea possible Special Area of Conservation (pSAC)	European site in close proximity to the array area (approx. 2 km away) and coincident with the offshore ECR corridor search area (Table 5.10). There is therefore potential for significant interaction between harbour porpoise at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Doggerbank (German Doggerbank) SCI	European site located at considerable distance from the array area (183 km) and offshore ECR corridor search area (204 km) (see Table 5.10). No potential for impact on harbour porpoises at this site from underwater noise associated with Hornsea Three.	No LSE
Doggersbank (Dutch Doggerbank) SCI	European site located beyond 26 km from the array area (42 km) and offshore ECR corridor search area (58 km) (see Table 5.10). No potential for impact on harbour porpoises at this site from underwater noise associated with Hornsea Three.	No LSE
Klaverbank SCI	European site in close proximity to the array area (approx. 11 km away) and offshore ECR corridor search area (18 km) (Table 5.10). Therefore potential for significant interaction between harbour porpoises form this site and underwater noise associated with Hornsea Three.	Potential for LSE
Noordzeekustzone SAC	European site located at considerable distance from the array area (138 km) and offshore ECR corridor search area (138 km) (see Table 5.10). No potential for impact on harbour porpoises at this site from underwater noise associated with Hornsea Three.	No LSE
Vadehavet med Ribe Á, Tved Å og Varde Å vest for Varde SAC	European site located at considerable distance from the array area (383 km) and offshore ECR corridor search area (391 km) (see Table 5.10). No potential for impact on harbour porpoises at this site from underwater noise associated with Hornsea Three.	No LSE

Harbour seal

6.2.43 Harbour seal tend to forage over shorter distances from their haul-outs compared with grey seal, with published studies from the North Sea suggesting that most seals forage within 40 km to 50 km of their haul-outs (SCOS, 2011). On a more site-specific basis, harbour seals tagged at The Wash haul-out were regularly recorded foraging between 75 km and 120 km offshore to assumed foraging locations (SMRU, 2011). On this basis, it is considered that harbour seal populations from European sites located at distances greater than 120 km from Hornsea Three, are beyond any potential for direct and indirect effects on foraging trips, and therefore, there are no LSEs anticipated from Hornsea Three.

It is therefore assumed at this stage that there is potential for LSEs in relation to underwater noise impacts for European sites with harbour seal as a qualifying feature which are located within 120 km of the Hornsea Three array area or the offshore ECR corridor search area. The assessment of LSE in respect of underwater noise impacts on harbour seal is summarised in Table 6.5 by European site.

Table 6.5 Determination of LSE for European sites with harbour seal as qualifying feature in respect of underwater noise

European site	Rationale for determination of LSE	Conclusion
The Wash and North Norfolk Coast SAC	Coincident with the Hornsea Three offshore ECR corridor search area and located within 120 km of the array area (Table 5.10). There is therefore potential for some level of interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Doggerbank (German Doggerbank) SCI	European site located beyond 120 km from the array area (183 km) and offshore ECR corridor search area (204 km) (see Table 5.10). No potential for interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	No LSE
Doggersbank (Dutch Doggerbank) SCI	European site located in the proximity of the array area (42 km) and offshore ECR corridor search area (58 km) (see Table 5.10). There is therefore potential for significant interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Klaverbank SCI	European site in close proximity to the array area (11 km away) and the offshore ECR corridor search area (18 km) (Table 5.10). Therefore potential for significant interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Noordzeekustzone SAC	European site located beyond 120 km from the array area (138 km) and offshore ECR corridor search area (138 km) (see Table 5.10). No potential for interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	No LSE
Vadehavet med Ribe Á, Tved Å og Varde Å vest for Varde SAC	European site located well beyond 120 km from the array area (383 km) and offshore ECR corridor search area (391 km) (see Table 5.10). No potential for interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	No LSE
Waddenzee SAC	European site beyond 120 km from the array area (146 km away) and the offshore ECR corridor search area (146 km) (Table 5.10). No potential for significant interaction between harbour seals at this site and underwater noise associated with Hornsea Three.	No LSE

Grey seal

6.2.44 Foraging ranges of grey seal have been recorded up to 145 km from grey seal haul-out sites (Thompson *et al*., 1996).

6.2.45 It is therefore considered that there is potential for LSEs in relation to underwater noise impacts for European sites with grey seal as a qualifying feature which are located within 145 km of the Hornsea Three array area or the offshore ECR corridor search area.

6.2.46 The assessment of LSE in respect of underwater noise for grey seal is summarised in Table 6.6 below by European site.

Table 6.6 Determination of LSE for European sites with grey seal as qualifying feature in respect of underwater noise

European site	Rationale for determination of LSE	Conclusion
Humber Estuary SAC	European site located 67 km away from offshore ECR corridor search area and located 141 km from the array area (Table 5.10). There is therefore potential for some level of interaction between grey seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Humber Estuary Ramsar	As above for Humber Estuary SAC.	Potential for LSE
Doggersbank (Dutch Doggerbank) SCI	European site located in the proximity of the array area (42 km) and offshore ECR corridor search area (58 km) (see Table 5.10). There is therefore potential for significant level of interaction between grey seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Klaverbank SCI	European site in close proximity to the array area (approx. 11 km away) and the offshore ECR corridor search area (18 km) (Table 5.10). Therefore potential for significant interaction between grey seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Noordzeekustzone SAC	European site located 138 km from the array area) and offshore ECR corridor search area (138 km) (see Table 5.10). There is therefore potential for interaction between grey seals at this site and underwater noise associated with Hornsea Three.	Potential for LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	European site located well beyond 145 km from the array area (383 km) and offshore ECR corridor search area (391 km) (see Table 5.10). No potential for interaction between grey seals at this site and underwater noise associated with Hornsea Three.	No LSE
Waddenzee SAC	European site located 146 km from the array area and 146 km from the offshore ECR corridor search area (Table 5.10). No potential for significant interaction between grey seals at this site and underwater noise associated with Hornsea Three.	No LSE

Vessel noise

6.2.47 Increased vessel traffic during construction may result in an increase in noise disturbance to marine mammals. During the construction phase of Hornsea Three, a variety of vessels may be used, ranging from large vessels such as jack up barges and heavy lift vessels, to smaller vessels such as crew transport vessels or small cable laying vessels. This will result in an increase in the vessel traffic in the area. It is anticipated, however, that for the most part, this increase will be localised to the Hornsea Three array area and offshore ECR corridor, and existing shipping routes to and from ports.

6.2.48 Marine mammals react to vessel noise, and as such, there may be potential for the increased vessel traffic in the area to result in an impact on these species. Noise levels associated with large surface vessels are unlikely to result in physiological damage to marine mammals, however this may be sufficient to cause disturbance in the vicinity of the vessel, depending on ambient noise levels (Malme *et al.,* 1989; Richardson *et al.,* 1995).

6.2.49 It is anticipated that the additional vessel movement during construction of Hornsea Three (in line with that associated with Project One and Project Two) would be relatively small in the context of baseline shipping activity in the area. Against a background[12] of high vessel activity from commercial shipping and fishing and including many smaller vessels operating at fast speeds, it is considered unlikely that vessel activity associated with Hornsea Three will significantly affect marine mammals due to their apparent habituation to vessel noise.

6.2.50 It is therefore not considered that increased vessel noise resulting from Hornsea Three has the potential to result in a LSE on Annex II marine mammal features. The assessment of LSE in respect of vessel noise is summarised in Table 6.7 below for all relevant sites and Annex II marine mammal features.

Table 6.7 Determination of LSE for European sites with marine mammals Annex II species as qualifying features in respect of vessel noise

European site	Feature(s)	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	• Harbour porpoise	It is anticipated that the additional vessel movement during construction/decommissioning would be relatively small in the context of baseline shipping activity in the area. Against a background of high vessel activity from commercial shipping and fishing, and including many smaller vessels operating at fast speeds, it is considered unlikely that this increase in vessel activity will significantly affect marine mammals due to their apparent habituation to vessel noise.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE

[12] An indication of the level of vessel movement within, and in the proximity of, Hornsea Three is provided within the Hornsea Three EIA Scoping Report (DONG, 2016) (Section 9.1: Commercial Fisheries and Section 9.2: Shipping and Navigation).

European site	Feature(s)	Rationale for determination of LSE	Conclusion
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal.		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey • Harbour seal.		No LSE
Noordzeekustzone II pSCI	• Harbour porpoise • Grey seal • Harbour seal.		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey sea.		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Vessel collision risk

6.2.51 The expected increase in vessel traffic during the construction and decommissioning phase may result in an increased risk of injury to marine mammals associated with vessel strikes.

6.2.52 As mentioned above in relation to vessel noise, the additional vessel movement resulting from the construction phase of Hornsea Three is anticipated to be relatively small in the context of the baseline activity.

6.2.53 In the particular case of seals additional concerns have in the past been raised in relation to the potential for vessel collisions to result in "corkscrew" injuries, with these injuries initially thought to be related to collisions with the propellers of vessels. It should be noted, however; that after further investigation it has been established that these injuries are caused by predation by other seals rather than a result of vessel collision (Thompson *et al.,* 2015).

6.2.54 Taking the above into account together with the relatively small increase in vessel traffic anticipated in relation to the construction of Hornsea Three, it is considered that there is little potential for the increased vessel activity to result in a significant impact in terms of collision risk with vessels. As such, no LSEs are anticipated to occur on marine mammal features as result of Hornsea Three in this respect.

6.2.55 The assessment of LSE in respect of vessel collision is summarised in Table 6.8 below for all relevant sites and Annex II marine mammal features.

Table 6.8 Determination of LSE for European sites with marine mammals Annex II species as qualifying features in respect of vessel collision.

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	• Harbour porpoise	Given the relatively small increase in vessel traffic associated with the construction of Hornsea Three it is considered that there is little potential for increased vessel activity to result in a significant impact in terms of collision risk for marine mammals.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise. • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal.		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey • Harbour seal.		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise. • Harbour seal • Grey sea.		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Increased suspended sediments

6.2.56 There may be potential for increased suspended sediments, arising from construction activities such as cable installation/removal and seabed preparation for foundation installation, to temporarily impair the foraging ability of marine mammals.

6.2.57 The potential area affected by increased suspended sediment concentrations is however anticipated to be small in extent being confined to the vicinity of the array and offshore ECR corridor search area (the ZOI identified in relation to increased suspended sediments is defined as 16 km around the Hornsea Three array area and up to approximately 12 km from the offshore ECR corridor search area (see paragraph 5.3.6)).

6.2.58 Marine mammals frequently occur in relatively turbid areas and therefore are adapted to find prey in such conditions. Furthermore, they possess mechanisms to detect prey through means other than visual detection. In the case of harbour porpoise the use of echolocation allows this species to detect prey in poor visibility conditions. Other species such as seals, possess sensitive muzzles with vibrissae or sensory whiskers which they use to find prey (Denhardt *et al.*, 2001).

6.2.59 Taking the above into account, together with the localised and intermittent nature of construction activities as well as the relatively wide foraging and distribution range of marine mammal species, it is considered that there is little potential for suspended sediment concentrations to result in significant effects through impacts on the foraging ability of marine mammals.

6.2.60 Accordingly, LSEs are not anticipated to occur on marine mammal features in this respect as a result of Hornsea Three.

6.2.61 The assessment of LSE in respect of increased suspended sediment concentrations is summarised in Table 6.9 below for all relevant sites and Annex II marine mammal features.

Table 6.9 Determination of LSE for European sites with marine mammals Annex II species as qualifying features in respect of increased suspended sediment concentrations.

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	• Harbour porpoise	Marine mammals frequently occur in relatively turbid areas and therefore are adapted to find prey in such conditions. Furthermore, they possess mechanisms to detect prey through means other than visual detection. In light of the above, together with the localised and intermittent nature of construction activities, the relatively small extent over which suspended sediment concentration will increase as well as the relatively wide foraging and distribution range of marine mammals species, it is considered that there is little potential for a significant effect through impacts on the foraging ability of marine mammals to occur.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey • Harbour seal		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise. • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Accidental pollution

6.2.62 There is a risk of pollution being accidentally released from sources including construction and installation vessels, machinery and offshore fuel storage tanks and from the construction process itself. The release of such contaminants may lead to impacts on marine mammals. The release of contaminants may lead to direct impacts on these species through ingestion, inhalation or absorption through the skin, and potentially longer-term indirect impacts from bioaccumulation in the food chain.

6.2.63 A number of mitigation measures and best practice approaches will be implemented during the construction phase to reduce the potential for, and manage the outcomes of, any accidental pollution events. This will include the development of a CoCP which will set out measures to follow, including published guidelines and best working practice, to prevent pollution events. With adherence to such approaches, LSEs on Annex II marine mammal qualifying features associated with accidental release of pollutants are not anticipated to arise as a result of the Project.

6.2.64 The assessment of LSE in respect of pollution events is summarised in Table 6.10 below for all relevant sites and Annex II marine mammal features.

Table 6.10 Determination of LSE for European sites with marine mammals Annex II species as qualifying features in respect of pollution events.

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	• Harbour porpoise	A number of mitigation measures and best practice approaches will be implemented during the construction phase to reduce the potential for, and manage the outcomes of, any accidental pollution events. This will include the development of a CoCP which will set out measures to follow, including published guidelines and best working practice, to prevent pollution events. With adherence to such approaches, LSEs on Annex II marine mammal qualifying features associated with accidental release of pollutants are not anticipated to arise as a result of the Project.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise. • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Changes in prey availability

6.2.65 Construction activities may indirectly result in an impact on marine mammals, assuming substantial changes to the fish and shellfish community and/or impacts on key species leading to a loss of prey for marine mammals occur.

6.2.66 Key prey species for marine mammals include clupeids (e.g., herring), gadoids (e.g., cod, whiting), flatfish species and sandeels. These species are important components of the fish community in areas relevant to Hornsea Three (DONG Energy, 2016).

6.2.67 At this early stage and given that an assessment of the impacts of Hornsea Three on the fish and shellfish community is yet to be carried out, a conservative approach has been taken and it has been assumed that there may be potential for changes in prey availability to result in a significant effect for marine mammal features of a number of European sites. The assessment of LSE is described in the following sections for each relevant marine mammal feature.

Harbour porpoise

6.2.68 As for assessment of underwater noise, taking JNCC advice for the Southern North Sea pSAC it is considered that there is potential for LSEs in relation to changes in prey availability for European sites located within 26 km from the boundary of the array area or the offshore ECR corridor search area as summarised Table 6.11.

Table 6.11 Determination of LSE for European sites with harbour porpoise as qualifying feature in respect of changes in prey availability.

European site	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	European site in close proximity to the array area (approx. 2 km away) and coincident with the offshore ECR corridor search area (Table 5.10). There is therefore potential for harbour porpoises from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Doggerbank (German Doggerbank) SCI	European site located at considerable distance from the array area (183 km) and offshore ECR corridor search area (204 km) (see Table 5.10). Limited potential for harbour porpoises from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Doggersbank (Dutch Doggerbank) SCI	European site located beyond 26 km from the array area (42 km) and offshore ECR corridor search area (58 km) (see Table 5.10). Limited potential for harbour porpoises from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Klaverbank SCI	European site in close proximity to the array area (approx. 11 km away) and offshore ECR corridor search area (18 km) (Table 5.10). There is therefore potential for harbour porpoises from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Noordzeekustzone SAC	European site located at considerable distance from the array area (138 km) and offshore ECR corridor search area (138 km) (see Table 5.10). Limited potential for harbour porpoises from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	European site located at considerable distance from the array area (383 km) and offshore ECR corridor search area (391 km) (see Table 5.10). Limited potential for harbour porpoises from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE

Harbour seal

6.2.69 As for assessment of underwater noise, it is considered that there is potential for LSEs in relation to prey availability impacts for European sites with harbour seal as a qualifying feature that are located within 120 km from the boundary of the array area or from the offshore ECR corridor search area.

6.2.70 The assessment of LSE in respect of prey availability for harbour seal is summarised in Table 6.12 below for all sites included in this assessment.

Table 6.12 Determination of LSE for European sites with harbour seal as qualifying feature in respect of changes in prey availability

European site	Rationale for determination of LSE	Conclusion
The Wash and North Norfolk Coast SAC	Coincident with the Hornsea Three offshore ECR corridor search area and located within 120 km from the array area. (Table 5.10). There is therefore potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Doggerbank (German Doggerbank) SCI	European site located beyond 120 km from the array area (183 km) and offshore ECR corridor search area (204 km) (see Table 5.10). Limited potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Doggersbank (Dutch Doggerbank) SCI	European site located in the proximity of the array area (42 km) and offshore ECR corridor search area (58 km) (see Table 5.10). There is therefore potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Klaverbank SCI	European site in close proximity to the array area (approx. 11 km away) and the offshore ECR corridor search area (18 km) (Table 5.10). There is therefore potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Noordzeekustzone SAC	European site located beyond 120 km from the array area (138 km) and offshore ECR corridor search area (138 km) (see Table 5.10). Limited potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	European site located well beyond 120 km from the array area (383 km) and offshore ECR corridor search area (391 km) (see Table 5.10). Limited potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Waddenzee SAC	European site beyond 120 km from the array area (approx. (146 km away) and the offshore ECR corridor search area (146 km) (Table 5.10). Limited potential for harbour seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE

Grey seal

6.2.71 As for assessment of underwater noise, it is considered that there is potential for LSEs in relation to prey availability impacts for European sites with grey seal as a qualifying feature that are located within 145 km from the array area or the offshore ECR corridor search area.

6.2.72 The assessment of LSE in respect of changes in prey availability for grey seal is summarised in Table 6.13 below for all sites included in this assessment.

Table 6.13 Determination of LSE for European sites with grey seal as qualifying feature in respect of changes in prey availability

European site	Rationale for determination of LSE	Conclusion
Humber Estuary SAC	European site located 67 km from the offshore ECR corridor search area and located within 241 km from the array area. (Table 5.10). There is therefore potential for grey seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Humber Estuary Ramsar	As above for Humber Estuary SAC.	Potential for LSE
Doggersbank (Dutch Doggerbank) SCI	European site located in the proximity of the array area (42 km) and offshore ECR corridor search area (58 km) (see Table 5.10). Limited potential for grey seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Klaverbank SCI	European site in close proximity to the array area (approx. 10 km away) and the offshore ECR corridor search area (18 km) (Table 5.10). There is therefore potential for grey seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Noordzeekustzone SAC	European site located 139 km from the array area) and offshore ECR corridor search area (138 km) (see Table 5.10). There is therefore potential for grey seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	Potential for LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	European site located well beyond 145 km from the array area (383 km) and offshore ECR corridor search area (391 km) (see Table 5.10). Limited potential for grey seals from this site to rely on feeding resources within Hornsea Three and its vicinity.	No LSE
Waddenzee SAC	European site located 146 km from the array area and 146 km from the offshore ECR corridor search area (Table 5.10). Limited potential for grey seals from this site to rely significantly on feeding resources within Hornsea Three and its vicinity.	No LSE

Operation and maintenance

Operational noise

6.2.73 During the operational phase, turbine operation will produce a low frequency, low level noise originating from the gearbox and the generator. Operational noise is generally broadband and low level, with some narrower band, tonal noise produced (Madsen *et al*., 2006; Tougaard and Henriksen, 2009).

6.2.74 The radiated levels of noise associated with operational noise are low and the spatial extent of the potential impact is generally small and thus unlikely to result in any injury to marine mammals (e.g., Tougaard and Henriksen, 2009).

6.2.75 Experiments and studies carried out at operational offshore wind farms indicate that significant behavioural responses to operational noise are unlikely to occur in marine mammals.

6.2.76 Koshinski *et al.* (2003) observed the response of harbour porpoise and harbour seal to playbacks of underwater sound recordings that simulated an operating wind turbine. Neither species showed aversive behaviour resulting from the noise; with harbour porpoise appearing curious of the sound source, approaching the playback equipment and investigating it with echolocation clicks. Whilst the approach distance to the sound source did increase slightly for both species, there was generally a weak behavioural response and numbers within the study area remained unchanged during the experiment.

6.2.77 These findings are supported by more recent observations in the field. At the Horns Rev and Nysted offshore wind farms in Denmark, long-term monitoring showed that both harbour porpoise and harbour seal were sighted regularly within the operational wind farms, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.,* 2008). Similarly, a monitoring programme of the Egmond aan Zee offshore wind farm in the Netherlands showed that during operation, significantly more porpoise activity was recorded within the wind farm compared to the reference area (Scheidat *et al.,* 2011). The findings from this study, together with similar results from other Dutch and Danish wind farms (Lindeboom *et al.,* 2011), suggest that harbour porpoise may be attracted to increased foraging opportunities within operating wind farms (Scheidat *et al*., 2011). Similarly, harbour and grey seal have been recorded exploiting feeding opportunities at operational wind farms in the immediate vicinity of the foundations (Russell *et al*., 2014). It is therefore considered that there is little potential for operational noise to result in significant impacts on marine mammals qualifying features. Accordingly, LSEs are not anticipated to occur on marine mammal features in this respect as a result of Hornsea Three.

6.2.78 The assessment of LSE in respect of operational noise is summarised in Table 6.14 for all relevant Annex II marine mammal features.

Table 6.14 Determination of LSE for European sites with marine mammals as qualifying features in respect of operational noise

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	• Harbour porpoise	Experiments and studies carried out to date indicate that significant behavioural responses to operational noise are unlikely to occur in marine mammals.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Vessel noise

6.2.79 Increased vessel traffic during operation may result in an increase in noise disturbance to marine mammals. As for the construction phase, it is anticipated, however, that for the most part, this increase will be localised to the array area and existing shipping routes to and from ports.

6.2.80 It is anticipated that the additional vessel movement during operation of Hornsea Three (in line with that associated with Project One and Project Two) would be relatively small in the context of baseline shipping activity in the area. As noted in respect of the construciton phase, against a background of high vessel activity from commercial shipping and fishing, and including many smaller vessels operating at fast speeds, it is considered unlikely that the increase in vessel activity associated with Hornsea Three will significantly affect marine mammals due to their apparent habituation to vessel noise.

6.2.81 It is therefore not considered that increased vessel noise has potential to result in LSEs on Annex II marine mammal features as a result of Hornsea Three.

6.2.82 The assessment of LSE in respect of vessel noise is summarised in Table 6.15 below for all relevant sites and Annex II marine mammal features.

Table 6.15 Determination of LSE for European sites with marine mammals as qualifying features in respect of vessel noise

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea proposed Special Area of Conservation (pSAC)	• Harbour porpoise	It is anticipated that the additional vessel movement during operation would be relatively small in the context of baseline shipping activity in the area. Against a background of high vessel activity from commercial shipping and fishing, and including many smaller vessels operating at fast speeds, it is considered unlikely that this increase in vessel activity will significantly affect marine mammals due to their apparent habituation to vessel noise.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Vessel collision risk

6.2.83 The expected increase in vessel traffic during the operation may result in an increased risk of injury to marine mammals associated with vessel strikes.

6.2.84 As mentioned above in relation to the construction phase, the additional vessel movement resulting from the operation phase of Hornsea Three is anticipated to be relatively small in the context of the baseline activity (i.e. in line with that associated with Project One and Project Two).

6.2.85 In the particular case of seals additional concerns have in the past been raised in relation to the potential for vessel collisions to result in "corkscrew" injuries, with these injuries initially thought to be related to collisions with the propellers of vessels. It should be noted, however; that after further investigation it has been established that these injuries are caused by predation by other seals rather than a result of vessel collision (Thompson *et al.,* 2015).

6.2.86 Taking the above into account together with the relatively small increase in vessel traffic anticipated in relation to the operation of Hornsea Three, it is considered that there is little potential for the increased vessel activity to result in a significant impact in terms of collision risk with vessels. As such, no LSEs are anticipated to occur on marine mammal features in this respect as result of Hornsea Three.

6.2.87 The assessment of LSE in respect of vessel collision is summarised in Table 6.16 below for all relevant sites and Annex II marine mammal features.

Table 6.16 Determination of LSE for European sites with marine mammals as qualifying features in respect of vessel collision

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea possible Special Area of Conservation (pSAC)	• Harbour porpoise	Given the relatively small increase in vessel traffic anticipated associated with the operation phase of Hornsea Three it is considered that there is little potential for increased vessel activity to result in a significant impact in terms of collision risk with vessels.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

EMFs

6.2.88 Marine mammals are not thought to be electro-sensitive, however there is some evidence to suggest that they may be able to detect magnetic fields. Theoretical evidence suggests that some species of cetacean may use the Earth's magnetic field for orientation during long distance migrations (Kirschvinck *et al.,* 1986). In addition, it has been suggested that cetaceans may use magnetic stimuli to aid a number of ecological functions such as determination of feeding locations, reproduction and refugia (Normandeau *et al., 2011*).

6.2.89 Whilst the current knowledge in relation to the effects of EMFs on marine mammals is limited, the information available from the literature indicates that there is no evidence that an effect on magneto-sensitive species may occur other than very localised and short term behavioural effects. Further, the strength of the magnetic field decreases rapidly horizontally and vertically with distance from source (Normandeau *et al.,* 2011) and as such, any potential effect on marine mammals will be localised within the immediate vicinity of the cables. As a result, only a very small proportion of habitat available to these species within Hornsea Three would be potentially affected.

6.2.90 In light of the above no LSEs are anticipated to occur on marine mammal features in respect of EMFs as a result of Hornsea Three.

6.2.91 The assessment of LSE in respect of EMFs is summarised in Table 6.17 below for all relevant sites and Annex II marine mammal features.

Table 6.17 Determination of LSE for European sites with marine mammals as qualifying features in respect of EMFs

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea pSAC	• Harbour porpoise	The information available from the literature indicates that there is no evidence that an effect on magneto-sensitive species may occur other than very localised and short term behavioural effects Further, the strength of the magnetic field decreases rapidly horizontally and vertically with distance from source and as such, any potential effect on marine mammals will be localised within the immediate vicinity of the cables.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise. • Harbour seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Accidental pollution

6.2.92 As for the construction phase, there is a risk of pollution being accidentally released from vessels, machinery and offshore fuel storage tanks. The release of such contaminants may lead to impacts on marine mammals. The release of contaminants may lead to direct impacts on these species through ingestion, inhalation or absorption through the skin, and potentially longer-term indirect impacts from bioaccumulation in the food chain.

6.2.93 A number of mitigation measures and best practice approaches will be implemented during the operational phase to reduce potential impacts associated with accidental pollution events. This will include following published guidelines and best working practice for the prevention of pollution events. Adhering to such approaches, LSEs on Annex II marine mammal qualifying features associated with accidental release of pollutants are not anticipated to arise as a result of Hornsea Three.

6.2.94 The assessment of LSE in respect of pollution events is summarised in Table 6.18 below for all relevant sites and Annex II marine mammal features.

Table 6.18 Determination of LSE for European sites with marine mammals Annex II species as qualifying features in respect of pollution events

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea pSAC	• Harbour porpoise	A number of mitigation measures and best practice approaches will be implemented during the operational phase to reduce potential impacts associated with accidental pollution events. This will include following published guidelines and best working practice for the prevention of pollution events. Adhering to such approaches, LSEs on Annex II marine mammal qualifying features associated with accidental release of pollutants are not anticipated to arise as a result of Hornsea Three.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal.		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Changes in prey availability

6.2.95 Operation and maintenance activities are considered unlikely to meaningfully impact on prey availability beyond local disturbance from vessel movement or jack up vessel mooring, and consequently are unlikely to lead to a loss of prey for marine mammals.

6.2.96 Operational noise from wind turbines and noise from maintenance and support vessel movement has been assessed as not likely to have a significant effect on marine mammals (Table 6.14 and 6.15). It is reasonable to assume that marine mammal prey species are not more sensitive to ambient noise levels than marine mammals themselves.

6.2.97 Indeed there is some evidence that wind turbine foundations and the surrounding rock placement (scour protection) have a "reef effect" that may enhance the local marine environment and cause the aggregation of marine mammal prey species (Raoux et al, 2017; Lindeboom et al, 2011).

6.2.98 As a result some marine mammal species appear to explicitly seek out wind farms to forage for prey (Scheidat *et al*., 2011; Russell *et al*., 2014).

6.2.99 The assessment of LSE in respect of changes in prey availability is summarised in Table 6.19.

Table 6.19 Determination of LSE for European sites with marine mammal Annex II species as qualifying features in respect of prey availability

European site	Features	Rationale for determination of LSE	Conclusion
Southern North Sea pSAC	• Harbour porpoise	Operational noise (from wind turbine rotors) and maintenance activity is considered unlikely to have a signiciant effect on marine mammals per se and by implication on their prey species whose hearing abilities are considered less advanced than marine mammals. There is some evidence for aggregation of prey species around wind turbine foundations and rock placement and for the preferential use of wind farms as foraging destinations by some marine mammals.	No LSE
The Wash and North Norfolk Coast SAC	• Harbour seal		No LSE
Humber Estuary SAC	• Grey seal		No LSE
Humber Estuary Ramsar site	• Grey seal		No LSE
Doggerbank (German Doggerbank) SCI	• Harbour porpoise • Harbour seal		No LSE
Doggersbank (Dutch Doggerbank) SCI	• Harbour porpoise • Harbour seal • Grey seal		No LSE

European site	Features	Rationale for determination of LSE	Conclusion
Klaverbank SCI	• Harbour porpoise • Grey seal • Harbour seal		No LSE
Noordzeekustzone SAC	• Harbour porpoise • Grey seal • Harbour seal.		No LSE
Vadehavet med Ribe Å, Tved Å og Varde Å vest for Varde SAC	• Harbour porpoise • Harbour seal • Grey seal		No LSE
Waddenzee SAC	• Grey seal • Harbour seal		No LSE

Ornithological features

Potential impacts on offshore ornithology features

Construction and decommissioning: Disturbance

6.2.100 During the construction phase seabed disturbance may lead to a reduction in suitable habitat for birds. Any loss of foraging habitat would be temporary, being primarily associated with the presence of machinery whilst construction works are undertaken. In addition, the anticipated habitat disturbed will be very small in the context of the wide areas in which seabirds are able to forage. In addition to the above, disturbance during construction may occur as a result of increased vessel activity and underwater noise. This may displace birds from an area of sea, effectively resulting in habitat loss during the period of disturbance (Drewitt and Langston, 2006).

6.2.101 Bird species most likely to be vulnerable to underwater sound are those that forage by diving after fish or shellfish, and include auks, divers and seaduck. Gull and tern species feed at the surface only and are considered the least vulnerable, with no apparent responses to piling activity recorded at Egmond aan Zee by Leopold and Camphuysen (2007). Hornsea Three is beyond the mean maximum or maximum foraging ranges for the majority of breeding seabirds potentially affected so that potential impacts on species such as auks are likely only to occur in the non-breeding season.

6.2.102 Taking the information above, the potential for a LSE to occur is investigated in the sections below for sites potentially affected by both the offshore ECR corridor and the array area.

Construction and decommissioning: Changes to prey availability

6.2.103 There is potential for indirect impacts to occur on birds associated with disturbance and displacement of prey species as a result of the construction phase of Hornsea Three. The potential loss of prey would however be expected to be minimal as in general terms, Hornsea Three is beyond the mean maximum or maximum foraging ranges for the birds potentially affected (see Section 5) and those that are present are likely to be near the limit of their foraging ranges during the breeding season. The distribution of seabirds across the wider area indicate that those that are displaced due to indirect impacts will be able to relocate to other suitable foraging areas in response to any changes in local prey distribution. During the non-breeding period the potential foraging area for displaced seabirds is greater than during the breeding season and displaced birds that feed on widely occurring fish species will be able to relocate to other suitable foraging areas within their normal range of distribution at this time.

6.2.104 LSE through changes to prey availability on bird features is not anticipated during the non-breeding or breeding season, although further investigation is presented below for relevant SPAs potentially affected by either the offshore ECR corridor or the array area.

Operation: Habitat loss

6.2.105 During the operational and maintenance phase, a permanent loss of seabed habitat will occur associated with the introduction of wind farm infrastructure (e.g. WTG foundations, scour protection). The area of seabed loss during the operational phase, will likely be very small both, in the context of the wide areas in which birds are known to forage and compared to the distribution ranges of the key prey species for seabirds. Taking the above into account, no LSEs associated with loss of seabed habitat are anticipated to occur on bird features as a result of Hornsea Three.

Operation: Displacement

6.2.106 Evidence from existing offshore wind farms indicates that some species of seabird may avoid entering wind farms and therefore be displaced from areas that they may otherwise utilise (e.g., Zucco *et al*., 2006). The level of displacement is species specific and the duration of displacement may vary across species, with some species avoiding offshore wind farms immediately post-construction and returning to the area after a period of time and other species showing little or no evidence of returning to the wind farm area post-construction. The likely scale of displacement effects varies by species, therefore, depending on their sensitivity (Langston, 2010) and the density within the proposed wind farm (and adjoining) areas. The implications for birds displaced from wind farms will also vary depending on the availability of other habitats which can support those birds. Quantifying the risk to birds requires, therefore, predictions based on modelling which takes into account these variables. Typically this involves estimating the proportion of birds present that are likely to be displaced and then the proportion of those birds that are displaced that will be unable to successfully relocate (leading to death or emigration). It also requires disaggregating the risk to birds that are associated with those populations that form designated SPA features from other populations that are not SPA features (as the birds recorded at a wind farm site are usually a mixture of both).

6.2.107 Pending more detailed displacement analysis, it is assumed that where a species vulnerable to displacement has been recorded at Hornsea Three, and where a population of that species is also a feature of an SPA that is within foraging range (for that species) of the wind farm, then, for the purposes of this screening exercise, it is assumed that a LSE could occur. This is on the basis that there is potential for foraging birds from the SPA to rely upon habitats within the operational wind farm from which they will become excluded (wholly or partially), although at this stage the scale of that risk has yet to be quantified.

6.2.108 Further species-specific investigation is presented below for relevant SPAs potentially affected by either the offshore ECR corridor or the array area.

Operation: Collision

6.2.109 The risk of collision with wind turbine generators depends on a number of variables, such as species-specific near and far field avoidance rates, flight heights, speed of flight, frequency of movements in or near to the turbines as well as the size and location of the turbines themselves. Further, additional factors such as weather and species' behaviour can also affect the risk of collision. Quantifying the risk to birds requires, therefore, predictions based on modelling which takes into account these variables. It also requires disaggregating the risk to birds that are associated with those populations that form designated SPA features from other populations that are not SPA features (as the birds recorded at a wind farm site are usually a mixture of both).

6.2.110 Pending more detailed collision risk assessment, it is assumed that where a species vulnerable to collision impacts has been recorded at Hornsea Three, and where a population of that species is also a feature of an SPA that is within foraging range (for that species) of the wind farm, then, for the purposes of this screening exercise, it is assumed that a LSE could occur. This is on the basis that there is likelihood that foraging birds from the SPA could occur within the operational wind farm and be exposed to collision risk, although at this stage the scale of that risk has yet to be quantified.

6.2.111 Further species-specific investigation is presented below for relevant SPAs potentially affected by the array area.

Operation: Barrier effects

6.2.112 The physical presence of Hornsea Three may result in a barrier to the movement of some bird species. Where birds avoid flying through the area of the offshore wind farm an increase in flying distance to reach their destination may occur. This may lead to increased energy expenditure, which may have a detrimental effect on fitness and/or reduce survival or fecundity rates. This is of particular concern if the area in which the wind farm is located is used for regular, daily movements (i.e., to foraging areas from a breeding colony).

6.2.113 The foraging ranges of the seabirds in the southern North Sea are relatively large during the breeding period with migratory movements through the North Sea occurring across a broad front (e.g., Thaxter *et al.,* 2012; Wemham *et al*., 2002). Many of the species subject to this assessment migrate many thousands of kilometres each year and it is therefore anticipated that they will be capable of flying around or over Hornsea Three should they choose to do so without a significant increase in distance travelled. The duration, magnitude and extent of impact resulting from barrier effects on SPA qualifying species are assessed as being unlikely to compromise the conservation objectives of any designated SPA. Whilst, therefore, there is no indication that barrier effects could lead to a LSE on any feature for the purposes of this screening exercise, further species-specific information is provided to rule out LSEs due to barrier effects.

The Greater Wash pSPA

6.2.114 Natural England is responsible for recommending SPAs in English waters out to 12 nautical miles to the Department for Environment, Food and Rural Affairs (Defra) for classification. As part of wider work to identify potential (p) SPAs in UK waters, Natural England has compiled information in relation to the creation of a new SPA called the 'Greater Wash SPA' off the eastern coast of England. This new marine SPA would be located between Bridlington Bay, East Yorkshire and the area just north of Great Yarmouth on the Norfolk coast. The SPA would have a landward boundary at Mean High Water and an offshore extent of around 30 km at its furthest point (Figure 5.7).

6.2.115 The identification of qualifying features for the pSPA was supported by Wilson *et al.* (2014) and Lawson *et al.* (2015). Six features have been identified (Natural England and JNCC, 2016) that will form part of the Greater Wash SPA designation. These bird features fall into three categories:

- Annex I tern species that use relatively restricted areas around their breeding colonies for foraging;
- Non-breeding Annex I species; and
- Non-breeding regularly occurring migratory species.

6.2.116 Annex I tern species include Sandwich tern, common tern and little tern. The non-breeding Annex I species are red-throated diver and little gull and the regularly occurring migratory species are common scoter.

6.2.117 A number of SPAs that are designated for breeding tern species (common tern, Sandwich tern and little tern) are located adjacent or in close proximity to the Greater Wash (Humber Estuary, Gibraltar Point, The Wash, North Norfolk Coast, Great Yarmouth North Denes and Breydon Water). The waters adjacent to these colonies are utilised by terns for a range of activities, including foraging. All terns are central place foragers leaving and returning to the breeding colony (the central place) on every foraging trip. However, the foraging areas upon which these terns rely are not currently afforded the same level of protection as breeding colonies. As such, work to identify potential marine SPAs undertaken by Natural England has included consideration of foraging areas used by tern species breeding in existing SPAs.

6.2.118 The inclusion of foraging terns as a qualifying feature of the Greater Wash pSPA was informed by Wilson *et al.* (2014) which investigated the usage of offshore areas by foraging common and Sandwich terns from a number of breeding colonies around the coast of the UK. Of relevance to the Greater Wash, Wilson *et al.* (2014) modelled the likely foraging activity of common terns and Sandwich terns from colonies at North Norfolk Coast SPA (amongst other SPAs as detailed above). Using these data the foraging areas of common tern and Sandwich tern from these colonies were identified and incorporated into the boundary for the Greater Wash pSPA.

6.2.119 In addition to common and Sandwich terns, the foraging areas of little tern from colonies adjacent to the Greater Wash were identified (Parsons *et al*., 2015) and also incorporated into the pSPA boundary. Of relevance to the Greater Wash, Parsons *et al.* (2015) identified the maximum seaward extent and maximum alongshore lengths for foraging of little tern at colonies on the North Norfolk Coast SPA, Gibraltar Point SPA and Great Yarmouth North Denes SPA. Using these data, the foraging areas of little tern were identified and incorporated into the boundary for the Greater Wash pSPA.

6.2.120 The Greater Wash incorporates areas of importance for non-breeding red-throated diver, common scoter and little gull. These species fall into one of two categories used for the identification of SPAs as defined in Natural England and JNCC (2016):

- Non-breeding Annex I species (red-throated diver and little gull); and
- Non-breeding regularly occurring migratory species (common scoter).

6.2.121 The distribution of these species in the Greater Wash pSPA was identified based on aerial survey data collected in the Greater Wash during the non-breeding season (October to March) from 2002/03 to 2007/08 (Lawson *et al.,* 2015).

6.2.122 Population estimates for each species within the Greater Wash were calculated using Distance Sampling for each individual survey. From individual survey estimates a peak count was identified within each winter season and an average of these peak counts from the five most recent winter seasons was calculated to derive the mean of peak population estimate. The mean was taken over five seasons where the data were available.

6.2.123 Red-throated divers were present in all of the surveys undertaken across the Greater Wash between 2002 and 2008. Red-throated divers were distributed throughout the Greater Wash with the highest densities fairly mobile within and between years. The mean peak population estimate was taken over three winter seasons (2002/03, 2004/05, 2005/06), and the SPA citation population was 1,511 birds making the Greater Wash the second most important area for the species in the UK. This population far exceeds the GB threshold for the species (170 individuals) (Lawson *et al.,* 2015, Natural England and JNCC, 2016).

6.2.124 A mean-peak population of 1,303 individual little gulls was estimated to be present in the Greater Wash during the non-breeding season making this the largest population in any inshore area around the UK. The highest densities of little gull were concentrated to the north-east of the Inner Wash. Populations of little gull exhibited a high degree of temporal variability with low populations recorded in some surveys (Lawson *et al.,* 2015).

6.2.125 As with little gull, populations of common scoter showed a high degree of temporal variability varying from flocks of a few individuals to flocks over 1,000 individuals. Lawson *et al.* (2015) estimated that a mean population of 3,463 common scoters was present in the Greater Wash area. This population is lower than the 1% threshold of the biogeographic population of the species and therefore does not meet the Stage 1.2 threshold of the UK SPA selection guidelines. However, it has been proposed that common scoter be considered for inclusion within the SPA designation based on the consistent presence of dense flocks of this species off the North Norfolk coast which make this area the fifth most important for the species in the UK (Natural England and JNCC, 2016).

6.2.126 The populations of features that are proposed for inclusion as part of the designation of the Greater Wash pSPA are included in Table 6.20.

Table 6.20 Populations of proposed features of the Greater Wash pSPA (Natural England and JNCC, 2016)

Feature	Type	Population (individuals)
Common scoter	Non-breeding	3, 463
Red-throated diver	Non-breeding	1,511
Little gull	Non-breeding	1,303
Sandwich tern	Breeding (foraging)	3,852 breeding pairs
Common tern	Breeding (foraging)	510 breeding pairs
Little tern	Breeding (foraging)	798 breeding pairs

Tern features (Sandwich tern, common tern and little tern)

6.2.127 The offshore ECR corridor search area is located within the boundary of the pSPA, with effects on designated features likely to occur as a result of disturbance or displacement from construction activities and/or vessel movement. The array area is located beyond the pSPA boundary and beyond the foraging range of any tern species and thus collision risk is not considered to lead to a LSE on these species.

6.2.128 Neither Sandwich tern, common tern or little tern are considered to have a high sensitivity to disturbance or displacement (Wade *et al.,* 2016) and therefore no LSE on these species is predicted as a result of Hornsea Three in either construction or operational phases.

Little gull

6.2.129 The offshore ECR corridor search area is located within the boundary of the pSPA, with effects on designated features likely to occur as a result of disturbance or displacement from construction activities and/or vessel movement. The array area is located beyond the pSPA boundary and thus collision risk is not considered to lead to a LSE on this species. Little gull are considered to have a very low sensitive to disturbance and displacement (Maclean *et al.*, 2009; Langston, 2010; Garthe and Hüppop, 2004) and therefore no LSE on this species is predicted as a result of Hornsea Three in either construction or operational phases.

Red-throated diver

Construction

Disturbance

6.2.130 Disturbance is predicted to be limited to that initiated by the movement of vessels or by noise causing evasive action to be taken by birds including flushing, typically into flight or by diving in the case of species such as red-throated diver.

6.2.131 Disturbance (visual presence, vessel activity and underwater noise) may displace birds from an area of sea, effectively amounting to habitat loss during the period of disturbance (Drewitt and Langston, 2006).

6.2.132 Red-throated diver are considered to be highly sensitive to disturbance and displacement (Wade *et al.,* 2016), given the export cable route corridor is located within the pSPA there is potential for displacement and disturbance effects to lead to a LSE on this species.

Changes to prey availability

6.2.133 During cable laying activity there may be potential for seabird prey to be disturbed. This would be primarily as a result of increased suspended sediment concentrations associated with cable laying activities. Noise associated with cable laying activity is minimal. Any changes in the behaviour/distribution of prey would be highly localized (limited to the immediate vicinity of cable laying operations), temporary and short term.

6.2.134 As such, any displacement of red-throated diver as a result of indirect impacts on their prey would be minimal and no LSE is predicted.

Operation

Displacement

6.2.135 The displacement effects attributable to wind farms may be variable and are species, season and site-specific. Displacement effectively leads to the exclusion of birds from the area in which a wind farm is located and can be regarded as analogous to habitat loss in its effects on birds.

6.2.136 The biological consequences of displacement and any resultant population level effects will depend on the importance of the area from which birds are displaced and the capacity of alternative habitats to support these displaced birds. Given the export cable route corridor is located within the pSPA there is potential for displacement effects to lead to a LSE on this highly sensitive species (Wade *et al.,* 2016).

Common scoter

Construction

Disturbance

6.2.137 Disturbance (visual presence, vessel activity and underwater noise) may displace birds from an area of sea, effectively amounting to habitat loss during the period of disturbance (Drewitt and Langston, 2006).

6.2.138 Many groups of seabirds exhibit species-specific behavioural responses to wind farms and the activities associated with these developments (e.g. vessel movements or construction activities). These responses generally constitute an avoidance response and can result in indirect habitat loss as species avoid areas in which disturbance events occur. Common scoters are considered to be particularly vulnerable to disturbance from ship traffic and are identified as one of the most sensitive species to disturbance (Wade *et al.,* 2016).

6.2.139 Given the export cable route corridor is located within the pSPA there is potential for displacement and disturbance effects to lead to a LSE on this species.

Changes to prey availability

6.2.140 During cable laying activity there may be potential for seabird prey to be disturbed. This would be primarily as a result of increased suspended sediment concentrations associated with cable laying activities. Noise associated with cable laying activity is minimal. Any changes in the behaviour/distribution of prey would be highly localized (limited to the immediate vicinity of cable laying operations), temporary and short term.

6.2.141 As such, any displacement of common scoter as a result of indirect impacts on their prey would be minimal and no LSE is predicted.

Operation

Displacement

6.2.142 Displacement effectively leads to the exclusion of birds from the area in which a wind farm is located and can be regarded as analogous to habitat loss in its effects on birds.

6.2.143 Common scoter are considered to be highly sensitive to disturbance (Wade *et al.,* 2016) and given the offshore ECR corridor search area goes through the pSPA it is considered there in potential for a LSE on this species.

Conclusion

6.2.144 A summary of the LSEs arising from Hornsea Three on the Greater Wash pSPA is presented in Table 6.21.

Table 6.21 summary of the LSEs arising from Hornsea Three on the Greater Wash pSPA

Feature	Project Phase	Effect	Conclusion
Sandwich tern	All	All	No LSE
Common tern	All	All	No LSE
Little tern	All	All	No LSE
Little gull	All	All	No LSE
Red-throated diver	Construction / decommissioning	Disturbance	Potential for LSE
		Changes to prey availability	No LSE
	Operation	Displacement	Potential for LSE
Common scoter	Construction / decommissioning	Disturbance	Potential for LSE
		Changes to prey availability	No LSE
	Operation	Displacement	Potential for LSE

Flamborough and Filey Coast pSPA/ Flamborough Head and Bempton Cliffs SPA

6.2.145 Section 5 identified the following sites as having qualifying features that have the potential for connectivity with the Hornsea 3 during breeding seasons based on mean-maximum foraging ranges:

- Flamborough Head and Bempton Cliffs SPA; and
- Flamborough and Filey Coast pSPA.

6.2.146 The Flamborough Head and Bempton Cliffs SPA is located on the Humberside and North Yorkshire Coast, north of Bridlington. The landward boundary of the SPA follows that of the existing Flamborough Head SSSI between Speeton Sand in the north west and South Landing in the south.

6.2.147 The site qualifies under articles 4.2 of the EC Birds Directive by regularly supporting an internationally important breeding population 83,700 pairs of kittiwake. It also supports nationally important populations of the migratory species shown in Table 6.22.

Table 6.22 Designated populations for the Flamborough Head and Bempton Cliffs SPA (Original citation 1992)

Feature	Population
Kittiwake	83,700 pairs
Guillemot	32,300 individuals
Razorbill	7,700 individuals
Puffin	7000 individuals

6.2.148 Flamborough and Filey Coast (FFC) pSPA is located on the Yorkshire coast between Bridlington and Scarborough. It includes the RSPB reserve at Bempton Cliffs, the Yorkshire Wildlife Trust Flamborough Cliffs nature reserve and the East Riding of Yorkshire Council Flamborough Head Local Nature Reserve.

6.2.149 The site qualifies under article 4.2 of the Directive (79/409/EEC) for supporting over 1% of the biogeographical population of four regularly occurring migratory species, see Table 6.23.

Table 6.23 Populations of features of the FFC pSPA (Natural England, 2014)

Feature	Population
Gannet	8,469 pairs 16,938 breeding adults (2008-2012)
Kittiwake	44,520 pairs 89,041 breeding adults (2008-2011)
Guillemot	41,607 pairs 83,214 breeding adults (2008-2011)
Razorbill	10,570 pairs 21,140 breeding adults (2008-2011)

6.2.150 The site qualifies under article 4.2 of the Directive (2009/147/EC) as it is used regularly by over 20,000 seabirds in any season:

6.2.151 During the breeding season, the area regularly supports 215,750 individual seabirds including: kittiwake, gannet, common guillemot, razorbill, fulmar (2008-2012). The fulmar population is listed as being of 569 pairs (1,138 individuals) based on 2010-2011 data (Natural England, 2014).

6.2.152 With regard to the FFC pSPA the qualifying features are as follows:

- Kittiwake;
- Gannet;
- Common guillemot;
- Razorbill; and
- Seabird assemblage (including fulmar and 'non-listed' puffin and herring gull).

Fulmar

Construction

Disturbance

6.2.153 Wade *et al*. (2016) assessed fulmar as being at low risk of disturbance / displacement from wind farms. Fulmar have an extensive foraging range as defined by the mean-maximum foraging range of 400 km from their breeding colonies (Thaxter *et al.,* 2012). They are a highly pelagic seabird and foraging trips can last up to 30 hours (Furness and Todd, 1984). Construction disturbance to fulmar is therefore considered likely to be minimal and no LSE is predicted.

Changes to prey availability

6.2.154 Fulmars feed on a wide diversity of food including planktonic crustacean, cephalopods and small fish (Cramp and Perrins, 1977). Wade *et al.* (2016) consider that fulmar is of low vulnerability to changes in habitat and prey availability and no LSE is therefore predicted.

Operation

Collision risk

6.2.155 Fulmar is considered to of particular low risk to collision; with for example Wade *et al.* (2016) detailing that 0% of fulmar would be expected to fly between 20 and 150 m (representing a risk window for collision with turbine blades). Therefore, no LSE is predicted with respect to operational collision.

Displacement

6.2.156 Wade *et al.* (2016) assessed fulmar as being at low risk of displacement from wind farms. Fulmar have an extensive foraging range as defined by the mean-maximum foraging range of 400 km from their breeding colonies (Thaxter *et al.,* 2012). They are a highly pelagic seabird and foraging trips can last up to 30 hours (Furness and Todd, 1984). Operational displacement to fulmar is therefore considered likely to be minimal and no LSE is predicted.

Barrier effects

6.2.157 Fulmar is considered to be of low risk of barrier effects (Maclean *et al.,* 2009) and considering the pelagic nature of the species and its large foraging range no LSE is predicted.

Kittiwake

Construction

Disturbance

6.2.158 Kittiwake are considered to be of low vulnerability to displacement effects. Construction period records from the Lincs Offshore Wind Farm showed that birds (198 observations) including large gulls, kittiwake and terns used turbine bases and monopiles to rest on. On several occasions gulls were clearly associated with the jack-up barge, the guard vessels and with the Resolution construction vessel while piling was in progress (RPS, 2012). Similarly, Vanermen *et al.* (2013) in their study of Belgian offshore wind farms, noted that initially birds (mainly gulls) were attracted to physical structures as roost locations and did not show any signs of displacement. Construction disturbance to kittiwake is therefore considered likely to be minimal and no LSE is predicted.

Changes to prey availability

6.2.159 The vulnerability of bird species to the habitat loss of their prey depends on their foraging flexibility, in particular their specific habitat and dietary requirements. Wade *et al.* (2016) consider that kittiwake is of low sensitivity as birds forage across the continental shelf within the 200 m depth contour, and are extremely pelagic, particularly in winter months. This has been shown in recent studies by Fredericksen *et al.* (2012) for example, where birds range widely across the North Sea and Atlantic. Langston (2010) also rated the species as being of low vulnerability to habitat and prey interactions. No LSE is therefore predicted.

Operation

Collision risk

6.2.160 Kittiwake was rated as being relatively high vulnerability to collision impacts by Wade *et al.* (2016), due to the proportion of flights likely to occur at potential risk height and percentage of time in flight, including at night. From previous studies in Flanders that have recorded mortality rates and collision rates, estimated micro-avoidance rates were, however, high for smaller gulls (Everaert, 2006; 2008; 2011; Everaert *et al.*, 2002; Everaert and Kuijken, 2007).

6.2.161 Figure 5.11 shows limited connectivity between the FFC pSPA colony and Hornsea Three, however given the high vulnerability of kittiwake to collision impacts, there is potential for a LSE on the kittiwake feature of the FFC pSPA as a result of collision impacts from Hornsea Three.

Displacement

6.2.162 Kittiwake are considered to be of low vulnerability to displacement effects. Based on evidence presented in literature (Wade *et al.*, 2016), it is considered that the species has a low vulnerability to disturbance/ displacement impacts and there is no potential for a LSE.

Barrier effects

6.2.163 Kittiwake is considered to be of low risk of barrier effects (Maclean *et al.,* 2009, which assume all gull species are of such sensitivity). As kittiwakes forage across the continental shelf within the 200 m depth contour, and are extremely pelagic, particularly in winter months (Fredericksen *et al.* 2012) no LSE is predicted.

Gannet

Construction

Disturbance

6.2.164 Gannet is likely to be largely unaffected by construction disturbance, being wide-ranging and seemingly tolerant of human activities at sea, with recent evidence showing that discards from fishing vessels form an important source of food for the species (Votier *et al.,* 2013). Wade *et al.* (2016) correspondingly consider gannet as being of low vulnerability to disturbance from vessels with considerable flexibility in habitat use.

6.2.165 No LSE predicted for gannet as a result of disturbance from construction activity.

Changes to prey availability

6.2.166 Gannets feed mainly on fish including herring, capelin, cod, whiting, haddock sandeel, and may also take discards (Votier *et al*., 2013). They are oceanic, pelagic foragers but mainly occur inshore over the continental shelf. Wade *et al.* (2016) considers the species as having very high habitat flexibility. This conclusion was reinforced by Langston (2010) rating the species as having low vulnerability to habitat/prey interactions, likely as a result of the wide foraging range and relative flexibility in prey / habitat choice.

6.2.167 No LSE is therefore predicted for gannet as a result of changes to prey availability during the Hornsea Three construction phase.

Operation

Collision risk

6.2.168 Gannet was ranked high in terms of vulnerability to collisions by Wade *et al.* (2016) although moderate vulnerability by Langston (2010).

6.2.169 Figure 5.9 shows the foraging range for gannet and limited connectivity from the FFC pSPA colony with the Hornsea Three array area. Given the vulnerability of gannet to collision impacts and the overlap of foraging range with the array area a potential for a LSE on this species is identified.

Displacement

6.2.170 Despite the wide foraging range of the species, Krijgsveld *et al.* (2010; 2011) have shown that gannets in flight strongly avoid wind farms, albeit relatively close to turbines (within 500 m).

6.2.171 JNCC and Natural England guidance suggests using a range of displacement values for this species from 0 to 100% when assessing displacement effects (JNCC and Natural England, 2012). Gannet is considered by Wade *et al*., (2016) to be highly sensitive to displacement and although there is considered to be limited connectivity with gannets from the pSPA with Hornsea Three, a LSE cannot be discounted.

Barrier effects

6.2.172 Gannet is considered to be of very low risk of barrier effects (Maclean *et al.,* 2009). As gannets are particularly pelagic and forage across the continental shelf no LSE is predicted.

Puffin

Construction

Disturbance

6.2.173 Puffin is deemed to be of medium vulnerability to displacement (Wade *et al.,* 2016), although it may be particularly sensitive during the post-breeding period during moult and when attending young.

6.2.174 The extent of any disturbance due to construction activities is likely to occur up to 2 km from the disturbance source, and potentially only involving the Hornsea Three array site. Cable installation may disturb birds although this is generally considered to be of lower magnitude than foundation installation for example.

6.2.175 It is considered that there is potential for a LSE on puffin as a result of construction disturbance.

Changes to prey availability

6.2.176 Auks feed mainly on sandeels, sprat and herring, and typically forage offshore with inshore and pelagic feeding less common. As such, they are less flexible in their prey requirements than gulls for example, and so guillemot, razorbill and puffin were all classified as being of moderate habitat flexibility by Wade *et al.* (2016) and medium vulnerability to habitat/prey interactions by Langston (2010).

6.2.177 Auks are visual predators that commonly dive down to depths of around 10 m and sometimes up to 60 m (BWPi). They are wing-propelled divers which often dip their heads repeatedly into the water before diving and may be more susceptible than other species to substrate and prey movements caused by pile-driving activities. Species also often feed swimming in lines, occasionally encircling and herding a shoal and catching fish at the periphery (BWPi).

6.2.178 Although increases in water turbidity may theoretically impact on the species' ability to capture prey, any additional localised substrate movements will be of a minimal magnitude in relation to the mean maximum foraging range and therefore no LSE on puffin as a result of changes to prey availability is predicted.

Operation

Collision risk

6.2.179 Not all species' populations are likely to be affected to any significant extent by additional mortality from collisions, either due to low numbers of flights recorded within Hornsea Three, or by behaviour that indicates that the species is not susceptible to collisions, in particular their predominant low flight height.

Displacement

6.2.180 As previously stated puffin is deemed to be of medium vulnerability to displacement (Wade *et al.,* 2016), although it may be particularly sensitive during the post-breeding period during moult and when attending young.

6.2.181 Figure 5.14 shows the mean-maximum foraging range of puffin from the FFC pSPA, there is limited potential for puffin from the pSPA to interact with the Hornsea Three array area and given their sensitivity to displacement effects there is potential for a LSE on this species.

Barrier effects

6.2.182 All auk species (therefore including puffin) are considered to be of highly sensitive to barrier effects (Maclean *et al.,* 2009). However, as shown in Figure 5.14, the mean-maximum foraging range of puffin from the FFC pSPA, there is limited potential for puffin from the pSPA to interact with the Hornsea Three array area and no barriers to movement are anticipated. There is therefore considered to be no potential for a LSE as a result of barrier effects.

Guillemot

Construction

Disturbance

6.2.183 Guillemot is deemed to be of medium vulnerability to displacement (Furness *et al.*, 2013), although it may be particularly sensitive during the post-breeding period during moult and when attending young.

6.2.184 It is considered that the extent of any disturbance due to construction activities is likely to occur within up to 2 km from the disturbance source and potentially only involving Hornsea Three during the non-breeding season. Cable installation may also disturb birds although this is generally considered to be of lower magnitude than foundation installation for example.

6.2.185 There is potential for a LSE on guillemot in the non-breeding season only as a result of construction disturbance and therefore further assessment is required.

Changes to prey availability

6.2.186 Auks feed mainly on sandeels, sprat and herring, and typically forage offshore with inshore and pelagic feeding less common. As such, they are less flexible in their prey requirements than gulls for example, and so guillemot, razorbill and puffin were all classified as being of moderate habitat flexibility by Furness *et al.* (2013) and medium vulnerability to habitat/prey interactions by Langston (2010).

6.2.187 Although increases in water turbidity may theoretically impact on the species' ability to capture prey, any additional localised substrate movements will be of a minimal magnitude in relation to the mean maximum foraging range and therefore no LSE on guillemot as a result of changes to prey availability is predicted.

Operation

Collision risk

6.2.188 Not all species' populations are likely to be affected to any significant extent by additional mortality from collisions, either due to low numbers of flights recorded within Hornsea Three, or by behaviour that indicates that the species is not susceptible to collisions, in particular their predominant flight height. Guillemot is not vulnerable to collision (Wade *et al.,* 2016) and no LSE is predicted.

Displacement

6.2.189 As previously stated guillemot is deemed to be of medium vulnerability to displacement (Furness et al., 2013), although it may be particularly sensitive during the post-breeding period during moult and when attending young.

6.2.190 Figure 5.12 shows the mean-maximum and maximum foraging range of from the FFC pSPA, there is no potential for guillemot from the pSPA to interact with the Hornsea Three array area during the breeding season. No LSE is therefore predicted for the breeding season. However, the species disperses widely post-breeding and given their sensitivity to displacement effects there is considered to be some potential for Hornsea Three to cause a LSE on this species during this period.

Barrier effects

6.2.191 All auk species (therefore including guillemot) are considered to be of highly sensitive to barrier effects (Maclean *et al.,* 2009). However, as shown in Figure 5.12 the mean-maximum foraging range of guillemot from the FFC pSPA, there is no potential for guillemot from the pSPA to interact with the Hornsea Three array area and no barriers to movement are anticipated. There is therefore considered to be no potential for a LSE as a result of barrier effects.

Razorbill

Construction

Disturbance

6.2.192 Razorbill is deemed to be of medium vulnerability to displacement (Furness *et al*., 2013), although it may be particularly sensitive during the post-breeding period during moult and when attending young.

6.2.193 It is considered that the extent of any disturbance due to construction activities is unlikely to occur within up to 2 km from the disturbance source and potentially only involving Hornsea Three during the non-breeding season. Cable installation may also disturb birds although this is generally considered to be of lower magnitude than foundation installation for example.

6.2.194 There is potential for a LSE on razorbill as a result of construction disturbance in the non-breeding season only and therefore further assessment is required.

Changes to prey availability

6.2.195 Auks feed mainly on sandeels, sprat and herring, and typically forage offshore with inshore and pelagic feeding less common. As such, they are less flexible in their prey requirements than gulls for example, and so guillemot, razorbill and puffin were all classified as being of moderate habitat flexibility by Furness *et al.* (2013) and medium vulnerability to habitat/prey interactions by Langston (2010).

6.2.196 Although increases in water turbidity may theoretically impact on the species' ability to capture prey, any additional localised substrate movements will be of a minimal magnitude in relation to the mean maximum foraging range and therefore no LSE on razorbill as a result of changes to prey availability is predicted.

Operation

Collision risk

6.2.197 Not all species' populations are likely to be affected to any significant extent by additional mortality from collisions, either due to low numbers of flights recorded within Hornsea Three, or by behaviour that indicates that the species is not susceptible to collisions, in particular their predominant low flight height. Razorbill is not vulnerable to collision (Wade *et al.*, 2016) and no LSE is predicted.

Displacement

6.2.198 As previously stated razorbill is deemed to be of medium vulnerability to displacement (Wade *et al*., 2016), although it may be particularly sensitive during the post-breeding period during moult and when attending young.

6.2.199 Figure 5.13 shows the mean-maximum and maximum foraging range of from the FFC pSPA, there is no potential for razorbill from the pSPA to interact with the Hornsea Three array area during the breeding season. No LSE is therefore predicted for the breeding season. However, the species disperses widely post-breeding and given their sensitivity to displacement effects there is considered to be some potential for Hornsea Three to cause a LSE on this species during this period.

Barrier effects

6.2.200 All auk species (therefore including razorbill) are considered to be of highly sensitive to barrier effects (Maclean *et al.,* 2009). However, as shown in Figure 5.13 the mean-maximum foraging range of razorbill from the FFC pSPA, there is no potential for razorbill from the pSPA to interact with the Hornsea Three array area and no barriers to movement are anticipated. There is therefore considered to be no potential for a LSE as a result of barrier effects.

Herring gull

Construction

Disturbance

6.2.201 Herring gull is deemed to be of low vulnerability to displacement (Wade *et al*., 2016) and there is no potential for a LSE as a result of construction disturbance.

Changes to prey availability

6.2.202 Herring gulls are opportunistic foragers and classified as being of high habitat flexibility by Wade *et al*. (2016). Therefore there is no predicted LSE on herring gull as a result of changes to prey availability.

Operation

Collision risk

6.2.203 Herring gull is considered to be of high vulnerability to collision impacts due its prevailing flight height and flight agility (Wade *et al*., 2016). Figure 5.15 presents the mean-maximum and maximum foraging ranges and there is no prospect of interaction with Hornsea Three in the breeding season. Herring gull has not been found to occur in notable numbers in the Hornsea Zone in the non-breeding season although at this stage a potential for a LSE is not ruled out.

Displacement

6.2.204 As previously stated herring gull is deemed to be of low vulnerability to displacement (Wade *et al*., 2016) and there is no potential for a LSE on this species.

Barrier effects

6.2.205 Gull species (therefore herring gull) are considered to be of low sensitivity to barrier effects (Maclean *et al.,* 2009). Considering the limited scope for interaction between Hornsea Three and breeding herring gulls from the pSPA and the species low degree of vulnerability, there is therefore considered to be no potential for a LSE as a result of barrier effects.

Conclusion

6.2.206 A summary of the LSEs arising from Hornsea Three on the FFC pSPA are presented in Table 6.24.

Table 6.24 LSE conclusion for the FFC pSPA

Feature	Project phase	Effect	Conclusion
Fulmar	Construction	Disturbance	No LSE
		Changes to prey availability	No LSE
	Operation	Collision risk	No LSE
		Displacement	No LSE
		Barrier effects	No LSE
Kittiwake	Construction/decommissioning	Disturbance	No LSE
		Changes to prey availability	No LSE
	Operation	Collision risk	Potential for LSE
		Displacement	No LSE
		Barrier effects	No LSE
Gannet	Construction/decommissioning	Disturbance	No LSE
		Changes to prey availability	No LSE
	Operation	Collision risk	Potential for LSE
		Displacement	Potential for LSE
		Barrier effects	No LSE
Puffin	Construction/decommissioning	Disturbance	Potential for LSE
		Changes to prey availability	No LSE

Feature	Project phase	Effect	Conclusion
	Operation	Collision risk	No LSE
		Displacement	Potential for LSE
		Barrier effects	No LSE
Guillemot	Construction/decommissioning	Disturbance	Potential for LSE[13]
		Changes to prey availability	No LSE
	Operation	Collision risk	No LSE predicted
		Displacement	Potential for LSE[13]
		Barrier effects	No LSE
Razorbill	Construction/decommissioning	Disturbance	Potential for LSE[13]
		Changes to prey availability	No LSE
	Operation	Collision risk	No LSE
		Displacement	Potential for LSE[13]
		Barrier effects	No LSE
Herring gull	Construction/decommissioning	Disturbance	No LSE
		Changes to prey availability	No LSE
	Operation	Collision risk	Potential for LSE[13]
		Displacement	No LSE
		Barrier effects	No LSE

Forth Islands SPA

6.2.207 The Forth Islands are located on the east coast of Scotland in and around the Firth of Forth. The SPA consists of a number of individual islands including Inchmickery, Fidra, Lamb, Craigleith, Bass Rock, the Isle of May and a several additional smaller islands. Those islands located in the inner Firth of Forth are very low lying with those in the outer Forth steeper and rockier. The islands provide suitable nesting habitat for several seabird species and the SPA is designated for breeding populations of gannet (21,600 pairs), shag (2,400 pairs), lesser black-backed gull (1,500 pairs), Sandwich tern (440 pairs), Roseate tern (8 pairs), common tern (334 pairs), Arctic tern (540 pairs) and puffin (14,000 pairs). The site regularly supports 90,000 seabirds during the breeding season, including breeding populations of fulmar (798 pairs), cormorant (200 pairs), herring gull (6,600 pairs), kittiwake (8,400 pairs), guillemot (16,000 pairs) and razorbill (1,400 pairs).

6.2.208 Section 5 of this screening assessment identified that there was an indication of potential connectivity between the Forth Islands SPA and Hornsea Three for a single feature, fulmar.

[13] Non-breeding season only

Fulmar

Construction

Disturbance

6.2.209 Furness *et al.* (2013) assessed fulmar as being at low risk of disturbance / displacement from wind farms. Fulmar have an extensive foraging range as defined by the mean-maximum foraging range of 400 km from their breeding colonies (Thaxter *et al*., 2012). They are a highly pelagic seabird and foraging trips can last up to 30 hours (Furness and Todd, 1984). Construction disturbance of fulmar is therefore considered likely to be minimal and no LSE is predicted.

Changes to prey availability

6.2.210 Fulmars feed on a wide diversity of food including planktonic crustacean, cephalopods and small fish (Cramp and Perrins, 1977). Furness *et al.* (2013) consider that fulmar is of low vulnerability to changes in habitat and prey availability and no LSE is therefore predicted.

6.2.211 Fulmar is also considered to be at low risk of habitat loss (Furness *et al*., 2013) and low risk of barrier effects (Maclean *et al.,* 2009).

Operation

Collision risk

6.2.212 Fulmar is considered to be of particular low risk to collision, with for example Wade *et al*. (2016) detailing that 0% of fulmar would be expected to fly between 20 and 150 m (representing a risk window for collision with turbine blades). Therefore, no LSE is predicted with respect to operational collision.

Displacement

6.2.213 Furness *et al.* (2013) assessed fulmar as being at low risk of displacement from wind farms. Fulmar have an extensive foraging range as defined by the mean-maximum foraging range of 400 km from their breeding colonies (Thaxter *et al.,* 2012). They are a highly pelagic seabird and foraging trips can last up to 30 hours (Furness and Todd, 1984). Operational displacement of fulmar is therefore considered likely to be minimal and no LSE is predicted.

Barrier effects

6.2.214 Fulmar is considered to be of low risk of barrier effects (Maclean *et al.,* 2009) and considering the pelagic nature of the species and its large foraging range no LSE is predicted.

ONSHORE

Introduction

6.2.215 The sections below provide an assessment of LSE for the European sites and features identified within Section 5 in respect of the onshore ECR corridor search area.

6.2.216 This is presented separately for individual European site for relevant Annex I habitats, Annex II species and ornithological features.

Norfolk Valley Fens SAC

Introduction

6.2.217 The Norfolk Valley Fens SAC comprises a series of valley-head spring-fed fens. Such spring-fed flush fens are very rare in the lowlands. The spring-heads are dominated by the small sedge fen type, mainly referable to black-bog-rush – blunt-flowered rush (*Schoenus nigricans – Juncus subnodulosus*) mire, but there are transitions to reedswamp and other fen and wet grassland types. The individual fens vary in their structure according to intensity of management and provide a wide range of variation. There is a rich flora associated with these fens, including species such as grass-of-Parnassus *Parnassia palustris*, common butterwort *Pinguicula vulgaris*, marsh helleborine *Epipactis palustris* and narrow-leaved marsh-orchid *Dactylorhiza traunsteineri*.

6.2.218 In places the calcareous fens grade into acidic flush communities on the valley sides. Purple moor-grass *Molinia caerulea* is often dominant with a variety of mosses including thick carpets of bog-moss Sphagnum spp. Marshy grassland may be present on drier ground and purple moor-grass is again usually dominant but cross-leaved heath *Erica tetralix* can be frequent. Alder *Alnus glutinosa* forms carr woodland in places by streams. Wet and dry heaths and acid, neutral and calcareous grassland surround the mires.

6.2.219 Within the Norfolk Valley Fens there are a number of marginal fens associated with pingos – pools that formed in hollows left when large blocks of ice melted at the end of the last Ice Age. These are very ancient wetlands and several support strong populations of Desmoulin's whorl snail *Vertigo moulinsiana* as part of a rich assemblage of rare and scarce species in standing water habitat. At Flordon Common, a strong population of narrow-mouthed whorl snail *Vertigo angustior* occurs in flushed grassland with yellow iris *Iris pseudacorus*.

6.2.220 As noted in Section 5.3, the onshore ECR corridor search area overlaps with some compenents of the Norfolk Valley Fens SAC site and therefore all its Annex I habitat and Annex II species qualifying features have been taken forward for assessment of LSE. These are listed in Table 6.25.

Table 6.25 Annex I habitats and Annex II species qualifying features of the Norfolk Valley Fens SAC considered for assessment of LSE

Type	Feature
Annex I habitats	• Alkaline fens (Calcium-rich springwater-fed fens) • Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae, Salicion albae*). (Alder woodland on floodplains)* • Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae*. (Calcium-rich fen dominated by great fen sedge (saw sedge))* • European dry heaths • Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*). (Purple moor-grass meadows) • Northern Atlantic wet heaths with *Erica tetralix* (Wet heathland with cross-leaved heath) • Semi-natural dry grasslands and scrubland facies: on calcareous substrates (*Festuco-Brometalia*) (Dry grasslands and scrublands on chalk or limestone)
Annex II species	• Narrow-mouthed whorl snail *Vertigo angustior* • Desmoulin's whorl snail *Vertigo moulinsiana*

Annex I priority habitats are denoted by an asterisk (*)

Annex I habitats

Construction

Permanent habitat loss

6.2.221 The construction of the onshore substation (and onshore HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint.

6.2.222 As shown in Figure 5.16, the onshore ECR corridor search area overlaps with the Norfolk Valley Fens SAC. Where the location of the substation(s) and associated infrastructure coincides with the distribution of Annex I habitat qualifying features of the site this would result in a permanent loss of Annex I habitat.

6.2.223 Given that the onshore ECR corridor search area overlaps with the Norfolk Valley Fens SAC and that that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for a loss of Annex I habitat in this SAC to occur associated with the placement of onshore infrastructure. It is therefore considered that a LSE on Annex I habitats of the Norfolk Valley Fens SAC as a result of loss of habitat cannot be discounted at this stage.

6.2.224 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary habitat disturbance/damage

6.2.225 Construction works associated with the onshore elements of Hornsea Three will result in temporary habitat disturbance. The level of potential disturbance/damage to Annex I habitat will depend on the overall extent of the habitat under consideration and the degree of overlap with construction activities.

6.2.226 Given that the onshore ECR corridor search area overlaps with the Norfolk Valley Fens SAC and that that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex I habitats of this SAC to occur. It is therefore considered that a LSE on Annex I habitats of the Norfolk Valley Fens SAC in this respect cannot be discounted at this stage.

6.2.227 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.228 During construction there may be potential for the accidental release of pollutants to occur (e.g. in proximity to fens, mires, or water courses during construction). This could in turn result in detrimental impacts on the wider habitats, including Annex I habitat features of Norfolk Valley Fens SAC. It is anticipated, however, that through the implementation of appropriate construction techniques, adherence to good environmental practice and, where required, the implementation of control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.229 Taking account of the above it is not considered that accidental release of contaminants during construction will result in a LSE on Annex I habitats of the Norfolk Valley Fens SAC.

Operation

Temporary habitat disturbance/damage

6.2.230 Maintenance works associated with the onshore elements of Hornsea Three could result in disturbance/damage to Annex I habitats of the North Norfolk Valley Fens SAC.

6.2.231 Given that the onshore ECR corridor search area overlaps with this SAC and that the exact location of the onshore components is yet to be defined, the assumption has been made that there may be potential for a disturbance/damage to Annex I habitat in this SAC to occur. It is therefore considered that a LSE on Annex I habitats of the Norfolk Valley Fens SAC as a result of habitat disturbance/damage cannot be discounted at this stage.

6.2.232 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.233 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitats, including Annex I habitat features of the Norfolk Valley Fens SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.234 Taking account of the above it is not considered that accidental release of contaminants will result in a LSE on Annex I habitats of the Norfolk Valley Fens SAC.

Annex II species

Construction

Permanent habitat loss

6.2.235 The construction of the onshore substation (and onshore HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect qualifying Annex II species of the Norfolk Valley Fens SAC (i.e. through direct loss of habitat, loss of feeding opportunities).

6.2.236 As shown in Figure 5.16, the onshore ECR corridor search area overlaps with this SAC. The level of potential habitat loss and implications for qualifying species would be dependent on the overall extent of the habitat under consideration, the degree of overlap with project infrastructure and the species specific level of dependence on that habitat.

6.2.237 Taking the above into account and given that that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for a significant impact on Annex II species of this SAC to occur associated with loss of habitat. It is therefore considered that a LSE on Annex II species of the Norfolk Valley Fens SAC in this respect cannot be discounted at this stage.

6.2.238 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary disturbance/damage to species

6.2.239 Construction works associated with the onshore elements of Hornsea Three may result in temporary disturbance/damage to Annex II qualifying species of the Norfolk Valley Fens SAC.

6.2.240 Given that the onshore ECR corridor search area overlaps with this SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for a significant impact on Annex II species of the this SAC to occur associated with disturbance/damage. It is therefore considered that a LSE on Annex II species of the Norfolk Valley Fens SAC in this respect cannot be discounted at this stage.

6.2.241 The above assessment will be revised once further information on the location of the ECR and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.242 During construction, there may be potential for the accidental release of pollutants to occur. This could in turn result in detrimental impacts on the wider habitat, and indirectly affect Annex II qualifying species of the Norfolk Valley Fens SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, the implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.243 Taking account of the above it is not considered that accidental release of contaminants will result in a LSE on Annex II species of the Norfolk Valley Fens SAC.

Operation

Temporary disturbance/damage to species

6.2.244 Operation and maintenance works associated with the onshore elements of Hornsea Three may result in temporary disturbance/damage of Annex II qualifying species of the Norfolk Valley Fens SAC. In addition, both maintenance and the operation of the onshore substation (and HVAC booster station, if required) may result in temporary disturbance to Annex II species.

6.2.245 Given that the onshore ECR corridor search area overlaps with this SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for a significant impact on Annex II species of this SAC to occur associated with disturbance/damage. It is therefore considered that a LSE on Annex II species of the Norfolk Valley Fens SAC in this respect cannot be discounted at this stage.

6.2.246 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.247 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitat, and indirectly affect Annex II qualifying species of the Norfolk Valley SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, implementation of control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.248 Taking account of the above it is not considered that accidental release of contaminants will result in a LSE on Annex II species of the Norfolk Valley Fens SAC.

Conclusion

6.2.249 A summary of the LSEs arising from Hornsea Three on the qualifying features of the Norfolk Valley Fens SAC are presented in Table 6.26.

Table 6.25 LSE conclusions for the Norfolk Valley Fens SAC

Feature		Project Phase	Effect	Conclusion
Annex I habitats	All qualifying features	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
Annex II species	All qualifying features	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary disturbance/damage	Potential for LSE
			Release of contaminants	No LSE

River Wensum SAC

Introduction

6.2.250 The Wensum is a naturally enriched, calcareous lowland river. The upper reaches are fed by springs that rise from the chalk and by run-off from calcareous soils rich in plant nutrients. This gives rise to beds of submerged and emergent vegetation characteristic of a chalk stream. Lower down, the chalk is overlain with boulder clay and river gravels, resulting in aquatic plant communities more typical of a slow-flowing river on mixed substrate. Much of the adjacent land is managed for hay crops and by grazing, and the resulting mosaic of meadow and marsh habitats, provides niches for a wide variety of specialised plants and animals.

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

6.2.252 As noted in Section 5.3, onshore ECR corridor search area overlaps with the River Wensum SAC site and therefore all the Annex I habitat and Annex II species qualifying features have been taken forward for assessment of LSE (Table 5.12,Table 5.13, Figure 5.16 and Figure 5.17). These are listed in Table 6.27.

Table 6.26 Annex I habitats and Annex II species qualifying features of the River Wensum SAC considered for assessment of LSE

Features	Feature
Annex I habitats	• Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation; Rivers with floating vegetation often dominated by water-crowfoot
Annex II species	• Desmoulin`s whorl snail *Vertigo moulinsiana* • White-clawed (or Atlantic stream) crayfish *Austropotamobius pallipes* • Brook lamprey *Lampetra planeri* • Bullhead *Cottus gobio*

Annex I habitats

Construction

Permanent habitat loss

6.2.253 As shown in Figure 5.16, the onshore ECR corridor search area overlaps with a section of the River Wensum SAC. Where the location of the substations and associated infrastructure coincides with the distribution of Annex I habitat qualifying features of the site this would result in permanent habitat loss. The level of potential loss of Annex I habitat would be dependent on the overall extent of the habitat under consideration and the degree of overlap with onshore infrastructure.

6.2.254 In light of the above and give that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for a loss of Annex I habitat to occur associated with the placement of onshore project infrastructure. It is therefore considered that a LSE on Annex I habitats of the River Wensum SAC as a result of loss of habitat loss cannot be discounted at this stage.

6.2.255 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary habitat disturbance/damage

6.2.256 Construction works associated with the onshore elements of Hornsea Three will result in temporary habitat disturbance. The level of potential disturbance/damage to Annex I habitat would be dependent on the overall extent of the habitat under consideration and the degree of overlap with construction activities.

6.2.257 Given that the onshore ECR corridor search area overlaps with the River Wensum SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for Annex I habitat to be disturbed/damaged. It is therefore considered that a LSE on Annex I habitats of the River Wensum SAC in this respect cannot be discounted at this stage.

6.2.258 The above assessment will be revised once further information on the location of the ECR and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.259 During construction there may be potential for the accidental release of pollutants to occur (e.g. in the proximity of water courses during construction of watercourse crossings).This could in turn result in detrimental impacts on the wider habitats, including Annex I habitat features of the River Wensum SAC. It is anticipated, however, that through the implementation of appropriate construction techniques, adherence to good environmental practice and where required control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.260 Taking account of the above it is not considered that accidental release of contaminants during construction will result in a LSE on Annex I habitats of the River Wensum SAC.

Operation

Temporary habitat disturbance/damage

6.2.261 Operation and maintenance works associated with the onshore elements of Hornsea Three may result in habitat disturbance. Subject to the final location of the onshore ECR corridor and associated infrastructure there may be potential for Annex I habitat qualifying features of the River Wensum SAC be subject to such disturbance/damage.

6.2.262 Given that the onshore ECR corridor search area overlaps with the River Wensum SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for a disturbance/damage to Annex I habitats to occur. It is therefore considered that a LSE on Annex I habitats of the River Wensum SAC in this respect cannot be discounted at this stage.

6.2.263 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.264 There may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitats, including Annex I habitat features of the River Wensum SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required the implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.265 Taking account of the above, it is not considered that accidental release of contaminants will result in a LSE on Annex I habitats of the River Wensum SAC.

Annex II species

Construction

Permanent habitat loss

6.2.266 The construction of the onshore substation (and HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect qualifying Annex II species of the River Wensum SAC (i.e. through direct loss of habitat, loss of feeding opportunities).

6.2.267 Given that the onshore ECR corridor search area overlaps with the River Wensum SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there is potential for the introduction of onshore infrastructure associated with Hornsea Three to result in a loss of habitat to Annex II species.

6.2.268 It is therefore considered that a LSE on Annex II species of the River Wensum SAC in this respect cannot be discounted at this stage.

6.2.269 The above assessment will be revised once further information on the location of the ECR and associated infrastructure is available and incorporated into the HRA Report.

Temporary disturbance/damage to species

6.2.270 Construction works associated with the onshore elements of Hornsea Three may result in temporary disturbance/damage to Annex II species.

6.2.271 Given that the onshore ECR corridor search area overlaps with the River Wensum SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex II species to occur. As such, it is considered that a LSE on Annex II species of the River Wensum SAC in this respect cannot be discounted at this stage.

6.2.272 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated in the HRA Report.

Potential release of contaminants

6.2.273 During construction there may be potential for the accidental release of pollutants to occur (i.e. in the proximity of water courses during construction of crossings). This could in turn result in detrimental impacts on the wider habitats, including Annex II species of the River Wensum SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, the implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.274 Taking account of the above, it is not considered that accidental release of contaminants will result in a LSE on Annex II species of the River Wensum SAC.

Operation

Temporary disturbance/damage to species

6.2.275 Maintenance works associated with the onshore elements of Hornsea Three may result in disturbance/damage to Annex II species. Further, operation and maintenance of the onshore substation (and HVAC booster station if required) could also result in disturbance to Annex II species.

6.2.276 Given that the onshore ECR corridor search area overlaps with the River Wensum SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex II species to occur. As such, it is considered that a LSE on Annex II species of the River Wensum SAC in this respect cannot be discounted at this stage.

6.2.277 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.278 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could result in detrimental impacts on the wider habitat, including Annex II species of the River Wensum SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.279 Taking account of the above it is not considered that the accidental release of contaminants during operation will result in a LSE on Annex II species of the River Wensum SAC.

Conclusion

6.2.280 A summary of the LSEs arising from Hornsea Three on the River Wensum SAC is presented in Table 6.28.

Table 6.28 LSE conclusions for the River Wensum SAC.

Feature		Project Phase	Effect	Conclusion
Annex I habitats	All qualifying features	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
Annex II species	All qualifying features	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary disturbance/damage	Potential for LSE
			Release of contaminants	No LSE

North Norfolk Coast SAC

Introduction

6.2.281 The North Norfolk Coast SAC contains a large, active series of dunes on shingle barrier islands and spits and is little affected by development. The exceptional length and variety of the dune/beach interface is reflected in the high total area of embryonic dune. Sand couch *Elytrigia juncea* is the most prominent sand-binding grass. The site supports a large area of shifting dune vegetation, which is also varied but dominated by marram grass *Ammophila arenaria*. The fixed dunes are rich in lichens and drought-avoiding winter annuals such as common whitlowgrass *Erophila verna*, early forget-me-not *Myosotis ramosissima* and common cornsalad *Valerianella locusta*. The main communities represented are marram with red fescue *Festuca rubra* and sand sedge *Carex arenaria*, with lichens such as *Cetraria aculeata*. The dune slacks within this site are comparatively small and the Yorkshire-fog *Holcus lanatus* community predominates. They are calcareous and the communities occur in association with swamp communities.

6.2.282 Some of the slacks support the liverwort petalwort *Petalophyllum ralfsii*. In addition the site supports otter *Lutra lutra*.

6.2.283 As noted in Section 5.3, the North Norfolk Coast SAC site overlaps with the onshore ECR corridor search area and therefore all its Annex I habitat and Annex II species qualifying features have been taken forward for assessment of LSE (Table 5.12,Table 5.13, Figure 5.16 and Figure 5.17). These are listed in Table 6.29.

Table 6.29 Annex I habitats and Annex II species qualifying features of the North Norfolk Coast SAC considered for assessment of LSE

Type	Feature
Annex I habitats	• Coastal lagoons* • Fixed dunes with herbaceous vegetation (grey dunes). (Dune grassland)* • Embryonic shifting dunes • Humid dune slacks • Mediterranean and thermo-Atlantic halophilous scrubs (*Sarcocornetea fruticosi*). (Mediterranean saltmarsh scrub) • Perennial vegetation of stony banks. (Coastal shingle vegetation outside the reach of waves) • Shifting dunes along the shoreline with *Ammophila arenaria* (white dunes). (Shifting dunes with marram).
Annex II species	• Otter *Lutra lutra* • Petalwort *Petalophyllum ralfsii*

Annex I priority habitats are denoted by an asterisk (*)

Annex I Habitats

Construction

Permanent habitat loss

6.2.284 The construction of the onshore substation (and HVAC booster station if required) ill result in a permanent loss of habitat proportional to their footprint.

6.2.285 As shown in Figure 5.16, the onshore ECR corridor search area overlaps with a small portion of the eastern section of the North Norfolk Coast SAC. Where the location of the stations and associated infrastructure coincides with the distribution of Annex I habitat qualifying features of the site this would result in a permanent habitat loss. The level of potential loss of Annex I habitat would be dependent on the overall extent of the habitat under consideration and the degree of overlap with project infrastructure.

6.2.286 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for a loss of Annex I habitat to occur associated with the placement of onshore project infrastructure. It is therefore considered that a LSE on Annex I habitats of the North Norfolk Coast SAC cannot be discounted at this stage.

6.2.287 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary habitat disturbance/damage

6.2.288 Construction works associated with the onshore elements of Hornsea Three will result in temporary habitat disturbance. The level of potential disturbance/damage to Annex I habitat would be dependent on the overall extent of the habitat under consideration and the degree of overlap with construction activities.

6.2.289 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex I habitat to occur. It is therefore considered that a LSE on Annex I habitats of the North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.290 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.291 During construction there may be potential for the accidental release of pollutants to occur (e.g. in the proximity of water courses during construction of crossings). This could in turn result in detrimental impacts on the wider habitats, including Annex I habitat features of the North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate construction techniques, adherence to good environmental practice and, where required, the implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.292 Taking account of the above it is not considered that accidental release of contaminants will result in a LSE on Annex I habitats of the North Norfolk Coast SAC.

Operation

Temporary habitat disturbance/damage

6.2.293 Maintenance works associated with the onshore elements of Hornsea Three will result in temporary habitat disturbance/damage. Similarly, operation and maintenance of the onshore substation (and HVAC booster station, if required), could result in further disturbance to habitats.

6.2.294 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex I habitat to occur. It is therefore considered that a LSE on Annex I habitats of the North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.295 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.296 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitats, including Annex I habitat features of the North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.297 Taking account of the above it is not considered that accidental release of contaminants during operation will result in a LSE on Annex I habitats of the North Norfolk Coast SAC.

Annex II species

Construction

Permanent habitat loss

6.2.298 The construction of the onshore substation (and HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect qualifying Annex II species of the North Norfolk Coast SAC (i.e. through direct loss of habitat, loss of feeding opportunities).

6.2.299 As shown in Figure 5.17, the onshore ECR corridor search area overlaps with a small portion of the eastern section of the North Norfolk Coast SAC. The level of potential habitat loss and implications for qualifying species would be dependent on the overall extent of the habitat under consideration, the degree of overlap with project infrastructure and the species specific level of dependence on that habitat.

6.2.300 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for Annex II species be affected through loss of habitat. It is therefore considered that a LSE on Annex II species of the North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.301 The above assessment will be revised once further information on the location of the ECR and associated and associated infrastructure is available and incorporated into the HRA Report.

Temporary disturbance/damage to species

6.2.302 Construction works associated with the onshore elements of Hornsea Three may result in damage to petalwort. In addition, it may also result in temporary disturbance to otters. Otters may attempt to avoid any periodic disturbance which will act as a barrier to their usual activities and deter them from using laying up sites. Avoidance of areas in the proximity of construction works may potentially also result in female otters abandoning their cubs. Further, otters may be prompted to forage further away to avoid disturbed areas.

6.2.303 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for Annex II species to be disturbed/damaged. It is therefore considered that a LSE on Annex II species of the North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.304 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Habitat fragmentation

6.2.305 Construction activity in the onshore ECR corridor could result in the fragmentation of key habitats for Annex II qualifying species of the North Norfolk Coast SAC, particularly otter. The siting of construction compounds, storage facilities and access roads close to watercourses and features which otters use to travel through the landscape may result in potential impacts by obstructing otter movements within and between existing areas of habitat.

6.2.306 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for an impact on otter associated with habitat fragmentation to occur. It is therefore considered that a LSE on otter as a qualifying feature of the North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.307 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated in the HRA Report.

Potential release of contaminants

6.2.308 During construction there may be potential for the accidental release of pollutants to occur (e.g. in the proximity of water courses during construction of crossings).This could in turn result in detrimental impacts on the wider habitats, including for Annex II species of the North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate construction techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.309 Taking account of the above it is not considered that accidental release of contaminants during construction will result in a LSE on Annex II species of the North Norfolk Coast SAC.

Operation

Temporary disturbance/damage to species

6.2.310 Operation and maintenance works associated with the onshore elements of Hornsea Three may damage petalwort. In addition, both maintenance works and the operation of the onshore substation (and HVAC booster substation, if required) may result in temporary disturbance to otters. Otters may attempt to avoid any periodic disturbance which will act as a barrier to their usual activities and deter them from using lying up sites. In addition, avoidance of areas in the proximity of maintenance works may also potentially result in female otters abandoning their cubs. Further, otters may be prompted to forage further away to avoid disturbed areas.

6.2.311 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex II species to occur. It is therefore considered that a LSE on Annex II species of the North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.312 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated and associated infrastructure is available and incorporated in the HRA Report.

Potential release of contaminants

6.2.313 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitat, including Annex II species of the North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and where required control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.314 Taking account of the above it is not considered that the accidental release of contaminants during operation will result in a LSE on Annex II species of the North Norfolk Coast SAC.

Conclusion

6.2.315 A summary of the LSEs arising from Hornsea Three on the North Norfolk Coast SAC is presented in Table 6.30.

Table 6.27 LSE conclusions for the North Norfolk Coast SAC

Feature		Project Phase	Effect	Conclusion
Annex I habitats	All qualifying features	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
Annex II species	All qualifying features	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
	Otter		Habitat fragmentation	Potential for LSE
	All qualifying features		Release of contaminants	No LSE
	All qualifying features	Operation	Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE

The Wash and North Norfolk Coast SAC

Introduction

6.2.316 As shown in Figure 5.16 the onshore ECR corridor search area overlaps with a small area of the eastern section of The Wash and North Norfolk Coast SAC.

6.2.317 Please note that there is no potential impact pathway associated with the onshore component of Hornsea Three on intertidal, subtidal and marine mammal features of this site. LSEs of Hornsea Three on these features have been addressed under the offshore component of Section 6 within this report.

6.2.318 The assessment provided in the section is therefore focused on the features with potential to be subject to impacts from the onshore elements of Hornsea Three. These are:

- Coastal lagoons (Annex I habitat);and

- Otter (Annex II species).

Annex I Habitats – coastal lagoons

Construction

Permanent habitat loss

6.2.319 The construction of the onshore substation (and HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint.

6.2.320 As shown in Figure 5.16, the onshore ECR corridor search area overlaps with a small portion of the eastern section of The Wash and North Norfolk Coast SAC. The level of potential loss of Annex I habitat from this site (coastal lagoons) would be dependent on the degree, if any, of overlap with project infrastructure.

6.2.321 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that the exact location of the onshore components of Hornsea Three is yet to be defined, the assumption has been made that there may be potential for a loss of coastal lagoon habitat to occur associated with the placement of onshore project infrastructure. Taking a precautionary approach, it is therefore considered that a LSE on coastal lagoons as a qualifying feature of The Wash and North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.322 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary habitat disturbance/damage

6.2.323 Construction works associated with the onshore elements of Hornsea Three will result in temporary habitat disturbance. The level of the potential disturbance/damage to coastal lagoon habitat would be dependent on the degree of overlap with/proximity to construction activities.

6.2.324 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex I habitat to occur. It is therefore considered that a LSE on coastal lagoons as a qualifying feature of The Wash and North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.325 The above assessment will be revised once further information on the location of the ECR and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.326 During construction there may be potential for the accidental release of pollutants to occur (e.g. in the proximity of water courses during construction of crossings). This could in turn result in detrimental impacts on the wider habitats, including coastal lagoon habitat of The Wash and North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate construction techniques, adherence to good environmental practice and, where required, the implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.327 Taking account of the above it is not considered that the accidental release of contaminants will result in a LSE on coastal lagoons as a qualifying feature of The Wash and North Norfolk Coast SAC.

Operation

Temporary habitat disturbance/damage

6.2.328 Maintenance works associated with the onshore elements of Hornsea Three will result in temporary habitat disturbance/damage. Similarly, operation and maintenance of the onshore substation (and HVAC booster station, if required), could result in further disturbance to habitats.

6.2.329 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to Annex I habitat to occur. It is therefore considered that a LSE on coastal lagoons as a feature of The Wash and North Norfolk coast SAC in this respect, cannot be discounted at this stage.

6.2.330 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.331 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitats, including coastal lagoons of The Wash North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, implementation of control measures, risks associated with accidental release of contaminants will be negligible.

6.2.332 Taking account of the above it is not considered that accidental release of contaminants during operation will result in a LSE on coastal lagoons as a qualifying feature of The Wash and North Norfolk Coast SAC.

Annex II species - otter

Construction

Permanent habitat loss

6.2.333 The construction of the onshore substation (and HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect otter through direct loss of habitat, access routes or loss of feeding opportunities.

6.2.334 As shown in Figure 5.17, the onshore ECR corridor search area overlaps with a small portion of the eastern section of The Wash and North Norfolk Coast SAC. The level of potential habitat loss and implications for otter would be dependent on the degree of overlap of key habitat with project infrastructure.

6.2.335 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for otters to be affected through loss of habitat. It is therefore considered that a LSE on otter as a qualifying feature of The Wash and North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.336 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary disturbance

6.2.337 Construction works associated with the onshore elements of Hornsea Three may result in temporary disturbance to otters. Otters may attempt to avoid any periodic disturbance which will act as a barrier to their usual activities and deter them from using laying up sites. Avoidance of areas in the proximity of construction works may potentially also result in female otters abandoning their cubs. Further, otters may be prompted to forage further away to avoid disturbed areas.

6.2.338 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for otters to be disturbed/displaced. It is therefore considered that a LSE on otter as a qualifying feature of The Wash and North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.339 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Habitat fragmentation

6.2.340 Construction activity in the onshore ECR corridor search area could result in the fragmentation of key habitats for otter. Through the siting of construction compounds, storage facilities and access roads close to watercourses and features which otters use to travel through the landscape may result in potential impacts by obstructing otter movements within and between existing areas of habitat.

6.2.341 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for an impact on otters associated with habitat fragmentation to occur. It is therefore considered that a LSE on otter as a qualifying feature of The Wash and North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.342 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.343 During construction there may be potential for the accidental release of pollutants to occur (i.e. in the proximity of water courses during construction of crossings).This could in turn result in detrimental impacts on the wider habitats, including otters in The Wash and North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate construction techniques, adherence to good environmental practice and where required, control measures, risks associated with the accidental release of contaminants would be negligible.

6.2.344 Taking account of the above it is not considered that accidental release of contaminants during construction will result in a LSE on otter as a qualifying feature of The Wash North Norfolk Coast SAC.

Operation

Temporary disturbance/damage to species

6.2.345 Operation and maintenance works associated with the onshore elements of Hornsea Three as well as maintenance works and the operation of the onshore substation (and HVAC booster substation, if required) may result in temporary disturbance to otters. Otters may attempt to avoid any periodic disturbance which will act as a barrier to their usual activities and deter them from using laying up sites. In addition, avoidance of areas in the proximity of maintenance works may also potentially result in female otters abandoning their cubs. Further, otters may be prompted to forage further away to avoid disturbed areas.

6.2.346 Given that the onshore ECR corridor search area overlaps with The Wash and North Norfolk Coast SAC and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for disturbance/damage to otters occur. It is therefore considered that a LSE on otter as a qualifying feature of The Wash and North Norfolk Coast SAC in this respect cannot be discounted at this stage.

6.2.347 The above assessment will be revised once further information on the location of the ECR and associated and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.348 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitat, including Annex II species of The Wash and North Norfolk Coast SAC. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and where required control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.349 Taking account of the above it is not considered that the accidental release of contaminants during operation will result in a LSE on otter as a qualifying feature of The Wash and North Norfolk Coast SAC.

Conclusion

A summary of the LSEs arising from Hornsea Three on The Wash and North Norfolk Coast SAC is presented in Table 6.31.

Table 6.28 LSE conclusions for The Wash and North Norfolk Coast SAC

Feature		Project Phase	Effect	Conclusion
Annex I habitats	Coastal lagoons	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary disturbance/damage	Potential for LSE
			Release of contaminants	No LSE
Annex II species	Otter	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
			Temporary habitat disturbance/damage	Potential for LSE
			Habitat fragmentation	Potential for LSE
			Release of contaminants	No LSE
		Operation	Temporary habitat disturbance/damage	Potential for LSE
			Release of contaminants	No LSE

The Broads SAC

Introduction

6.2.350 The Broads SAC contains various examples of naturally nutrient-rich lakes, these and the ditches in areas of fen and drained marshlands support relict vegetation of the original Fenland flora, and collectively the site contains one of the richest assemblages of rare and local aquatic species in the UK. The range of wetlands and associated habitats provide suitable conditions for otter *Lutra lutra*.

6.2.351 As noted in Section 5.3, The Broads SAC does not overlap with the onshore ECR corridor search area with otter being the only qualifying feature considered for assessment of LSE, based on the application of a 5 km ZOI (CIEM 2016) for this species (see Table 5.13 and Figure 5.17). However, it is important to note that The Broads SAC is located at its closest point approx. 4.9 km from the onshore ECR corridor search area and therefore the degree of overlap of the site with the 5 km ZOI is minimal. The Broads SAC is designated for a range of fen, wetland, and woodland habitats. As this SAC lies beyond the ECR corridor search area these features are screened out of consideration in this report.

Annex II species (otter)

Construction/decommissioning

Permanent habitat loss

6.2.352 The construction of the onshore substation (and onshore HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect otter as a qualifying feature of The Broads SAC (i.e. through direct loss of habitat, loss of feeding opportunities).

6.2.353 Given the lack of overlap between the onshore ECR corridor search area and The Broads SAC there is considered no potential for the onshore infrastructure to result in a direct loss of habitat for otter within SAC.

6.2.354 It is therefore considered that there is no potential for a LSE on otter as a qualifying feature of The Broads SAC to occur in respect of permanent habitat loss.

Temporary disturbance

6.2.355 Construction works associated with the onshore elements of Hornsea Three may result in temporary disturbance to otters. Otters may attempt to avoid any periodic disturbance which will act as a barrier to their usual activities and deter them from using laying up sites. Avoidance of areas in the proximity of construction works may potentially also result in female otters abandoning their cubs. Further, otters may be prompted to forage further away to avoid disturbed areas. As the onshore ECR corridor search area is located 4.9 km away from The Broads SAC the 5 km ZoI around the onshore ECR corridor overlaps with only a very small proportion of this SAC, the potential disturbance to otter from construction works is considered to be negligible.

6.2.356 It is therefore considered that there is no potential for a LSE on otter as a qualifying feature of The Broads SAC in respect of temporary disturbance.

Habitat fragmentation

6.2.357 Construction activities in the onshore ECR corridor search area could result in the fragmentation of habitats used by otter as a qualifying feature of The Broads SAC. The siting of construction compounds, storage facilities and access roads close to watercourses and features which otters use to travel through the landscape may result in potential impacts by obstructing their movements within and between existing areas of habitat.

6.2.358 As the onshore ECR corridor search area is located 4.9 km away from The Broads SAC the 5 km ZOI around the onshore ECR corridor overlaps with only a very small proportion of this SAC, significant impacts on otter as a result of onshore construction works and potential habitat fragmentation are considered to be negligible.

6.2.359 It is therefore considered that there is no potential for a LSE on otter as a qualifying feature of The Broads SAC.

Potential release of contaminants

6.2.360 During construction, there will be the potential for the accidental release of pollutants to occur during works. This could in turn result in detrimental impacts on the wider habitat, indirectly affecting otters. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.361 Taking account of the above it is not considered that the accidental release of contaminants will result in a LSE on otter as a qualifying feature of The Broads SAC.

Operation

Temporary disturbance

6.2.362 Operation and maintenance works associated with the onshore elements of Hornsea Three may result in disturbance to otters. Otters may attempt to avoid any periodic disturbance which will act as a barrier to their usual activities and deter them from using laying up sites. Avoidance of areas in the proximity of maintenance works may also potentially result in female otters abandoning their cubs. Further, otters may be prompted to forage further away to avoid disturbed areas.

6.2.363 As the onshore ECR corridor search area is located 4.9 km away from the Broads SAC, the 5 km ZOI around the onshore ECR corridor search area overlaps with only a very small proportion of this SAC. Significant disturbance to otters associated with construction works are therefore considered to be negligible.

6.2.364 It is therefore considered that there is no potential for a LSE on otter to occur as a qualifying feature of The Broads SAC.

Potential release of contaminants

6.2.365 During operation, there may be potential for the accidental release of pollutants to occur during maintenance activities. This could in turn result in detrimental impacts on the wider habitat, and indirectly affect otters. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.366 Taking account of the above it is not considered that accidental release of contaminants during operation will result in a LSE on otter as a qualifying feature of The Broads SAC.

Conclusion

6.2.367 A summary of the LSEs arising from Hornsea Three on The Broads SAC is presented in Table 6.32.

Table 6.29 LSE conclusions for The Broads SAC

Annex II species	Project Phase	Effect	Conclusion
Otter	Construction/Decommissioning	Permanent habitat loss	No LSE
		Temporary habitat disturbance	No LSE
		Habitat fragmentation	No LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance	No LSE
		Release of contaminants	No LSE

Broadland SPA

Introduction

6.2.368 This SPA is of international importance for a variety of wintering and breeding raptors and waterbirds associated with extensive lowland marshes.

6.2.369 As noted in Section 5.3, the Broadland SPA does not overlap with the onshore ECR corridor search area. Based on the use of a 5 km ZOI in relation to ornithological features (see Table 5.14 and Figure 5.18) all the features of this site have been taken forward for determination of LSE within this section. These are listed in Table 6.33.

6.2.370 In the context of the assessment provided below, it is important to note that the Broadland SPA is located at approx. 4.9 km from the onshore ECR corridor search area and therefore the degree of overlap of the site with the 5 km ZOI is minimal.

Table 6.33. Ornithological features of the Broadland SPA considered for assessment of LSE

Ornithological features
Annex 1 Species (qualified under Article 4.1): During the breeding season: • Bittern *Botaurus stellaris* • Marsh harrier *Circus aeruginosus* Over winter: • Bewick's Swan *Cygnus columbianus bewickii* • Bittern *Botaurus stellaris** • Hen harrier *Circus cyaneus* • Ruff *Philomachus pugnax* • Whooper swan *Cygnus Cygnus* Migratory species (qualified under Article 4.2): Over winter: • Gadwall *Anas strepera* • Pink-footed goose *Anser brachyrhynchus* * • Shoveler *Anas clypeata* • Wigeon *Anas penelope* Assemblage of waterfowl (qualified under Article 4.2)*: • Over winter, the area regularly supports 22,603 individual waterfowl (RSPB, Count 99/00) including: cormorant *Phalacrocorax carbo*, Bewick's Swan, whooper swan, ruff, pink-footed goose *Anser brachyrhynchus*, gadwall, bittern, great crested grebe, coot, bean goose *Anser fabalis*, white-fronted goose *Anser albifrons albifrons*, wigeon, teal *Anas crecca*, pochard *Aythya ferina*, tufted duck *Aythya fuligula*, Shoveler

* *feature included in the SPA 2001 review but not in the site citation*

Ornithological features

Construction/decommissioning

Permanent habitat loss

6.2.371 The construction of the onshore substation (and HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect ornithological features of the Broadland SPA (i.e. through loss of roosting, foraging or breeding habitat).

6.2.372 Given the lack of overlap between the onshore ECR corridor search area and the Broadland SPA there is no potential for the introduction of onshore infrastructure to result in a direct loss of habitat to ornithological features within this site.

6.2.373 It is therefore considered that there is no potential for a LSE to occur on ornithological qualifying features of the Broadland SPA in respect of permanent habitat.

Temporary disturbance

6.2.374 Construction works associated with the onshore elements of Hornsea Three may result in temporary disturbance and displacement of ornithological features.

6.2.375 The level of potential disturbance/displacement will depend on the degree of overlap between the onshore components of the project and the key habitats for the ornithological features of the site.

6.2.376 As the onshore ECR corridor search area is located 4.9 km away from the Broadland SPA, the 5 km ZOI around the onshore ECR corridor search area overlaps with only a very small proportion of this SPA, significant disturbance to ornithological features associated with construction works will be negligible.

6.2.377 It is therefore considered that there is no potential for a LSE on ornithological features of the Broadland SPA in respect of temporary disturbance.

Potential release of contaminants

6.2.378 During construction there may be potential for the accidental release of pollutants to occur (e.g. in the proximity of water courses during construction of crossings). This could in turn result in detrimental impacts on the wider habitat, indirectly affecting ornithological features of the Broadland SPA. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.379 Taking account of the above it is not considered that the accidental release of contaminants will result in a LSE on ornithological features of the Broadland SPA.

Operation

Temporary disturbance

6.2.380 Operation and maintenance works associated with the onshore elements of Hornsea Three may result in temporary disturbance/displacement of ornithological features of the Broadland SPA. In addition, maintenance and operation of the onshore substation (and HVAC booster station, if required) may result in further disturbance to ornithological qualifying features of the SPA.

6.2.381 As the onshore ECR corridor search area is located 4.9 km away from the Broadland SPA, the 5 km ZOI around the onshore ECR corridor search area overlaps with only a very small proportion of this SPA, significant disturbance to ornithological features associated with operation/maintenance works will be negligible.

It is therefore considered that there is no potential for a LSE on ornithological features of the Broadland SPA in respect of temporary disturbance.

Potential release of contaminants

6.2.382 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitat and indirectly affect ornithology features of the Broadland SPA. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.383 Taking account of the above it is not considered that the accidental release of contaminants during operation will result in a LSE on ornithological features of the Broadland SPA.

Conclusion

6.2.384 A summary of the LSEs arising from Hornsea Three on the Broadland SPA is presented in Table 6.34.

Table 6.30 LSE conclusions for the Broadland SPA

Ornithological feature	Project phase	Effect	Conclusion
All ornithological features	Construction/Decommissioning	Permanent habitat loss	No LSE
		Temporary habitat disturbance	No LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance	No LSE
		Release of contaminants	No LSE

Broadland Ramsar Site

Introduction

6.2.385 The Broadland Ramsar Site is located in the same geographical area as the Broads SAC and the Broadland SPA. The site supports a number of rare species and habitats including various Annex I habitats and Annex II species as well as outstanding assemblages of rare plants. In addition, the site is of international importance to a range of wintering and breeding raptors and waterbirds.

6.2.386 As noted in Section 5.3, the Broadland Ramsar Site does not overlap with the onshore ECR corridor search area. Based on the established 5 km ZOI in relation to otter and ornithological features (see Table 5.13, Table 5.14,Figure 5.17 and Figure 5.18) otter and ornithological features of this site have been taken forward for determination of LSE within this section. These are listed in Table 6.35.

Table 6.35 Qualifying features of the Broadland Ramsar Site considered for assessment of LSE

European site	Feature
Annex II species	Ramsar criterion 2: • Otter *Lutra lutra*
Ornithological features	Ramsar criterion 6: Qualifying species/populations (as identified at designation). Species with peak counts in winter: • Bewick's swan, NW Europe • Wigeon, NW Europe • Gadwall, NW Europe Species populations identified subsequent to designation for possible future consideration under criterion 6. Species with peak counts in winter: • Pink-footed goose *Anser brachyrhynchus* • Greylag goose *Anser anser*

Annex II species and Ornithological Features

6.2.387 All the qualifying Annex II species features and ornithological features of the Broadland Ramsar Site are also qualifying features in The Broads SAC (in the case of Annex II species) and in the Broadland SPA (in the case of ornithological features). As such, the conclusions of the assessment carried out for The Broads SAC and Broadland SPA for relevant features (see Table 6.34 and Table 6.36) are also applicable to the Broadland Ramsar Site.

Conclusion

6.2.388 A summary of the LSEs arising from Hornsea Three on the Broadland Ramsar Site is presented in Table 6.36. This is based on the assessments carried out for The Broads SAC (in respect of Annex II species) and the Broadland SPA (in respect of ornithological features).

Table 6.31 LSE conclusions for the Broadland Ramsar Site

Feature	Project phase	Effect	Conclusion
Otter	Construction/Decommissioning	Permanent habitat loss	No LSE
		Temporary habitat disturbance	No LSE
		Habitat fragmentation	No LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance	No LSE
		Release of contaminants	No LSE
All ornithological features	Construction/Decommissioning	Permanent habitat loss	No LSE
		Temporary habitat disturbance	No LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance	No LSE
		Release of contaminants	No LSE

North Norfolk Coast SPA

Introduction

6.2.389 The site is located east of The Wash on the northern coastline of Norfolk, eastern England. As noted in Section 5.3 the onshore ECR corridor search area overlaps with a small area of the eastern section of the site (see Figure 5.18) and therefore all its ornithological features have been taken forward for initial consideration of LSE (Table 5.14).

6.2.390 It is noted that the North Norfolk Coast SPA colonies of qualifying breeding tern species and Mediterranean gull, are present at Scolt Head and Blakeney Point (Wilson *et al.,* 2014). These locations are over 5 km from the onshore ECR corridor search area for onshore works and as such there is no potential for any impact pathway between the onshore elements of Hornsea Three and the colony features. Impacts on offshore foraging areas of these species are considered under the offshore ornithology section of this document. These species are therefore not considered further in the assessment of LSE provided below for ornithological features of the North Norfolk Coast SPA in respect of onshore works.

6.2.391 Taking account of the above, ornithological features of the North Norfolk Coast SPA considered for assessment of LSE in respect of the onshore elements are described in Table 6.37.

Table 6.32 Ornithological features of the North Norfolk Coast SPA considered for assessment of LSE

Feature
Annex 1 species (qualified under Article 4.1): <u>During the breeding season:</u> • Avocet *Recurvirostra avosetta,* • Bittern *Botaurus stellaris* • Marsh harrier • Roseate Tern Sterna *dougallii** • Sandwich Tern <u>Over winter:</u> • Avocet *Recurvirostra avosetta** • Bar-tailed Godwit *Limosa lapponica** • Bittern *Botaurus stellaris** • Golden Plover *Pluvialis apricaria*,* • Hen Harrier *Circus cyaneus*,* • Ruff *Philomachus pugnax** Migratory species (qualified under Article 4.2): <u>During the breeding season:</u> • Redshank *Tringa tetanus** • Ringed Plover *Charadrius hiaticula** <u>On passage:</u> • Ringed Plover *Charadrius hiaticula *,* <u>Over-winter:</u> • Dark-bellied Brent *Goose Branta bernicla bernicla* • Knot *Calidris canutus* • Pink-footed Goose • Pintail *Anas acuta** • Redshank *Tringa totanus** • Wigeon *Anas penelope* Waterfowl assemblage (qualified under Article 4.2): Over winter, the area regularly supports 91,249 individual waterfowl (5 year peak mean 1991/2 - 1995/6) including: Shelduck *Tadorna tadorna*, Avocet Golden Plover , Ruff , Bar-tailed Godwit *Limosa lapponica*, Pink-footed Goose *Anser brachyrhynchus*, Dark-bellied Brent *Goose Branta bernicla bernicla*, Wigeon *Anas penelope*, Pintail *Anas acuta*, Knot *Calidris canutus,* Redshank *Tringa totanus*, Bittern *Botaurus stellaris*, White-fronted Goose *Anser albifrons albifrons*, Dunlin *Calidris alpina alpina,* Gadwall *Anas strepera*, Teal *Anas crecca*, Shoveler *Anas clypeata*, Common Scoter *Melanitta nigra*, Velvet Scoter *Melanitta fusca*, Oystercatcher *Haematopus ostralegus*, Ringed Plover *Charadrius hiaticula*, Grey Plover *Pluvialis squatarola*, Lapwing*Vanellus vanellus*, Sanderling *Calidris alba*, Cormorant *Phalacrocorax carbo.*

**feature includes in the SPA 2001 review but not in the site citation*

Ornithological features

Construction

Permanent habitat loss

6.2.392 The construction of the onshore substation (and HVAC booster station if required) will result in a permanent loss of habitat proportional to their footprint. This in turn could affect ornithological features of the North Norfolk Coast SPA (i.e. through loss of foraging/breeding habitat).

6.2.393 As shown in Figure 5.18, the onshore ECR corridor search area overlaps with a small area of the eastern section of the North Norfolk Coast SPA. The level of potential loss of foraging/breeding habitat and implications on ornithological features would be dependent on the overall extent of the habitat under consideration, the degree of overlap with project infrastructure and species specific sensitivities.

6.2.394 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SPA and that the exact location of the onshore components of the project is yet to be defined, the precautionary assumption is that there may be potential ornithological features affected through habitat loss. It is therefore considered that a LSE on the ornithological features of the North Norfolk Coast SPA in this respect cannot be discounted at this stage.

6.2.395 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Temporary disturbance

6.2.396 Construction works associated with the onshore elements of Hornsea Three may result in temporary disturbance and displacement of ornithological features. The level of disturbance/displacement would depend on the degree of overlap between the onshore components of Hornsea Three and the breeding and foraging habitat of ornithological features of the site.

6.2.397 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SPA and that that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential for the ornithological features of the site to be disturbed/displaced. It is therefore considered that a LSE on ornithological features of the North Norfolk Coast SPA in this respect cannot be discounted at this stage.

6.2.398 The above assessment will be revised once further information on the location of the onshore ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.399 During construction there may be potential for the accidental release of pollutants to occur (e.g. in the proximity of water courses during construction of crossings). This could in turn result in detrimental impacts on the wider habitat, indirectly affecting ornithological features of the North Norfolk Coast SPA. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and, where required, control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.400 Taking account of the above it is not considered that accidental release of contaminants during construction will result in a LSE on ornithological features of the North Norfolk Coast SPA.

Operation

Temporary disturbance

6.2.401 Operation and maintenance works associated with the onshore elements of Hornsea Three may result in temporary disturbance/displacement of birds. In addition operation and maintenance of the onshore substation (and HVAC booster substation, if required) may result in further disturbance to birds. The level of disturbance/displacement would depend on the degree of overlap between the onshore components of the project and the breeding and foraging habitat of ornithological features of the SPA.

6.2.402 Given that the onshore ECR corridor search area overlaps with the North Norfolk Coast SPA and that the exact location of the onshore components of the project is yet to be defined, the assumption has been made that there may be potential ornithological features to be disturbed/displaced during operation. It is therefore considered that a LSE on ornithological features of the North Norfolk Coast SPA in this respect cannot be discounted at this stage.

6.2.403 The above assessment will be revised once further information on the location of the ECR corridor and associated infrastructure is available and incorporated into the HRA Report.

Potential release of contaminants

6.2.404 During operation, there may be potential for the accidental release of pollutants to occur during the undertaking of maintenance activities. This could in turn result in detrimental impacts on the wider habitat and indirectly affect ornithology features of the North Norfolk Coast SPA. It is anticipated, however, that through the implementation of appropriate maintenance techniques, adherence to good environmental practice and where, required control measures, risks associated with the accidental release of contaminants will be negligible.

6.2.405 Taking account of the above it is not considered that accidental release of contaminants during operation will result in a LSE on ornithological features of the North Norfolk Coast SPA.

Conclusion

6.2.406 A summary of the LSEs arising from Hornsea Three on the North Norfolk Coast SPA is presented in Table 6.38.

Table 6.38 LSE conclusions for the North Norfolk Coast SPA

Ornithological feature	Project phase	Effect	Conclusion
All ornithological features*	Construction/Decommissioning	Permanent habitat loss	Potential for LSE
		Temporary habitat disturbance	Potential for LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance	Potential for LSE
		Release of contaminants	No LSE

**Excluding tern species and Mediterranean gulls.*

North Norfolk Coast Ramsar Site

6.2.407 The North Norfolk Coast Ramsar Site is located in the same geographical area as the North Norfolk Coast SAC and SPA. The site extends for 40 km from Holme to Weybourne and encompasses a variety of habitats including intertidal sands and muds, saltmarshes, shingle and sand dunes, together with areas of land-claimed freshwater grazing marsh and reedbed, which is developed in front of rising land. Both freshwater and marine habitats support internationally important numbers of wildfowl in winter and several nationally rare breeding birds. The sandflats, sand dune, saltmarsh, shingle and saline lagoons habitats are of international importance for their fauna, flora and geomorphology.

6.2.408 As noted in Section 5.3 the onshore ECR corridor search area overlaps with a small area of the eastern section of the site (see Figure 5.18) and therefore all its Annex I habitat and ornithological features have been taken forward for initial consideration of LSE (Table 5.14). These are listed in Table 6.39.

Table 6.33 Annex I habitat and ornithological features of the North Norfolk Coast Ramsar Site considered for assessment of LSE

Type	Feature
Annex I habitat	Ramsar criterion 1: The site is one of the largest expanses of undeveloped coastal habitat of its type in Europe. It is a particularly good example of a marshland coast with intertidal sand and mud, saltmarshes, shingle banks and sand dunes. There are a series of brackish-water lagoons and extensive areas of freshwater grazing marsh and reed beds.
Ornithological features	Ramsar criterion 5: Assemblages of international importance: Species with peak counts in winter: waterfowl Ramsar criterion 6- species populations occurring at levels of international importance: <u>Qualifying species/populations (as identified at designation):</u> *Species regularly supported during the breeding season:* • Sandwich tern, *Sterna sandvicensis* • Common tern, *Sterna hirundo* • Little tern, *Sterna albifrons albifrons*, W Europe *Species with peak counts in spring/autumn:* • Red knot, *Calidris canutus islandica*, W & Southern Africa (wintering) *Species with peak counts in winter:* • Pink-footed goose, *Anser brachyrhynchus*, Greenland, Iceland/UK • Dark-bellied brent goose, *Branta bernicla bernicla* • Eurasian wigeon, *Anas penelope*, NW Europe • Northern pintail, *Anas acuta*, NW Europe <u>Species/populations identified subsequent to designation for possible future consideration under criterion 6:</u> • Species with peak counts in spring/autumn: • Ringed plover, *Charadrius hiaticula*, Europe/Northwest Africa • Sanderling , *Calidris alba*, Eastern Atlantic • Bar-tailed godwit, *Limosa lapponica lapponica*, W Palearctic

Annex I habitats and Ornithological Features

6.2.409 All the qualifying habitat features and ornithological features of the North Norfolk Coast Ramsar Site are also qualifying features of the North Norfolk Coast SAC and SPA. As such, the conclusions of the assessment carried out for the North Norfolk Coast SAC and SPA for relevant features (Table 6.38 and Table 6.30) also apply to the North Norfolk Coast Ramsar Site.

Conclusion

6.2.410 A summary of the LSEs arising from Hornsea Three on the North Norfolk Coast Ramsar Site is presented in Table 6.40. This is based on the assessments carried out for the North Norfolk Coast SAC (Annex I habitats) and SPA (ornithological features).

Table 6.34 LSE conclusions for the North Norfolk Coast Ramsar Site

Feature	Project Phase	Effect	Conclusion
Annex I habitats	Construction/ Decommissioning	Permanent habitat loss	Potential for LSE
		Temporary habitat disturbance/damage	Potential for LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance/damage	Potential for LSE
		Release of contaminants	No LSE
All ornithological features*	Construction/Decommissioning	Permanent habitat loss	Potential for LSE
		Temporary habitat disturbance	Potential for LSE
		Release of contaminants	No LSE
	Operation	Temporary disturbance	Potential for LSE
		Release of contaminants	No LSE

**Excluding tern species and Mediterranean gulls.*

7. In-combination Effects

7.1.1 Planning Inspectorate (PINS) Advice Note Ten: Habitats Regualtions Assessment (version 7, January 2016) indicates that an appraisal of the effects of any other plans or projects which, in combination with the proposed development, might be likely to have a significant effect on the European site(s) should be undertaken. The scope of this appraisal should be clearly agreed with the local authorities and SNCBs.

7.1.2 PINS Advice Note Seventeen: Cumulative Effects Assessment Relevant to Nationally Significant Infrastructure Projects (PINS, 2015) provides guidance on the categories of projects that are relevant for consideration in cumulative assessments and suggests the use of tiers to distinguish different degrees of certainty in the information publically available to inform assessments, with Tier 1 being the most certain.

7.1.3 In the context of the Project the tiered approach would use the following categories:

- Tier 1: Hornsea Three considered alongside other project/plans currently under construction and/or those consented but not yet implemented, and/or those submitted but not yet determined and/or those currently operational that were not operational when baseline data was collected, and/or those that are operational but have an on-going impact;
- Tier 2: Projects/plans on the PINS Programme of Projects where a Scoping Report has been submitted; and
- Tier 3: Projects/plans on the PINS Programme of Projects where a Scoping Report has not been submitted; (where appropriate) projects identified in the relevant Development Plan (and emerging Development Plans - with appropriate weight being given as they move closer to adoption); and projects identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward (PINS, 2015).

7.1.4 Natural England, in recent advice to the Hornsea Project Two and East Anglia One offshore wind farm projects (reported in DONG, 2015), has suggested the refinement of the tier system for ornithological in-combination effects using 7 tiers as follows:

Tier 1: Built and operational projects;
Tier 2: Projects under construction;
Tier 3: Permitted application(s), but not yet implemented;
Tier 4: Submitted application(s) not yet determined (including under judicial review);
Tier 5: All refusals subject to appeal procedures not yet determined
Tier 6: Projects on the PINS Programme of Projects;
Tier 7: Projects identified in relevant development plans; and projects identified in other plans and programmes as may be relevant, where such development is reasonably likely to come forward.

7.1.5 Offshore, it is likely that it will be primarily other offshore wind farms that are most likely to potentially cause LSE on similar European sites as Hornsea Three for ornithological receptors. For other receptors, such as marine mammals, other sources of percussive piling noise will need to be considered. Further discussion will be held with SNCBs (including Natural England), to identity relevant offshore wind farms for each site and feature. Any other relevant plans and projects will also be identified and agreement on the scope of the appraisal will be sought with SNCBs.

7.1.6 Onshore, there are currently no other NSIP Applications that are proposed within the same area as that proposed for the onshore components of Hornsea Three other than the Norfolk Vanguard offshore wind farm (onshore cable corridor). However, there are other categories of potential development and management activity that may also need to be considered. Further discussion will be held with relevant Local and County Authorities and statutory advisors to identify those plans and projects which have the potential for LSE on identified onshore European sites and to agree the scope of the appraisal.

7.1.7 An intial list of offshore and onshore projects is provided in Table 7.1.

Table 7.1 Initial list of potential HRA in-combination projects

Category	Project
Operational wind farms in the Southern North Sea	Round 1 and 2 offshore wind farms
Consented offshore wind farms not yet constructed	Dogger Bank Creyke Beck Dogger Bank Teeside (A & B) Hornsea Project One Hornsea Project Two East Anglia One
Offshore wind farms identified to PINS but not yet consented	Norfolk Vanguard East Anglia One North East Anglia Two East Anglia Three
Offshore wind farms not yet identified to PINS	Hornsea Four Norfolk Boreas
Coastal projects	Coastal defence works (Bacton)
Onshore projects	Gas pipeline works Major road works (Northern Distributor Road) Catchment Manangement Plans (River Wensum)

Assessment stage

7.1.8 A tiered approach consistent with PINS Advice Note Seventeen: (PINS, 2015) and the Renewable UK CIA Guidelines, specifically Guiding Principle 4 and Guiding Principle 7 (Renewable UK, 2013) is proposed. For the ornithological assessment (collision and displacement risk) the refined tier approach suggested by Natural England (Section 7.1.4) will be followed.

7.1.9 The tiered approach assists the decision maker in placing relative weight upon the potential for each project/plan assessed cumulatively to ultimately be realised, based upon the project/plan's current stage of maturity.

8. Summary of Likely Significant Effect (LSE)

8.1.1 A summary of the European sites, features and potential impacts for which a potential for a LSE has been identified as a result of Hornsea Three alone and/or in combination with other plans or projects (recognising that there will be further discussion with local authorities and SNCBs to identify other potential in-combination effects), is given in Table 8.1 (offshore) and Table 8.2 (onshore).

Table 8.1 European sites and features for which LSEs have been identified (offshore)

Site	Feature	Project phase	Effect
North Norfolk Sandbanks and Saturn Reef cSAC	• Sandbanks which are slightly covered by seawater all the time • Reefs	Construction/ Decommissioning Operation	Temporary habitat loss/disturbance Temporary increases in suspended sediments/smothering Long-term habitat loss Colonisation of hard structures Changes in physical processes Temporary seabed disturbance
Haisborough, Hammond and Winterton SAC	• Sandbanks which are slightly covered by seawater all the time • Reefs	Construction/ Decommissioning Operation	Temporary increases in suspended sediments/smothering Changes in physical processes
The Wash and North Norfolk Coast SAC	• Sandbanks which are slightly covered by sea water all the time • Mudflats and sandlflats not covered by seawater at low tide • Large shallow inlets and bays • Reefs • Salicornia and other annuals colonizing mud and sand • Atlantic salt meadow • Mediterranean and thermo-Atlantic halophilous scrubs • Coastal lagoons	Construction/ Decommissioning Operation	Temporary habitat loss/disturbance Temporary increases in suspended sediments/smothering Long-term habitat loss Colonisation of hard structures Changes in physical processes Temporary seabed disturbance
	• Harbour seal	Construction//Decommissioning	Underwater noise from foundation installation Changes in prey availability (Construction/Decommissioning)

Site	Feature	Project phase	Effect
Doggersbank SAC (Dutch designation)	• Harbour seal • Grey seal	Construction/ Decommissioning	Underwater noise from foundation installation Changes in prey availability (Construction/Decommissioning)
Klaverbank SCI (Dutch designation)	• Reef	Construction/ Decommissioning Operation	Temporary increases in suspended sediments/smothering Changes in physical processes
	• Harbour seal • Grey seal • Harbour porpoise	Construction/ Decommissioning	Underwater noise from foundation installation Changes in prey availability (Construction/Decommissioning)
Inner Dowsing, Race Bank and North Ridge SAC	• Sandbanks which are slightly covered by seawater all the time • Reefs	Construction/ Decommissioning Operation	Temporary increases in suspended sediments/smothering Changes in physical processes
Humber Estuary SAC/Ramsar	• Grey seal	Construction/ Decommissioning	Underwater noise from foundation installation Changes in prey availability (Construction/Decommissioning)
Noordzeekustzone SAC (Dutch designation)	• Grey seal	Construction/decommissioning	Underwater noise from foundation installation Changes in prey availability (Construction/Decommissioning)
Southern North Sea pSAC	• Harbour porpoise	Construction/ Decommissioning	Underwater noise from foundation installation Changes in prey availability (Construction/Decommissioning)

Site	Feature	Project phase	Effect
Greater Wash pSPA	• Red-throated diver • Common scoter	Construction/ decommissioning	Disturbance / displacement
		Operation	Displacement
Flamborough and Filey Coast pSPA Flamborough Head and Bempton Cliffs SPA	• Gannet	Operation	Collision risk Displacement
	• Kittiwake	Operation	Collision risk
	• Herring gull (non-breeding season)	Operation	Collision risk
	• Puffin	Construction/ decommissioning	Disturbance
		Operation	Displacement
	• Guillemot (non-breeding season)	Construction/ decommissioning	Disturbance
		Operation	Displacement
	• Razorbill (non-breeding season)	Construction/ decommissioning	Disturbance
		Operation	Displacement

Table 8.2 European sites and features for which LSEs have been identified (onshore)

Site	Feature		Project phase	Effect
Norfolk Valley Fens SAC	Annex I habitats	All qualifying features	Construction/ Decommissioning	Permanent habitat loss
				Temporary habitat disturbance/damage
			Operation	Temporary habitat disturbance/damage
	Annex II species	All qualifying features	Construction/ Decommissioning	Permanent habitat loss
				Temporary disturbance/damage
			Operation	Temporary disturbance/damage
River Wensum SAC	Annex I habitats	All qualifying features	Construction/ Decommissioning	Permanent habitat loss
				Temporary habitat disturbance/damage
			Operation	Temporary habitat disturbance/damage
	Annex II species	All qualifying features	Construction/ Decommissioning	Permanent habitat loss
				Temporary disturbance/damage
		All qualifying features	Operation	Temporary disturbance/damage
North Norfolk Coast SAC	Annex I habitats	All qualifying features	Construction/ Decommissioning	Permanent habitat loss
				Temporary habitat disturbance/damage
		All qualifying features	Operation	Temporary habitat disturbance/damage
	Annex II species	All qualifying features	Construction/ Decommissioning	Permanent habitat loss
				Temporary disturbance/damage

Site	Feature		Project phase	Effect
		Otter		Habitat fragmentation
		All qualifying features	Operation/ Decommissioning	Temporary disturbance/damage
The Wash and North Norfolk Coast SAC	Annex I habitats	Coastal lagoons	Construction/ Decommissioning	Permanent habitat loss
				Temporary habitat disturbance/damage
			Operation	Temporary habitat disturbance/damage
	Annex II species	Otter	Construction/ Decommissioning	Permanent habitat loss
				Temporary disturbance/damage to species
				Habitat fragmentation
			Operation	Temporary disturbance/damage to species
North Norfolk Coast SPA	Ornithological features	All features[14]	Construction	Permanent habitat loss
				Temporary habitat disturbance/displacement
			Operation	Temporary habitat disturbance/displacement
North Norfolk Coast Ramsar Site	Annex I habitats	All qualifying features	Construction	Permanent habitat loss
				Temporary habitat disturbance/damage
			Operation	Temporary habitat disturbance/damage
	Ornithological features	All features[15]	Construction	Permanent habitat loss

[14] All features of the SPA excluding tern species and Mediterranean gull

[15] All ornithological features of the Ramsar site excluding tern species

Site	Feature		Project phase	Effect
				Temporary habitat disturbance/displacement
			Operation	Temporary habitat disturbance/displacement

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Appendix A: Migratory seabird collision risk assessment

A.1 Sites designated for terns, skuas and little gull

Introduction

A.1.1 This Appendix presents an example of an extended screening exercise for terns, skuas and little gull features of UK SPAs (collectively referred to as migratory seabirds for the purposes of HRA screening). The collision risk modelling for these features involves a theoretical modelling exercise similar to that undertaken for Hornsea Project Two (Smart Wind, 2015).

Species considered

A.1.2 In order to determine the Natura 2000 sites with designated migratory seabird features that may interact with the site it is necessary to determine the Biologically Defined Minimum Population Scale (BDMPS) for each species and identify the SPAs located within this defined scale.

A.1.3 In carrying out this screening process, it is assumed on a precautionary basis for initial site identification that there is potential for a LSE on all SPAs located within the BDMPS for each of the species listed below.

Arctic skua

A.1.4 Arctic skuas breed in small numbers in northern Scotland and more widely in the Arctic and sub-Arctic. The species is a transequatorial migrant moving to wintering areas off Australia, South Africa and southern South America (Wernham *et al*., 2002). Arctic skuas generally migrate through coastal waters, often associating with aggregations of terns and small gulls in areas such as estuaries from which they are able to obtain food by kleptoparasitism (Taylor, 1979). Birds that migrate through UK waters are considered to be UK breeding birds, mainly from Shetland and Orkney, and birds that breed in northern Europe (Furness, 1987).

A.1.5 Autumn migration of Arctic skua starts in August (Wernham *et al*., 2002; Forrester *et al*., 2007; Pennington *et al*., 2004). Peak autumn migration through UK waters as a whole occurs in August-September (Wernham *et al*., 2002) with peak migration in English waters concentrated in September (Brown and Grice, 2005). In spring, birds begin to reach UK waters from early April with peak in migratory movements later in April through to May (Wernham *et al*., 2002).

A.1.6 Furness (2015) presents UK North Sea and Channel BDMPS populations for Arctic skua in both the post-breeding and pre-breeding (autumn and spring migration) seasons. In the post-breeding season the BDMPS is 6,427 birds composed mainly of birds from Scottish colonies with a smaller proportions from Arctic and northern European populations. In the pre-breeding season the BDMPS is 1,227 birds again composed mainly of birds from Scottish colonies and much smaller proportions from Arctic and northern European colonies. Both of these BDMPS populations include breeding birds from the following SPAs:

- Fetlar;
- Foula;
- Fair Isle;
- West Westray;

- Papa Westray;
- Hoy; and
- Rousay.

Great skua

A.1.7 The majority of the global population of great skua breed in Scotland with the remainder breeding in Iceland. Great skua is principally a passage migrant through English waters moving between breeding colonies in Scotland and wintering grounds in southern Europe (Wernham *et al*., 2002).

A.1.8 Autumn migration of great skua starts in August with peak autumn migration through UK waters occurring later in August through to October (Wernham *et al*., 2002; Brown and Grice, 2005). In spring, migration begins in March and peaks from late March into April (Wernham *et al*., 2002; Pennington *et al*., 2004; Forrester *et al*., 2007). During spring migration, a much smaller proportion of great skuas migrate through the North Sea when compared to autumn.

A.1.9 Furness (2015) presents UK North Sea and Channel BDMPS populations for great skua in both the post-breeding and pre-breeding seasons. In the post-breeding season, the North Sea and Channel waters BDMPS population is 19,556 birds composed mainly of birds from Scottish colonies with a smaller proportion from northern European populations. In the pre-breeding season, the North Sea and Channel waters population is 8,485 birds again composed mainly of birds from Scottish colonies and smaller proportions from northern European colonies. Both of these BDMPS populations include breeding birds from the following SPAs:

- Hermaness, Saxa Vord and Valla Field;
- Fetlar;
- Ronas Hill - North Roe and Tingon;
- Foula;
- Noss;
- Fair Isle; and
- Hoy.

Little gull

A.1.10 Little gull is primarily a passage migrant to the UK occurring during both autumn and spring migration. Birds from breeding colonies in north-western Russia migrate through the Baltic into the North Sea and then moving on to wintering areas in the western Mediterranean (Wernham *et al*., 2002).

A.1.11 Little gulls begin to arrive in the North Sea in late July and early August off the coast of eastern Scotland. These birds precede a second wave of birds which reaches England and Wales (Wernham *et al*., 2002). Movements of birds out of the North Sea occur in October with the majority of the flyway population of little gull (40-100%) leaving the North Sea through the English Channel (Wernham *et al*., 2002; Stienen *et al*., 2007).

A.1.12 Spring migratory movements of little gull back to breeding areas occurs from April into early May with birds moving both up the west coast of the UK and through the English Channel into the southern North Sea (Wernham *et al*., 2002).

A.1.13 The population of birds that migrate via the North Sea in autumn and spring has not been quantified (see for example Furness 2015) and therefore for the purposes of this analysis the flyway population of little gull (75,000 individuals) is applied to the analysis as defined for the English Channel by Stienen *et al*. (2007).

A.1.14 The only SPA of relevance to little gull in terms of the screening process for Hornsea Three is the Greater Wash pSPA.

Common tern

A.1.15 Common tern is a migrant breeder and passage visitor to the UK and throughout Europe that winters on the western and southern African coast, with a small proportion wintering as far north as Portugal (Wernham *et al*., 2002).

A.1.16 Post-fledging dispersal of common tern starts as early as July and continues into October (Wernham *et al*., 2002). Peak autumn migratory movements of common tern through UK waters occurs in August-September (Wernham *et al*., 2002) with peak movements through northern England occurring in August with the movement of many birds likely to occur overland (Ward, 2000). Many common terns return to breeding areas by April with peak pre-breeding movements occurring in English waters during this month (Brown and Grice, 2005). The frequency of inland sightings during spring suggests that a large proportion of spring movements also occur overland.

A.1.17 Furness (2015) presents UK North Sea and Channel BDMPS populations for common tern for migratory seasons with the same number of birds considered to migrate through this area during both autumn and spring. This population is estimated to consist of 144,911 birds originating mainly from UK North Sea colonies but also from northern European colonies and a smaller proportion from colonies on the west coast of the UK. This population includes breeding birds from a total of 22 SPAs:

- Breydon Water;
- Carlingford Lough;
- Ynys Feurig, Cemlyn Bay and The Skerries;
- Coquet Island;
- Cromarty Firth;
- Dungeness to Pett Level;
- Farne Islands;
- Firth of Forth Islands;
- Foulness;
- Glas Eileanan;
- Imperial Dock, Leith;
- Inner Moray Firth;
- Larne Lough;
- Lough Neagh and Lough Beg;
- North Norfolk Coast;
- Poole Harbour;
- Ribble and Alt Estuaries;

- Solent and Southampton Water;
- Strangford Lough;
- The Dee Estuary;
- The Wash; and
- Ythan Estuary, Sands of Forvie and Meikle Loch.

A.1.18 The breeding population of common tern at the Monach Isles SPA is not included as a named colony in Furness (2015). It is likely that this colony no longer exists as only one breeding pair was present in 2001 recorded as part of Seabird 2000 (JNCC, 2016).

Arctic tern

A.1.19 Arctic tern is a migrant breeder and passage visitor to the UK which undertakes extensive migratory movements to waters off the west and south African coast, continuing on as far south as Australia. The species has a circumpolar breeding distribution with the populations in the UK and Ireland on the southern limit of this distribution (Wernham *et al*., 2002).

A.1.20 Autumn migratory movements of Arctic tern through UK waters start in early July, with the majority of movements completed by October (Pennington *et al*., 2004; Forrester *et al*., 2007). The majority of these movements are thought to occur offshore (Wernham *et al*., 2002). Peak autumn migratory movements through Shetland and Scotland occurs in July (Pennington *et al*., 2004; Forrester *et al*., 2007), with peak movements in southern England occurring in September (Brown and Grice, 2005). The first spring migrants arrive in UK waters in March (Wernham *et al*., 2002) with peak spring migratory movements occurring through UK waters in May (Brown and Grice, 2005; Pennington *et al*., 2004; Forrester *et al*., 2007).

A.1.21 Furness (2015) presents UK North Sea and Channel BDMPS populations for Arctic tern for migration seasons. The same population of birds is considered to migrate through the UK North Sea and Channel during both the post-breeding and pre-breeding seasons. This population is estimated to consist of 163,930 birds originating mainly from UK North Sea colonies but also from northern European colonies. This population includes breeding birds from a total of 17 SPAs:

- Auskerry;
- Coquet Island;
- Fair Isle;
- Farne Islands;
- Fetlar;
- Firth of Forth Islands;
- Foula;
- Mousa;
- Papa Stour;
- Papa Westray;
- Pentland Firth Islands;
- Rousay;
- Sumburgh Head; and
- West Westray.

Apportioning methodology

Overview

A.1.22 Unlike the approach that is typically used to inform collision risk modelling for regularly occurring seabird species, density data collected during site-specific surveys is deemed to be unsuitable to estimate the impact of collision for migratory seabird species. This is due to the snapshot nature of site-specific surveys and consequential limitations in recording sporadic movements of migratory species. Therefore the collision risk modelling used to inform this extended screening of migratory seabirds incorporates species-specific information relating to population estimates and migratory behaviour. A generic 'migratory front' is then defined which is used to calculate the number of birds that have the potential to interact with the array area during both spring and autumn migration.

A.1.23 In order to identify the interacting population for use in collision risk modelling the following stages are applied:

- Stage 1: Define relevant seasonal BDMPS populations for each species considered;
- Stage 2: Define a migratory front that incorporates the longest width of the array area across which migration will occur;
- Stage 3: Calculate the proportion of the migratory front represented by the array area; and
- Stage 4: Calculate interacting populations for each species in each migratory season.

A.1.24 The interacting populations are then incorporated into collision risk modelling to provide a collision risk estimate for each species. These estimates can then be compared to an appropriate threshold (i.e. 1% of baseline mortality). Where estimates surpass the threshold further analysis may be appropriate.

Calculation of interacting populations

A.1.25 The proportion of the defined BDMPS population that may interact with the array area is calculated based on the proportion of the migratory front represented by the array area. The migratory front represents a hypothetical line across which the whole BDMPS population will cross, incorporating the greatest width of the array area. It is assumed that birds are equally distributed across this front, however it should be noted that the migratory movements of some species may be biased towards inshore or offshore waters (Stienen *et al*., 2007). It is expected that the notably offshore location of the array area makes this assumption precautionary, with most species observed to favour inshore migratory movements. Equally for the purpose of this assessment all of the BDMPS population is assumed to fly within UK waters.

A.1.26 The extent of the migratory front used to estimate the population of migratory seabirds passing through the array area is assumed to extend from the UK coast to the edge of UK waters (Figure A.1). The populations of migratory seabird species considered to have potential to interact with the array area are calculated using the following formula:

*Interacting population = Width of array area / width of migration route * species population*

A.1.27 The length of this migratory front is 202.1 km with the array area representing 32.4 km. The array area therefore represents 16.0% of the total migratory front with this proportion applied to the BDMPS populations in Table A.1.

Table A.1 Migratory seabird BDMPS populations and the proportion of these populations predicted to have potential to interact with the array area.

Species	Season	BDMPS population (individuals) (Furness, 2015)	Proportion of BDMPS population represented by breeding birds from SPAs (%)[16]	Migrant estimate of BDMPS population (individuals)
Arctic skua	Autumn	6,427	4.37	1,031
	Spring	1,227	15.40	197
Great skua	Autumn	19,556	33.67	3,136
	Spring	8,485	38.80	1,361
Little gull	Spring/Autumn	75,000[17]	1.74	12,026
Common tern	Spring/Autumn	144,911	3.18	23,236
Arctic tern	Spring/Autumn	163,930	7.40	26,286

[16] Proportion of BDMPS population represented by breeding birds from SPAs = Total SPA population/BDMPS population * 100

[17] No BDMPS population is presented for little gull in Furness (2015) and therefore the Flyway population of little gull from Stienen *et al.* (2007) is used

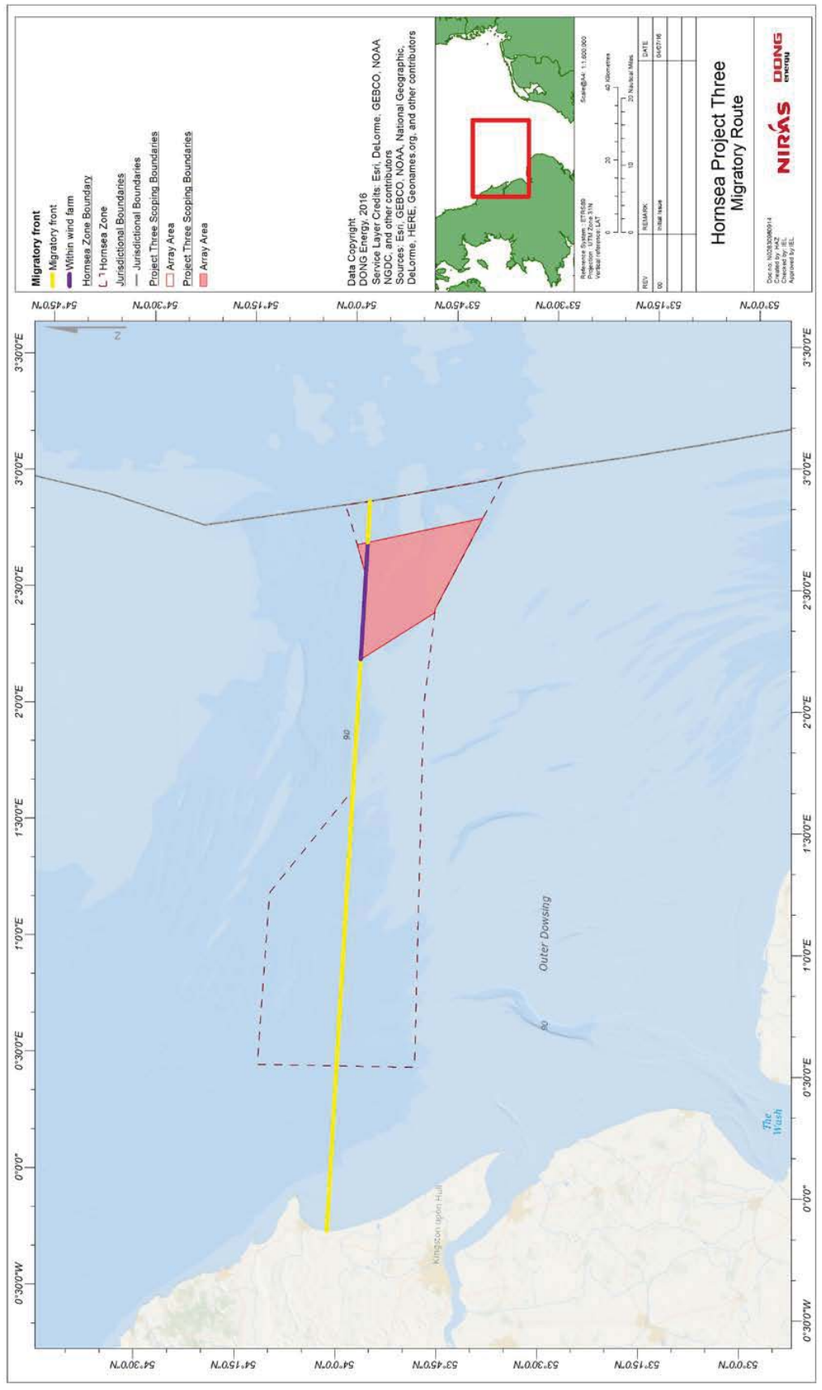

Figure A.1 Migratory front used to calculate populations of migratory seabirds interacting with the Hornsea Three array area.

Peak migratory movements

A.1.28 To populate a collision risk model, single months are selected to represent autumn movements and spring movements respectively. In the Band (2012) CRM these months are populated with the populations in Table A.1, while the months selected are presented in Table A.2.

Table A.2 Months population with potentially interacting populations for collision risk modelling.

Species	Post-breeding peak migratory month	Pre-breeding peak migratory month
Arctic skua	September	April
Great skua	September	April
Little gull	September	April
Common tern	August	April
Arctic tern	August	May

Collision risk modelling

A.1.29 To quantify collision risk, collision risk modelling has been undertaken using the Band (2012) CRM. Band (2012) uses information derived from population estimation, bird behaviour, biological parameters and project specific turbine information to calculate monthly collision risk values. There are six stages to the Band (2012) CRM:

- Stage A: quantify the number of flights, which in the absence of birds being displaced or taking other avoiding action, or being attracted to the wind farm, are potentially at risk from wind farm turbines;
- Stage B: use the flight activity data to estimate the potential number of bird transits through rotors of the wind farm;
- Stage C: calculate the probability of collision during a single bird rotor transit;
- Stage D: multiply these to yield the potential collision mortality rate, allowing for the proportion of time that turbines are not operational, assuming current bird use of the site with no avoidance behaviour;
- Stage E: allow for the proportion of birds likely to avoid the wind farm or its turbines, either due to displacement or evasive action and allow for attraction behaviour;
- Stage F: express the uncertainty associated with the collision risk estimate.

A.1.30 In Stages B, C and D the wind farm and turbine parameters in Table A.3 have been used to calculate the number of collisions assuming no avoidance or attraction behaviour.

Table A.3 Wind farm and turbine parameters used in the Band (2012) CRM[18]

Parameter	6 MW turbine
Number of turbines	400
Hub height (m) above MSL	113.17
Rotor radius (m)	80
Maximum chord (m)	5.4
Rotor speed (rpm)	9.6
Blade pitch (°)	3
Monthly proportion of time operational (%)	88 (all months)

A.1.31 The species-specific parameters used in the Band (2012) collision risk model for migratory seabirds are presented in Table A.4.

Table A.4 Species input parameters used in collision risk modelling.

Parameter	Arctic skua	Great skua	Little gull	Common tern	Arctic tern
Bird length (m)[19]	0.44	0.56	0.26	0.33	0.34
Wingspan (m)[20]	1.18	1.36	0.78	0.88	0.8
Flight speed (m/sec)[21]	13.8	14.9	11.5	*10.9*[22]	10.9
Nocturnal activity[23]	1	1	2	1	1
Flight type (flapping/gliding)	Flapping	Flapping	Flapping	Flapping	Flapping

A.1.32 In Stage E of the Band (2012) CRM, the avoidance and attraction behaviour of birds towards a wind farm is taken into account. With the exception of little gull, there is limited published evidence relating to avoidance rates to be applied for migratory species as such for Arctic skua, great skua, common tern and Arctic tern, collision risk estimates calculated using a default 98% avoidance rate are used in the assessment of LSE.

A.1.33 Cook *et al*. (2014) derived avoidance rates for small gull spp. and gull spp., two groups which included data relating to the avoidance behaviour of little gull. Avoidance rates of 99.2% and 98.9% were derived for the small gull spp. and gull spp. respectively. As such, avoidance rates of 98%, 98.9%, 99.2% and 99.5% will be used in the collision risk modelling for little gull, with the small gull spp. avoidance rate (99.2%) considered to be the most relevant for assessment purposes.

[18] These values are illustrative only and do not represent the design envelope turbine values for Hornsea Three

[19] Robinson (2015)

[20] Robinson (2015)

[21] Alerstam *et al., (*2007) or Pennycuick (1987)

[22] No flight speed is available for common tern therefore flight speed for Arctic tern is used as a surrogate

[23] Garthe and Hüppop (2004)

A.1.34 The Band (2012) CRM includes two models (basic and extended) which both incorporate two 'Options'. In order to calculate collision risk estimates Options 2 (basic model) and 3 (extended model) of the Band (2012) CRM have been used incorporating generic flight height data from Johnston *et al*. (2014).

A.1.35 It should be noted that the use of the basic model is precautionary as it does not take into account the variability in risk of collision that occurs across a rotor swept area, with the risk of collision decreasing as the distance from the hub of the turbine increases. If this were to be taken into account (as when using Option 3) it is likely that collision risk estimates would be lower as the vertical distribution of birds flying across water is skewed towards lower heights (i.e. those associated with a lower risk of collision within a rotor swept area).

Assessment of LSE

A.1.36 The collision risk estimate calculated for each species is apportioned to relevant SPAs based on the contribution each SPA makes to the total BDMPS population. The apportioned collision risk estimate is then compared to the 1% threshold of the baseline mortality of the relevant SPA population. If the apportioned impact surpasses the 1% threshold then the SPA is taken forward for further assessment in the HRA.

Results

A.1.37 Collision risk estimates calculated using Options 2 and 3 of the Band (2012) CRM are presented in Table A 5 and Table A 6 respectively. No specific avoidance rates are available for the migratory seabird species considered (e.g. in Cook *et al*., 2014) and therefore results are presented at a variety of rates.

Table A 4 Band (2012) Option 2 migratory seabird collision risk results (collisions/annum).

Species	Avoidance rate (%)				
	95	98	99	99.2	99.5
Arctic skua	0.01	0	0		0
Great skua	0.22	0.09	0.04		0.02
Little gull	3.61	1.44	0.72	0.58	0.36
Common tern	2.31	0.92	0.46		0.23
Arctic tern	0.90	0.36	0.18		0.09

Table A 5 Band (2012) Option 3 migratory seabird collision risk results (collisions/annum).

Species	Avoidance rate (%)				
	95	98	99	99.2	99.5
Arctic skua	0	0	0		0
Great skua	0.04	0.02	0.01		0
Little gull	0.76	0.30	0.15	0.12	0.08
Common tern	0.42	0.17	0.08		0.04

Species	Avoidance rate (%)				
Arctic tern	0.13	0.05	0.03		0.01

A.1.38 Collision risk estimates calculated for each species using Options 2 and 3 of the Band (2012) CRM are attributed to relevant SPA populations in Table A 7 and Table A 8, respectively. The impact attributable to each SPA is then compared to 1% threshold of baseline mortality of that SPA population. If the impact exceeds this threshold then a LSE is identified and further assessment is considered to be required in the forthcoming HRA Report.

Table A.6 Collision risk (Option 2) apportioned to SPA populations.

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Fetlar	Arctic skua (autumn)	100	1.56	0.00	N
Foula	Arctic skua (autumn)	42	0.65	0.00	N
Fair Isle	Arctic skua (autumn)	23	0.36	0.00	N
West Westray	Arctic skua (autumn)	32	0.50	0.00	N
Papa Westray	Arctic skua (autumn)	26	0.40	0.00	N
Hoy	Arctic skua (autumn)	14	0.22	0.00	N
Rousay	Arctic skua (autumn)	44	0.68	0.00	N
Fetlar	Arctic skua (spring)	66	5.38	0.00	N
Foula	Arctic skua (spring)	28	2.28	0.00	N
Fair Isle	Arctic skua (spring)	15	1.22	0.00	N
West Westray	Arctic skua (spring)	22	1.79	0.00	N
Papa Westray	Arctic skua (spring)	18	1.47	0.00	N
Hoy	Arctic skua (spring)	10	0.81	0.00	N
Rousay	Arctic skua (spring)	30	2.44	0.00	N
Hermaness, Saxavord	Great skua (autumn)	1175	6.01	0.00	N
Fetlar	Great skua (autumn)	702	3.59	0.00	N
Ronas Hill	Great skua (autumn)	227	1.16	0.00	N

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Foula	Great skua (autumn)	1988	10.17	0.01	N
Noss	Great skua (autumn)	558	2.85	0.00	N
Fair Isle	Great skua (autumn)	319	1.63	0.00	N
Hoy	Great skua (autumn)	1615	8.26	0.00	N
Hermaness, Saxavord	Great skua (spring)	587	6.92	0.00	N
Fetlar	Great skua (spring)	351	4.14	0.00	N
Ronas Hill	Great skua (spring)	113	1.33	0.00	N
Foula	Great skua (spring)	994	11.71	0.00	N
Noss	Great skua (spring)	279	3.29	0.00	N
Fair Isle	Great skua (spring)	160	1.89	0.00	N
Hoy	Great skua (spring)	808	9.52	0.00	N
Greater Wash	Little gull	1303	1.74	0.01	N
Cromarty Firth	Common tern	95	0.07	0.00	N
Inner Moray Firth	Common tern	0	0.00	0.00	N
Ythan Estuary	Common tern	6	0.00	0.00	N
Forth Islands	Common tern	36	0.02	0.00	N
Imperial Dock, Leith	Common tern	1145	0.79	0.01	N
Farne Islands	Common tern	132	0.09	0.00	N
Coquet Island	Common tern	1457	1.01	0.01	N
The Wash	Common tern	309	0.21	0.00	N
North Norfolk Coast	Common tern	277	0.19	0.00	N

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Breydon Water	Common tern	129	0.09	0.00	N
Foulness	Common tern	35	0.02	0.00	N
Dungeness to Pett Level	Common tern	111	0.08	0.00	N
Poole Harbour	Common tern	228	0.16	0.00	N
Solent and Southampton Water	Common tern	392	0.27	0.00	N
Glas Eileanan	Common tern	4	0.00	0.00	N
Carlingford Lough	Common tern	24	0.02	0.00	N
Larne Lough	Common tern	46	0.03	0.00	N
Lough Neagh and Lough Beg	Common tern	16	0.01	0.00	N
Strangford Lough	Common tern	70	0.05	0.00	N
The Dee Estuary	Common tern	33	0.02	0.00	N
Ribble and Alt Estuaries	Common tern	22	0.02	0.00	N
Cemlyn Bay	Common tern	36	0.02	0.00	N
Fetlar	Arctic tern	38	0.02	0.00	N
Foula	Arctic tern	36	0.02	0.00	N
Papa Stour	Arctic tern	2110	1.29	0.00	N
Mousa	Arctic tern	32	0.02	0.00	N
Sumburgh Head	Arctic tern	365	0.22	0.00	N
Fair Isle	Arctic tern	52	0.03	0.00	N
West Westray	Arctic tern	900	0.55	0.00	N
Papa Westray	Arctic tern	317	0.19	0.00	N
Rousay	Arctic tern	108	0.07	0.00	N
Auskerry	Arctic tern	1350	0.82	0.00	N
Pentland Firth Islands	Arctic tern	0	0.00	0.00	N
Forth Islands	Arctic tern	530	0.32	0.00	N
Farne Islands	Arctic tern	3842	2.34	0.01	N

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Coquet Island	Arctic tern	2448	1.49	0.01	N

Table A 7 Collision risk (Option 3) apportioned to SPA populations.

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Fetlar	Arctic skua (autumn)	100	1.56	0.00	N
Foula	Arctic skua (autumn)	42	0.65	0.00	N
Fair Isle	Arctic skua (autumn)	23	0.36	0.00	N
West Westray	Arctic skua (autumn)	32	0.50	0.00	N
Papa Westray	Arctic skua (autumn)	26	0.40	0.00	N
Hoy	Arctic skua (autumn)	14	0.22	0.00	N
Rousay	Arctic skua (autumn)	44	0.68	0.00	N
Fetlar	Arctic skua (spring)	66	5.38	0.00	N
Foula	Arctic skua (spring)	28	2.28	0.00	N
Fair Isle	Arctic skua (spring)	15	1.22	0.00	N
West Westray	Arctic skua (spring)	22	1.79	0.00	N
Papa Westray	Arctic skua (spring)	18	1.47	0.00	N
Hoy	Arctic skua (spring)	10	0.81	0.00	N

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Rousay	Arctic skua (spring)	30	2.44	0.00	N
Hermaness, Saxavord	Great skua (autumn)	1175	6.01	0.00	N
Fetlar	Great skua (autumn)	702	3.59	0.00	N
Ronas Hill	Great skua (autumn)	227	1.16	0.00	N
Foula	Great skua (autumn)	1988	10.17	0.00	N
Noss	Great skua (autumn)	558	2.85	0.00	N
Fair Isle	Great skua (autumn)	319	1.63	0.00	N
Hoy	Great skua (autumn)	1615	8.26	0.00	N
Hermaness, Saxavord	Great skua (spring)	587	6.92	0.00	N
Fetlar	Great skua (spring)	351	4.14	0.00	N
Ronas Hill	Great skua (spring)	113	1.33	0.00	N
Foula	Great skua (spring)	994	11.71	0.00	N
Noss	Great skua (spring)	279	3.29	0.00	N
Fair Isle	Great skua (spring)	160	1.89	0.00	N
Hoy	Great skua (spring)	808	9.52	0.00	N
Greater Wash	Little gull	1303	1.74	0.00	N
Cromarty Firth	Common tern	95	0.07	0.00	N
Inner Moray Firth	Common tern	0	0.00	0.00	N
Ythan Estuary	Common tern	6	0.00	0.00	N

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
Forth Islands	Common tern	36	0.02	0.00	N
Imperial Dock, Leith	Common tern	1145	0.79	0.00	N
Farne Islands	Common tern	132	0.09	0.00	N
Coquet Island	Common tern	1457	1.01	0.00	N
The Wash	Common tern	309	0.21	0.00	N
North Norfolk Coast	Common tern	277	0.19	0.00	N
Breydon Water	Common tern	129	0.09	0.00	N
Foulness	Common tern	35	0.02	0.00	N
Dungeness to Pett Level	Common tern	111	0.08	0.00	N
Poole Harbour	Common tern	228	0.16	0.00	N
Solent and Southampton Water	Common tern	392	0.27	0.00	N
Glas Eileanan	Common tern	4	0.00	0.00	N
Carlingford Lough	Common tern	24	0.02	0.00	N
Larne Lough	Common tern	46	0.03	0.00	N
Lough Neagh and Lough Beg	Common tern	16	0.01	0.00	N
Strangford Lough	Common tern	70	0.05	0.00	N
The Dee Estuary	Common tern	33	0.02	0.00	N
Ribble and Alt Estuaries	Common tern	22	0.02	0.00	N
Cemlyn Bay	Common tern	36	0.02	0.00	N
Fetlar	Arctic tern	38	0.02	0.00	N
Foula	Arctic tern	36	0.02	0.00	N
Papa Stour	Arctic tern	2110	1.29	0.00	N
Mousa	Arctic tern	32	0.02	0.00	N
Sumburgh Head	Arctic tern	365	0.22	0.00	N
Fair Isle	Arctic tern	52	0.03	0.00	N

SPA	Qualifying feature	SPA population (individuals)	Proportion of BDMPS population represented by SPA	Collision risk apportioned to SPA (no. of collisions)	Potential LSE (Yes/No)
West Westray	Arctic tern	900	0.55	0.00	N
Papa Westray	Arctic tern	317	0.19	0.00	N
Rousay	Arctic tern	108	0.07	0.00	N
Auskerry	Arctic tern	1350	0.82	0.00	N
Pentland Firth Islands	Arctic tern	0	0.00	0.00	N
Forth Islands	Arctic tern	530	0.32	0.00	N
Farne Islands	Arctic tern	3842	2.34	0.00	N
Coquet Island	Arctic tern	2448	1.49	0.00	N

Conclusion

A.1.39 The maximum number of collisions attributable to any SPA population is 0.01 collisions/annum for any migratory seabird species. This does not exceed 1% of the baseline mortality for any SPA. As such, no LSEs have been identified for any of the SPAs incorporated into this extended screening assessment for migratory seabirds. Therefore, it is concluded that no further consideration of these features will be necessary in the forthcoming HRA Report for HornseaThree.

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