Offshore Petroleum Regulator for Environment & Decommissioning

RECORD OF THE HABITATS REGULATIONS ASSESSMENT UNDERTAKEN UNDER REGULATION 5 OF THE OFFSHORE PETROLEUM ACTIVITIES (CONSERVATION OF HABITATS) REGULATIONS 2001

Net Zero North Sea Storage (Ltd): Northern Endurance Partnership CO_2 Storage Development

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1 INTRODUCTION

Council Directive 92/43/EC on the conservation of natural habitats and of wild fauna and flora (the Habitats Directive) and Council Directive 2009/147/EC on the conservation of wild birds (the Birds Directive) aim to ensure the long-term survival of certain habitats and species in Europe, by protecting them from the adverse effects of plans and projects.

The Habitats Directive aims to restore and maintain Europe's biodiversity by protecting habitats and species of European importance. It achieves this through the designation of protected sites known as Special Areas of Conservation (SACs). The goal is to ensure that these species and habitats are maintained or restored to a Favourable Conservation Status.

The Birds Directive aims to protect all naturally occurring wild bird species and their most important habitats, including rare, vulnerable, and migratory bird species. Along with the Habitats Directive, the Birds Directive also contributes to the designation of protected sites, known as Special Protection Areas (SPAs).

SPAs and SACs collectively form the United Kingdom (UK)'s national site network.

In the UK, a Habitats Regulations Assessment (HRA) is triggered for oil and gas activities (including Carbon Capture, Utilisation, and Storage (CCUS) projects) based on specific legislation:

- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended); and
- The Conservation of Offshore marine Habitats and Species Regulations 2017 (known as the Offshore Marine Habitats Regulations).

The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended) transpose the Habitats and Birds Directives into UK law for oil and gas activities carried out wholly or partly in the UK continental shelf (including CCUS projects). The regulations set down obligations for assessing the impact of offshore oil and gas activities (including gas and carbon dioxide unloading and storage) on habitats and species protected under the Habitats Directive and Birds Directive.

The Conservation of Offshore marine Habitats and Species Regulations 2017, which apply to broader marine activities (not just oil and gas or CCUS), work alongside the Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 to protect European sites. These "Habitats Regulations" serve as the governing legislation for implementing several other requirements contained in the Directives. Whilst the 2001 Regulations focuses on assessing impacts of oil and gas activities (including CCUS), the Habitats Regulations provide a broader framework for conservation in offshore marine environments. While the specific mention of CCUS projects isn't explicit, the Habitats Regulations apply broadly to any activity that could impact European sites.

Since the departure of the UK from the European Union (EU), the requirements under the Habitats Regulations remain largely unchanged with any amendments made under the Conservation of Habitats and Species Amendment (EU Exit) Regulations 2019, which ensure that these regulations continue to work upon the UK's exit from the EU. In the UK, the Habitats Regulations created a new national site network that replaced the EU's Natura 2000 ecological network. European sites, formerly Natura 2000 network, are now part of the UK's National Site Network. The term "European site" has been retained in accordance with guidance issued by the UK Government on the 2019 (EU Exit) Regulations (Defra, 2021).

The following European sites are protected by the Habitats Regulations and any proposals that could affect them will require an HRA:

- Special Areas of Conservation (SACs) including proposed SACs; and
- Special Protection Areas (SPAs) including potential SPAs.

Under the Habitats Regulations, all competent authorities must consider whether any plan or project could affect a European site before authorising or carrying it out. This includes assessing whether it will have a "Likely Significant Effect" (LSE) on a European site, either alone or in-combination with other plans or projects. If such an effect is anticipated or cannot be ruled out, they must conduct an "Appropriate Assessment" (AA) to determine the implications for a site's integrity and conservation objectives. Such a plan or project may only be agreed after ascertaining that it will not adversely affect the integrity of a European Site unless there are imperative reasons of overriding public interest for carrying out the plan or project.

Regulation 5(1) of the 2001 Regulations provides that: *The Secretary of State shall, before granting any Petroleum Act licence, any consent, any authorisation, or any approval, where he considers that anything that might be done or any activity which might be carried on pursuant to such a licence, consent, authorisation or approval is likely to have a significant effect on a relevant site, whether individually or in-combination with any other plan or project, including but not limited to any other relevant project, make an appropriate assessment of the implications for the site in view of the site's conservation objectives.*

An application for a Storage Permit under the Storage of Carbon Dioxide (Licensing etc.) Regulations 2010 has been received by the North Sea Transition Authority (NSTA) from bp for the NEP Transportation and Storage Project (hereafter 'the Development'). Net Zero North Sea Storage Limited (hereafter NZNSS) has subsequently taken over as the owner and operator of the Development.

An Environmental Statement documenting the assessment of environmental impacts of the proposed Development has been submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020.

This is a record of the Appropriate Assessment in the form of a HRA undertaken by the Secretary of State for The Department for Energy Security and Net Zero (DESNZ) in respect of the proposed Development.

The proposed Development is not directly connected with, or necessary to, the management of any National sites but it may affect them. The purpose of this HRA is to determine whether the proposed Development will adversely affect the integrity of any UK National Site Network designated site.

Defra (2021) guidance outlines that the HRA process can have up the three stages, as outlined below, where the outcome of each successive stage determines whether a further stage in the process is required:

Screening - to check if the proposal is likely to have a significant effect on the site's conservation objectives.

Appropriate Assessment - to assess the likely significant effects of the proposal on the integrity of the site and its conservation objectives and to consider ways to avoid or minimise any effects.

Derogation - to consider if proposals that would have an adverse effect on a European site qualify for an exemption, subject to three legal tests being satisfied (i.e. alternative solutions, imperative reasons of overriding public interest and compensatory measures).

2 DEVELOPMENT DESCRIPTION

The purpose of the Development is to develop the Endurance Store for the injection and storage of Carbon Dioxide (CO_2), enabling CO_2 to be captured from industrial centres in Teesside and Humberside, and transported to a permanent geological storage site below the southern North Sea. The Development is one component of the East Coast Cluster (ECC), a strategic initiative that aims to deliver the UK's first zero carbon industrial cluster with an ambition to capture 23 million tonnes per annum of CO_2. The Development represents the initial phase (Phase 1) of the ECC which is designed to capture an initial 4 million tonnes per annum while facilitating subsequent development phases.

The Development is described within Section 3 of the applicant's Environmental Statement (bp 2023a) and includes the installation, testing, commissioning, operation, maintenance and monitoring of equipment and infrastructure required to meet this purpose.

An overview of the Development is provided here. Further particulars necessary for assessing specific impacts are described in subsequent sections of the HRA.

The Endurance storage site, for which the applicant holds a Storage Licence issued under the Storage of Carbon Dioxide (Licensing etc.) Regulations 2010, is within the Endurance saline aquifer, located in waters of between 40 m and 65 m depth below lowest astronomical tide (LAT) approximately 63 km east from the nearest coastline at Flamborough Head. The location of Development infrastructure is shown in Figure 1.

CO_2 will be transported offshore to the Endurance Store via two 28" pipelines, one originating at Teesside (*c*. 142 km in length from Mean Low Water Spring (MLWS)), and the other at Humberside (*c*. 100 km in length from MLWS). An electric power and fibre-optic communications control cable will run from Teesside to the subsea infrastructure at the Endurance Store. At the Endurance Store, all installed infrastructure will be subsea. The subsea facilities will consist of two manifolds which combine, distribute, control, and monitor flow of CO_2 to five injection wells. A sixth well will be used to monitor CO_2 within the Endurance Store. Infield flowlines will connect the five injection wells to the manifolds and power and communication cables will connect all six wells to the manifolds.

The proposed Development can be summarised as follows:

- Installation, connection to subsea infrastructure and commissioning of two CO_2 export pipelines from Teesside and Humber industrial clusters (MLWS) to the Endurance Store;
- Installation of subsea infrastructure at the Endurance Store including two manifolds, infield flowlines and an infield pipeline;
    - One crossover co-mingling manifold to combine the flows from the Teesside and Humber pipelines, and from which CO_2 will be distributed for injection into two of the wells and to the second manifold;
    - The second manifold is connected to the other three injection wells;
    - The manifolds connect to the five injection wells via 8" flowlines, up to 3 km in length;
    - The two manifolds will be connected by an infield pipeline, up to 28" in diameter and *c.*6 km in length;

- Drilling of five CO_2 injection wells, one monitoring well and installation of six subsea trees;
- Operations and maintenance of subsea infrastructure and pipelines;
- Monitoring and management of the Endurance Store during and after CO_2 injection in accordance with relevant regulatory consents; and
- Installation, commissioning and operation and maintenance of cables;
  - One electric power and fibre-optic communications control cable running from Teesside to the subsea infrastructure at the Endurance Store; and
  - One electric power and fibre-optic communications control cable between the two manifolds and six cables from the manifolds to each of the wells.

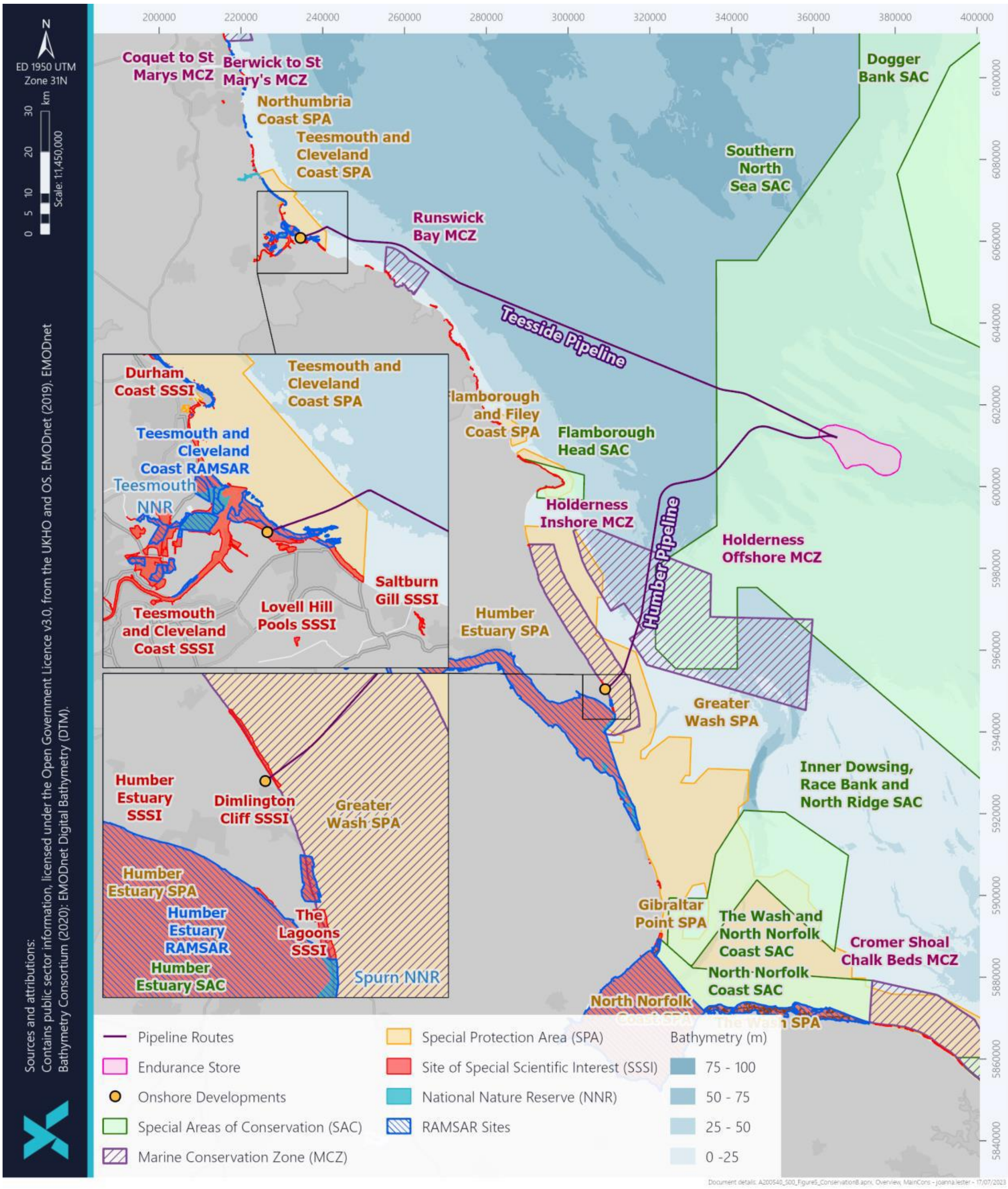

Figure 1: Map of the pipeline routing and infrastructure locations.

3 HRA STAGE 1: LIKELY SIGNIFICANT EFFECTS TEST

Under regulation 63 of the Habitats Regulations the Secretary of State must consider whether a development is likely to have a likely significant effect (LSE), either alone or in combination with other plans or projects on any European site (UK National Site Network designated site). Where significant effects are likely and are not directly connected with or necessary to the management of that site, an AA is required of the implications of the plan or project for that site in view of its conservation objectives. The purpose of this section is to identify any LSEs on European sites and to record the Secretary of State's conclusions on the need for an AA and his reasons for including activities, sites or plans and projects for further consideration in the AA.

The Secretary of State has applied a coarse filter to identify LSEs in keeping with English Nature guidance (English Nature, 1997). He considers that any impact on a European site, from the Project alone or in-combination with other plans or projects, should be classified as an LSE unless impacts have been demonstrated to be trivial and inconsequential. All sites considered for LSE along with their qualifying features and the potential impact that could cause an LSE is provided in the relevant subsections below. All the impacts listed have the potential to arise from the Project alone and in-combination with other plans and projects.

In developing the short list of relevant sites, the Secretary of State has had regard to the following:

- Sites which the Development will directly intersect with;
- SPAs for which established foraging ranges of qualifying features intersect with any element of the Development;
- Sites for which qualifying features could potentially be affected by sources of percussive sound generated by Development activities following propagation either through air or water;
- Sites for which qualifying features or habitats on which they depend, or their prey could be affected by the mobilisation, dispersion and/or resettlement of sediments;
- Sites for which qualifying features, or their prey could be affected by sources of contamination caused by the Development;
- Sites for which qualifying features might reasonably be anticipated to be disturbed by the physical presence of people or vessels connected with the Development.

In view of the evidence presented to him, the Secretary of State has identified five sites for which LSE cannot be ruled out and therefore have been considered for Appropriate Assessment. These sites are:

- Greater Wash SPA;
- Humber Estuary SPA;
- Teesmouth and Cleveland Coast SPA;
- Flamborough and Filey Coast SPA; and
- Southern North Sea SAC.

3.1 Special Protection Areas

The potential for LSE to features of SPAs as a result of activities associated with the Development has been considered in a stepwise manner.

Firstly, SPAs have been identified based on connectivity to the Development.

Secondly, features of those identified SPAs have been screened to determine those that may be present in areas impacted by the Development.

Thirdly the sensitivity for screened features to be affected by impacts resulting from Development activities has been considered to determine whether the potential for LSE can be ruled out.

3.1.1 SPAs for which LSE has been Considered

The physical footprint of the Development overlaps with two SPAs.

A further twelve SPAs have been considered to determine whether the foraging ranges of any of their seabird features overlap with the Development footprint.

3.1.1.1 SPAs overlapping the Development footprint

The Teesside pipeline is planned to make landfall to the north of Redcar on the Redcar and Cleveland coast. The landfall location is within the Teesmouth and Cleveland Coast SPA and consideration of the potential for LSE to features of this SPA has therefore been undertaken.

The Teesmouth and Cleveland Coast SPA is designated to protect certain seabird species and a number of intertidal and terrestrial bird species.

The intertidal and terrestrial features of the Teesmouth and Cleveland Coast SPA include avocet (*Recurvirostra avosetta*), knot (*Calidris canutus*), redshank (*Tringa tetanus*), ruff (*Calidris pugnax*) and a non-breeding waterbird assemblage which includes as main components, gadwall (*Mareca strepera*), shoveler (*Spatula clypeata*), sanderling (*Calidris alba*), wigeon (*Vanelus vanelus*) and lapwing (*Mareca Penelope*).

Of these species, information on the long-term changes in bird usage of the Tees Estuary provided in Ward *et al.* (2003) indicates that only knot, redshank and sanderling may utilise areas that may be affected by impacts associated with the Development.

The seabird features of the Teesmouth and Cleveland Coast SPA include:

- Little tern (*Sternula albifrons*) and common tern (*Sterna hirundo*) in the breeding season;
- Sandwich tern (*Thalasseus sandvicensis*) during passage; and
- An assemblage of wintering seabirds, including herring gull (*Larus argentatus*) and black-headed gull (*Chroicocephalus ridibundus*).

The Humber pipeline is planned to make landfall between Easington and Out Newton on the East Riding of Yorkshire coast. The approach to landfall for the Humber pipeline is within the Greater Wash SPA which extends to MLWS.

The Greater Wash SPA is designated for:

- Little tern (*Sternula albifrons*), Sandwich tern (*Thalasseus sandvicensis*) and common tern (*Sterna hirundo*) in the breeding season; and
- Little gull (*Hydrocoloeus minutus*), red-throated diver (*Gavia stellata*) and common scoter (*Melanitta nigra*) in the non-breeding season.

3.1.1.2 Other SPAs for which seabird species are features

Due to their long foraging ranges some seabird features of many other SPAs may utilise parts of the sea which could be impacted by the Development and consideration of the potential for LSE to such features has also been undertaken.

Of the seabird species which breed regularly in Britain and Ireland, fulmar (*Fulmar glacialis*), cormorant (*Phalacrocorax carbo*), shag (*Phalacrocorax aristotelis*), gannet (*Morus bassanus*), three species of auk, six species of gull and five species of tern breed around the North Sea coast of England (DTI, 2001). Seabird colonies support nationally and internationally important populations at the Farne Islands, Coquet Island, the coastline from Scremerston near Berwick-Upon-Tweed in the north to Blyth in the south and at Flamborough Head and Bempton Cliffs.

As a preliminary step towards determining the SPAs for which there may be connectivity between the Development and qualifying features, a list of those SPAs within 100 km of the Development has been compiled.

Seabird features of SPAs that are within 100 km of the Development are listed in Table 1.

Consideration of LSE has also been given to the following two breeding seabird species which have foraging ranges exceeding 100 km:

- Part of the Development area is within the foraging range of puffin (*Fratercula arctica*) from the Farne Islands SPA, for which puffin is a listed species of the qualifying breeding seabird assemblage.
- Part of the Development area is also within the foraging range of kittiwake (*Rissa tridactyla*) from the St Abbs Head to Fast Castle SPA, for which kittiwake is a breeding feature, and the Farne Islands SPA, for which kittiwake is a listed species of the qualifying breeding seabird assemblage.

For foraging ranges of seabirds, the principal source of information has been those derived from a comprehensive set of studies as analysed in Woodward *et al*. (2019).

Table 1: SPAs within 100 km of the Development and their designated seabird features

SPA	Breeding Species	Non-Breeding Species
North Norfolk Coast	Sandwich tern (*Thasseleus sandvicensis*) Common tern (*Sterna hirundo*) Little tern (*Sternula albifrons*)	
Greater Wash	Sandwich tern (*Thasseleus sandvicensis*) Common tern (*Sterna hirundo*) Little tern (*Sternula albifrons*)	Little gull (*Hydrocoloeus minutus*)
The Wash	Common tern (*Sterna hirundo*) Little tern (*Sternula albifrons*)	
Gibraltar Point	Little tern (*Sternula albifrons*)	
Humber Estuary	Little tern (*Sternula albifrons*)	
Flamborough and Filey Coast	Kittiwake (*Rissa tridactyla*) Gannet (*Morus bassanus*) Guillemot (*Uria aalge*) Razorbill (*Alca torde*) Assemblage including fulmar (*Fulmarus glacialis*)	
Teesmouth and Cleveland Coast	Common tern (*Sterna hirundo*) Little tern (*Sternula albifrons*)	Sandwich tern (*Thasseleus sandvicensis*) Assemblage including herring gull (*Larus argentatus*) and black headed gull (*Chroicocephalus ridibundus*)
Coquet Island	Sandwich tern (*Thasseleus sandvicensis*) Common tern (*Sterna hirundo*) Arctic tern (*Sterna paradisaea*) Roseate tern (*Sterna dougallii*) Assemblage including puffin (*Fratercula arctica*) and black headed gull (*Chroicocephalus ridibundus*)	
Northumbria Coast	Arctic tern (*Sterna paradisaea*) Little tern (*Sternula albifrons*)	

3.1.1.3 SPAs excluded from consideration

Seabird features of other more distant SPAs have been excluded from consideration of LSE as follows:

- Part of the Development area is within the foraging range of gannet from the Forth Islands SPA for which gannet is a breeding feature. However, foraging areas of gannets are essentially specific to each colony, with little overlap (Wakefield *et al*. 2013). As such gannets from the Forth Islands SPA are not expected to forage within the Development area, which is foraging grounds for gannet of the Flamborough and Filey Coast SPA.

- The foraging range for fulmar is quoted as 542.3 km (+/- 657.9 km) which, to seaward, stretches across the North Sea basin. Fulmar is a listed species of the qualifying breeding assemblage of the Flamborough and Filey Coast SPA. It is not a feature of any other SPA within at least 300 km of the Development area and, given the extremely large area over which fulmars could forage, their dependence on the Development area is not considered significant. Consequently, fulmars from colonies in more distant SPAs are not considered prone to LSE from the Development.
- The Northumberland Marine SPA covers areas of the sea with the characteristics typical of areas used most heavily for foraging by breeding terns at existing colonies that are features of abutting sites (Northumbria Coast SPA, Farne Islands SPA and Coquet Island SPA). The site is consequently not included in Table 1 since potential for connectivity of the Development with species foraging within the site is determined in relation to the sites at which the relevant features breed.

3.1.2 Screening of features for potential presence in the Development area

Secondary screening of features and sites of the preliminary list for connectivity with the Development has utilised information drawn from departmental briefs for relevant SPAs, where available, and form the following studies on the observed distribution of seabirds as well as their foraging ranges.

- Waggitt *et al.* (2019)
- Bradbury *et al*. (2014)
- Kober *et al*. (2010)
- Stone *et al*. (1995)
- Woodward *et al.* (2019)
- Lawson *et al.* (2015)
- Wilson *et al.* (2014)
- Parsons *et al.* (2015)
- Wakefield *et al.* (2013)
- Cleasby *et al*. (2020)

This has served to refine the understanding of potential for connectivity between the Development and the qualifying species of the SPAs listed in Table 1, plus puffin and kittiwake of the Farne Islands SPA and kittiwake of the St Abbs Head to Fast Castle SPA.

Fulmar (*Fulmarus glacialis*)

Fulmar, have a large mean-maximum foraging range (542.3 km +/- 657.9 km; Woodward *et al*., 2019) meaning that they may forage across much of the North Sea basin.

Whereas the Development is within foraging range of fulmar from a number of breeding colonies, including within the Flamborough and Filey Coast SPA, for which this species forms part of the breeding assemblage for which the site qualifies, the density layers associated with Waggitt *et al*. (2019) suggest that offshore sea areas through which both Development pipelines will pass and the sea area in which the Endurance Store is located are not of importance to fulmar in the breeding and non-breeding seasons.

No LSE are anticipated for fulmar due to lack of connectivity with the Development.

Gannet (*Morus bassanus*)

Tracking data presented in Wakefield *et al*. (2013) suggest that the sea areas through which both Development pipelines will pass and the sea area in which the Endurance Store is located are of importance for gannet in the breeding season.

Consideration is therefore required to determine whether there could be LSE to gannet of the Flamborough and Filey Coast SPA.

Guillemot (*Uria aalge*)

The density layers associated with Waggitt *et al.* (2019) suggest that the sea areas through which both Development pipelines will pass and the area in which the Endurance Store is located are of importance for common guillemot outside of the breeding season.

Cleasby *et al.* (2020) also suggests that the Development will pass through sea areas within the utilisation distribution of common guillemot from Flamborough and Filey Coast SPA in the breeding season.

The generic mean-maximum foraging range, plus one standard deviation, of common guillemot is 95.2 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of common guillemot from the Flamborough and Filey Coast SPA.

Consideration is therefore required to determine whether there could be LSE to guillemot of the Flamborough and Filey Coast SPA.

Razorbill (*Alca torde*)

The density layers associated with Waggitt *et al.* (2019) suggest that inshore sea areas through which both Development pipelines will pass and the sea area in which the Endurance Store is located are of importance for razorbill outside of the breeding season.

Cleasby *et al.* (2020) also suggests that the Development will pass through sea areas within the utilisation distribution of razorbill from Flamborough and Filey Coast SPA in the breeding season.

The generic mean-maximum foraging range, plus one standard deviation, of razorbill is 122.2 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of razorbill from the Flamborough and Filey Coast SPA.

Consideration is therefore required to determine whether there could be LSE to razorbill of the Flamborough and Filey Coast SPA

Puffin (*Fratercula artica*)

The generic mean-maximum foraging range, plus one standard deviation, of puffin is 265.4 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of puffin from the Coquet Island SPA and the Farne Islands SPA (Teesside Pipeline).

Whereas the density layers associated with Waggitt *et al.* (2019) suggest that inshore sea areas through which the Teesside Pipeline will pass are of importance for puffin outside of the breeding season, they indicate no connectivity in the breeding season between birds from these SPAs and the sea areas in which the Development will be located.

No LSE are anticipated for puffin due to lack of connectivity with the Development.

Kittiwake (*Rissa tridactyla*)

The density layers associated with Waggitt *et al.* (2019) suggest that offshore sea areas through which both pipelines will pass are of importance for kittiwake throughout the year. In addition, the sea areas through which the Humber Pipeline will pass and the area in which the Endurance Store is located are of importance for kittiwake in the nonbreeding season.

The generic mean-maximum foraging range, plus one standard deviation, of kittiwake is 300.6 km (Woodward *et al.*, 2019) and means that the Development is within the foraging range of breeding kittiwake from the Flamborough and Filey Coast SPA and smaller colonies on the north-east coast of England.

Cleasby *et al.* (2020) also suggests that the Development will pass through sea areas within the utilisation distribution of breeding kittiwake from Flamborough and Filey Coast SPA in the breeding season.

Consideration is therefore required to determine whether there could be LSE to kittiwake of the Flamborough and Filey Coast SPA, the Farne Islands SPA, and/or the St Abbs to Fast Castle SPA.

Arctic tern (*Sterna paradisaea*)

The density layers associated with Bradbury *et al.* (2014) suggest that offshore sea areas through which the two pipelines will pass are of importance for Arctic tern during the breeding season.

The closest breeding colony of Arctic tern to the Development pipelines are at Coquet Island (Teesside Pipeline) and on the north Norfolk coast (Humber Pipeline).

Both breeding colonies are beyond the maximum site-specific (data available for Coquet Island only) (Wilson *et al.*, 2014) and generic foraging ranges (40.5 km; Woodward *et al.*, 2019) reported for Arctic tern. It is therefore unlikely that breeding birds will be present in the sea areas through which the Development will pass with birds that are present more likely to be non-breeding or immature birds.

The months incorporated into the seasons (Furness, 2015) used when modelling the density layers associated with Bradbury *et al.* (2014) are also likely to result in an overlap between the presence of breeding birds at colonies and the pre-breeding and post-breeding movements of birds. This can lead to certain sea areas appearing to be of importance in the breeding season with these areas actually representing the pre- and/or post-breeding movements of birds.

No LSE are anticipated for arctic tern due to lack of connectivity with the Development.

Common tern (*Sterna hirundo*)

The density layers associated with Bradbury *et al*. (2014) suggest that offshore sea areas through which the Humber pipeline will pass are of importance for common tern in the breeding season.

The closest breeding colonies to the two pipelines are at the Teesmouth and Cleveland Coast SPA (Teesside pipeline) and at the Humber Estuary (Humber pipeline). Common tern breeding colonies associated with the Greater Wash SPA are more distant, at Blakeney Point and Scolt Head on the Norfolk coast, approximately 90 km from the Development.

The generic mean-maximum foraging range, plus one standard deviation, of common tern (26.9 km; Woodward *et al.*, 2019) suggests connectivity between the Teesmouth and Cleveland Coast SPA and the Development.

Consideration is therefore required to determine whether there could be LSE to common tern of the Teesmouth and Cleveland Coast SPA.

Little tern (*Sternula albifrons*)

The density layers associated with Bradbury *et al.* (2014) do not suggest that the sea areas through which both Development pipelines will pass are of importance for little tern in the breeding or non-breeding seasons of the species.

Whereas the Teesside pipeline is located close to little tern breeding colonies which are part of the Teesmouth and Cleveland Coast SPA, site-specific foraging range data presented in Wilson *et al.* (2014) suggests no connectivity between little terns from the Teesmouth and Cleveland Coast SPA and the Teesside Pipeline. The little tern colony within the SPA has been located at Seaton Carew since 2019 having been previously located at Crimdon Dene to the north of Hartlepool. The Teesside Pipeline is beyond the site-specific foraging range of little tern from both breeding locations and therefore an LSE is discounted for little tern.

Site-specific foraging data for little tern from the Humber Estuary SPA indicates birds forage up to 6 km along the shore from the site of the little tern colony at the Lagoons Site of Special Scientific Interest

(Parsons *et al.*, 2015) which is approximately 3 km from the Humber Pipeline landfall. There is no information on the seaward extent of the foraging behaviour of birds from the SPA, but generic foraging range information suggests a mean-maximum foraging range of 5 km (Woodward *et al.*, 2019).

The colony of the Humber Estuary SPA would also forage within the northern part of the Greater Wash SPA.

Consideration is therefore required to determine whether there could be LSE to little tern of the Humber Estuary SPA and the Greater Wash SPA.

Roseate tern (*Sterna dougallii*)

Roseate tern is not included in the analyses presented in Waggitt *et al.* (2019), Bradbury *et al*. (2014), Kober *et al.* (2010) or Stone *et al.* (1995). The closest breeding colony to the Development is located at Coquet Island SPA. The mean-maximum foraging range, plus one standard deviation, of roseate tern is 23.2 km (Woodward *et al*., 2019) which suggests the Development is beyond the foraging range of the species from Coquet Island SPA which is more than 80 km from the Development area.

No LSE are anticipated for roseate tern due to lack of connectivity with the Development.

Sandwich tern (*Thalasseus sandvicensis*)

The density layers associated with Bradbury *et al.* (2014) suggest that inshore sea areas through which the Teesside Pipeline will pass are of importance for Sandwich tern in the breeding season.

The closest extant breeding colony is to the north of the Teesside cable at Coquet Island although generic foraging range data (57.5 km; Woodward *et al.*, 2019) suggests no connectivity between this colony and the Teesside Pipeline.

It is therefore unlikely that breeding birds will be present in the sea areas through which the Development will pass, with birds that are present more likely to be nonbreeding or immature birds.

The months incorporated into the seasons (Furness, 2015) used when modelling the density layers associated with Bradbury *et al.* (2014) are also likely to result in an overlap between the presence of breeding birds at colonies and the pre-breeding and post-breeding movements of birds. This can lead to certain sea areas appearing to be of importance in the breeding season with these areas actually representing the pre- and/or post-breeding movements of birds.

No LSE are anticipated for Sandwich tern due to lack of connectivity with the Development.

Little gull (*Hydrocoloeus minutus*)

The maps presented in Kober *et al.* (2010) suggest that the inshore areas of the Humber pipeline are of importance for little gull in the breeding season.

The closest SPA at which little gull is a designated feature is the Greater Wash SPA, where the species is a feature in the non-breeding season, with the main concentration of little gull within the SPA in the sea areas adjacent to The Wash (Lawson *et al.*, 2015).

Little gull occurs in UK waters during the non-breeding season and it is therefore unclear the distribution maps in Kober *et al*. (2010) suggest there are important areas in UK waters for little gull in the breeding season.

There is no evidence to suggest that the sea areas through which the Development will pass are of importance for little gull during the non-breeding season when bird will be present in UK waters.

No LSE are anticipated for little gull due to lack of connectivity with the Development.

Herring gull (*Larus argentatus*)

The offshore areas through which the Teesside Pipeline passes are important in the breeding season. The Development is beyond the foraging range of herring gull from those SPAs at which herring gull is a designated breeding feature (85.6 km; Woodward *et al.*, 2019).

Herring gull are a listed part of the non-breeding assemblage of Teesmouth and Cleveland Coast SPA

The density layers associated with Waggitt *et al.* (2019) suggest that inshore sea areas through which both Development pipelines will pass are of importance for herring gull outside of the breeding Season.

Consideration is therefore required to determine whether there could be LSE to herring gull of the Teesmouth and Cleveland Coast SPA.

Red-throated diver (*Gavia stellata*)

The density layers associated with Bradbury *et al.* (2014) suggest that inshore sea areas through which Humber Pipeline will pass is of importance for red-throated diver in the non-breeding season. These areas correspond with the Greater Wash SPA of which red-throated diver is a qualifying feature in the non-breeding season. Lawson *et al.* (2016) suggests that the area through which the Humber pipeline will pass supports moderate densities of red-throated diver in the non-breeding season.

Red-throated diver does not breed in England and the foraging range of the species from breeding locations in Scotland does not interact with the sea areas in which the Development is located (Woodward *et al.*, 2019).

Consideration is therefore required to determine whether there could be LSE to red throated diver of the Greater Wash SPA.

Common scoter (*Melanitta nigra*)

The maps presented in Stone *et al*. (1995) do not suggest that the sea areas associated with the Development are of importance for common scoter at any point during the year. Since Stone *et al*. (1995), there has been no evidence of substantial changes in the distribution of common scoter in recent years to suggest that the Development will interact with areas of high density for this species. This is supported by the survey data underpinning the designation of the Greater Wash SPA which suggests important areas for common scoter occur in the outer reaches of The Wash (Lawson *et al*., 2015) rather than further north toward the Development area.

No LSE are anticipated for common scoter due to lack of connectivity with the Development.

3.1.3 Qualifying features for LSE determination

The following features of the named SPAs have connectivity with the Development and have consequently been identified for consideration of LSE in respect to each of the impact mechanisms identified for the Development.

Flamborough and Filey Coast SPA

- Gannet (*Morus bassanus*)
- Guillemot (*Uria allge*)
- Razorbill (*Alca torde*)
- Kittiwake (*Rissa tridactyla*)

Farne Islands SPA

- Kittiwake (*Rissa tridactyla*)

St Abbs Head to Fast Castle SPA

- Kittiwake (*Rissa tridactyla*)

Teesmouth and Cleveland Coast SPA

- Knot (*Calidris canutus*)
- Redshank (*Tringa totanus*)
- Sanderling (*Calidris alba*)
- Common tern (*Sterna hirundo*)
- Herring gull (*Larus argentatus*)

Humber Estuary SPA

- Little tern (*Sternula albifromns*)

Greater Wash SPA

- Little tern (*Sternula albifromns*)
- Red throated diver (*Gavia stellata*)

3.1.4 LSE Determination

The Development may have potential to impact features of SPAs by causing a reduction in the extent and/or quality of their foraging areas via the following mechanisms from planned activities:

- Reduction in prey density due to temporary displacement of prey as a response to physical disruption of the seabed for the installation of subsea infrastructure and pipelines, including shoreline crossings;
- Reduction in prey density due to temporary displacement of prey as a response to increased sediments in the water column following their suspension during installation activities;
- Temporary avoidance by birds of an area where underwater visibility is reduced because of high sediment suspension caused by seabed disturbance during e.g. pipeline installation;
- Temporary avoidance by birds of areas as a response to the physical presence of installation vessels and associated noise and light sources;
- Disturbance of waders from shoreline/foreshore due to noise from installation of trestles if HDD is the selected method for installation of the Teesside pipeline landfall;
- Reduction in prey density due to mortality of prey from disturbance of the seabed; and
- Reduction in prey density due to the permanent loss of seabed habitat on which prey species are reliant where Development structures are laid.

The potential for activities to result in LSE has been screened on the basis of the sensitivity of each feature for which connectivity has been established to the mechanisms of impact.

In relation to disturbance, the sensitivity scores presented in Wade *et al*. (2016) are used and, if not included in Wade *et al*. (2016), the sensitivity scores presented in Bradbury *et al*. (2014), are used. It is noted that the sensitivity scores presented in Wade *et al*. (2016) are based upon impacts associated with offshore wind farms and therefore the application of them to the Development is considered to be precautionary, with any equivalent impacts from the installation and operation of the Development considered to be lower in magnitude as the equivalent impacts associated with offshore wind farms involve larger spatial and temporal scales.

For habitat loss and effects on prey, the habitat flexibility scores provided in Wade *et al*. (2016) are used.

3.1.4.1 Reduction in prey availability in foraging areas

Little tern are largely restricted to foraging in shallower, nearshore waters and, if these habitats are impacted, have relatively limited opportunity to forage in other areas. There could be potential for LSE to little tern from Development activities that result in temporary or permanent reduction in prey from foraging areas. Such activities being those associated with the installation of the Humber pipeline, including its landfall, which cause disturbance of the seabed within the foraging range of little tern from the Easington Lagoons colony of the Humber Estuary SPA during the breeding season. These activities alter the seabed habitat and give rise to increased suspended sediment concentrations. This colony also utilises part of the Greater Wash SPA, for which little tern is a qualifying feature.

Red-throated diver is largely restricted to foraging in relatively shallow, nearshore waters and, if these habitats are impacted, have more limited opportunity to forage in other areas. There could be potential for LSE to red throated diver of the Greater Wash SPA from Development activities that result in temporary or permanent reduction in prey from foraging areas. Such activities being those associated with the installation of the Humber pipeline, including its landfall, which cause disturbance of the seabed and suspension of sediment within the Greater Wash SPA outside of the breeding season.

Conversely, gannet, guillemot, razorbill and puffin are not restricted to foraging in shallow, nearshore water and therefore have negligible sensitivity to this impact mechanism (Snow and Perrins, 2008). The impact to opportunistic and surface feeding seabirds such as kittiwake are also negligible.

The Development will not result in reduction of prey in foraging areas of waders such as knot, sanderling and redshank of the Teesmouth and Cleveland Coast SPA since these species forage in the inter-tidal zone. None of the three landfall options for the Teesside pipeline disturb the sands landward of MLWS.

It is concluded that LSE to red-throated diver and little tern cannot be ruled out from the temporary reduction in prey density in certain parts of their foraging areas due to disturbance of the seabed and/or increased suspended sediment in the water column.

3.1.4.2 Disturbance of birds from their foraging areas

Development activities may directly disturb birds leading to displacement from foraging or loafing areas, causing birds to move elsewhere, potentially affecting breeding productivity or survival rates at an individual or population level. A single, localised disturbance event does not have an immediate effect on the survival or productivity of an individual bird. However, repeated disturbance events could lead to displacement affecting the survival and productivity of a bird.

Disturbance may be either in response to light, noise or visual triggers from vessels or human activity or in response to increased suspended sediments in the water column making underwater foraging less favourable.

Installation of the Development will require the presence and activity of vessels at multiple work fronts within all parts of the Development offshore area including at pipeline landfalls.

The sensitivity of a species to disturbance events varies. Those species and species groups that are less sensitive to vessel movements include fulmar and gulls, opportunistic scavengers that will forage within tens of metres of machinery and moving vessels. Whilst there is evidence to demonstrate that gannet are displaced by structures, evidence suggests they are not disturbed by vessels (Wade *et al.*, 2016).

Of the species identified as SPA features with connectivity to the Development, guillemot, razorbill, red-throated diver, redshank, sanderling and knot are identified as being vulnerable to disturbance.

During foraging, knot utilise the intertidal zone at the Coatham Sands and Redcar Rocks areas of the Teesmouth and Cleveland Coast SPA (Natural England, 2018). Sanderling are found on the sandy beaches at Redcar and Coatham Sands with smaller numbers in Hartlepool Bay. Redshank can be found feeding on the intertidal mudflats, saltmarsh areas and intertidal rocky shores within the SPA. When roosting, for example at high tide when the intertidal zone is covered, all three species utilise areas away from the proposed landfall location (Ward *et al*., 2003).

The intertidal area at the Teeside landfall will not be exposed to significant disturbance during the shoreline crossing as the application does not propose any pipeline excavation on the intertidal foreshore i.e. the entry and exit pits for buried pipeline landfall are either in the shallow subitidal or inland. However one of the installation method options could require piling of trestles at approximately 1 km seaward of MLWS. The noise of piling could potentially cause disturbance to shoreline birds. Cutts *et al*. (2013) identify redshank and knot as being highly sensitive to noise disturbance whereas sanderling is considered to have a low sensitivity.

Given the vulnerability to disturbance, there could be potential for LSE to the following:

- Guillemot of the Flamborough and Filey Coast SPA due to vessel activity associated with installation of the Humber pipeline, including its landfall and offshore parts of the Teesside pipeline;
- Razorbill of the Flamborough and Filey Coast SPA due to vessel activity associated with installation of all parts of the Development and associated with the operation of the Store;
- Red-throated diver of the Greater Wash SPA due to vessel activity outside of the breeding season associated with the installation of the Humber pipeline within the SPA, including landfall;
- Knot of the Teesmouth and Cleveland Coast SPA due to noise from piling of trestles if HDD were selected for the Teesside pipeline shoreline crossing and the need for piled trestles was deemed necessary; and
- Redshank of the Teesmouth and Cleveland Coast SPA due to noise from piling of trestles if HDD were selected for the Teesside pipeline shoreline crossing and the need for piled trestles was deemed necessary.

3.1.4.3 Mortality to prey

Adult fish on which seabirds' prey are highly mobile and there is little likelihood of direct mortality from direct seabed impacts to adult and sub-adult fish from either crushing or smothering. Fish are generally highly mobile and sensitive to pressure changes and visual stimuli, and it is therefore expected that the majority of fish in the path of the proposed operations will avoid physical damage. Given the wide area of similar habitat available and the temporary nature of the operations it is expected that fish will move outside the area of disturbance while installation activities are ongoing, and the Development area will be rapidly re-colonised following the cessation of installation activities.

Conversely, fish eggs cannot actively avoid impact.

Offshore installation is expected to take place between March and September. The works may therefore coincide with spawning periods for herring, lemon sole, sprat, plaice, whiting, sole (nearshore part of Humber Pipeline route only) and Nephrops (nearshore part of Teesside Pipeline route only; Coull *et al*., 1998). The majority of these species spawn in the water column over large areas, therefore the proposed operations are expected to affect only a small proportion of the eggs, spawn and juveniles of each affected species.

Sandeel and herring spawning are considered more vulnerable to seabed disturbance because these species spawn on the seabed and have very specific and limiting benthic habitat requirements. ‘Preferred’ herring spawning potential has been identified by offshore surveys for the Development at only four locations on the Teesside Pipeline route and three stations on the Humber Pipeline route, with no stations meeting the full criteria for suitable herring spawning areas (Gardline, 2022).

Pipeline installation activity, including nearshore trench backfill, offshore pipelay and rock placement, all of which require calmer summer weather, is expected to occur between April and September. This overlaps with the expected herring spawning period of August to October. Given the low potential for herring spawning in the Development area and, the small area of potential herring spawning ground that would be affected compared to the total area available regionally, it is considered unlikely that the Development will have a significant direct impact on herring spawning.

Although use of some part of the Development area by sandeel is apparent, sandeel spawn during the winter months (MacDonald *et al*., 2019) and therefore it is unlikely that installation activities will have any direct impact on sandeel spawning and recruitment.

The shellfish identified as being present in the area are also generally mobile, although brown crab, lobster and scallops are less capable of moving rapidly away from disturbance and may therefore tend to be subject to crushing or smothering. Individuals that are unearthed from the sediment or buried under sediment are likely to survive and re-establish themselves. Given the wide area of similar habitat available and the ongoing fishery activities in the area (which in themselves suggest reasonable rates of recovery), the proposed operations are not expected to have a significant direct impact on fish or shellfish populations.

LSE to seabird features of SPAs resulting from mortality to prey due to Development activities is consequently not deemed credible.

3.1.4.4 Permanent loss of prey habitat

The Development will install structures on the seabed that will cover a combined footprint estimated to be 1.05 km^2. This includes pipelines, cables, wellheads, manifolds, SSIV, monitoring equipment, and protective rock cover and concrete. This will result in a permanent loss of seabed habitat.

This represents a negligible proportion of the regional habitat supporting the production of fish, shellfish and benthic organisms that form the food chain of seabirds.

Boulders removed from the pipeline routes to allow installation will be moved to a 5 m corridor either side of the pipeline installation corridor. The area of the boulder clearance corridor is estimated to be approximately 3.72 km^2. This area will be subject to some degree of change to its present habitat type but remain a productive area for supporting prey species of seabirds.

There will be no LSE to seabird features of SPAs due to changes in prey resulting from permanent loss of seabed.

3.1.5 In-combination Effects

A large number of projects have been identified that will be contemporaneous with the Development and which could in-combination exacerbate any effects of disturbance or changes to prey availability on the features for which LSE cannot be ruled out.

The in-combination effects for these mechanisms of impact require consideration as part of the Appropriate Assessment.

3.1.6 Conclusions of LSE to Features of SPAs

Following completion of the Stage 1 assessment, the Secretary of State concludes that an appropriate assessment is required to determine whether the Development could adversely affect the integrity of the Greater Wash SPA, the Humber Estuary SPA, the Flamborough and Filey Coast SPA or the Teesmouth and Cleveland Coast SPA.

The assessment is required in relation to the potential for features listed in Table 2 to be impacted through the mechanisms identified in that table due to the Development activities stated for each mechanism.

Table 2: Mechanisms of potential impact to features of SPAs for which appropriate assessment is required.

SPA	Species	Impact	Activity
Greater Wash	Little tern	Reduced extent/value of foraging area	Humber PL installation
	Red-throated diver	Reduced extent/value of foraging area	Humber PL installation
		Disturbance by physical presence of vessels	Humber PL installation
Humber Estuary	Little tern	Reduced extent/value of foraging area	Humber PL installation
Flamborough and Filey Coast	Guillemot	Disturbance by physical presence of vessels	All Development installation
	Razorbill	Disturbance by physical presence of vessels	All Development installation
Teesmouth and Cleveland Coast	Knot	Disturbance due to noise from trestle piling	Teesside PL installation
	Redshank	Disturbance due to noise from trestle piling	Teesside PL installation

3.2 Special Areas of Conservation

The **Southern North Sea SAC** (SNS SAC) has been designated due to its importance as habitat for harbour porpoise (*Phocoena phocoena*) during both the summer and winter months (JNCC, 2019). The Endurance Store, and both pipeline routes (Teesside Pipeline and Humber Pipeline), are partly located within the summer habitat for the species. Additionally, the Humber Pipeline route passes adjacent to an area of harbour porpoise winter habitat prior to its landfall.

No other SACs are directly intersected by the Development infrastructure. However, there are a number of sites located within 50 km of the Development:

- Humber Estuary SAC is located *c.* 4 km south-southwest of the Humber Pipeline route, designated for a number of Annex I habitats including 'Sandbanks which are slightly covered by seawater all the time', 'Coastal lagoons', 'Salicornia and other annuals colonizing mud and sand', 'Atlantic salt meadows (Glauco-Puccinellietalia maritimae)', 'Embryonic shifting dunes', 'Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')', 'Fixed coastal dunes with herbaceous vegetation ('grey dunes')', 'Dunes with *Hippopha rhamnoides'*, and Annex II species grey seal (*Halichoerus grypus*), sea lamprey (*Petromyzon marinus*) and river lamprey (*Lampetra fluviatilis*).
- Flamborough Head SAC is located *c.* 19 km west-northwest of the Humber Pipeline route, designated for Annex I 'Reefs', 'Vegetated sea cliffs of the Atlantic and Baltic Coasts ', and 'Submerged or partially submerged sea caves'.
- Dogger Bank SAC is located *c.* 21 km north-northeast of the Endurance Store, designated for Annex I 'Sandbanks which are slightly covered by seawater all the time'.
- Inner Dowsing, Race Bank and North Ridge SAC (*c.* 45 km east-southeast of the Humber Pipeline route); designated for Annex I 'Sandbanks which are slightly covered by seawater all the time' and 'Reefs'.

The only SAC which is considered to have a potential LSE is the SNS SAC. A summary of all SACs considered for LSE is provided in Table 3, including a justification for those that have been ruled out.

Table 3 Stage 1 screening results for LSE of SACs considered.

European Site	Distance from the Project (km)	Features	Potential Impact	LSE	Reasoning
Southern North Sea SAC	0	Harbour porpoise (*Phocoena phocoena*)	Injury and disturbance to harbour porpoise and fish (as prey species) through underwater noise from piling, seismic surveys, drilling, vessels and clearance of UXO (if required) across the Development area. An initial desk based UXO assessment was undertaken (see Section 3.2.3.1 of the ES). Based on the results, it is assumed that it will be possible to avoid any UXO encountered. Therefore, sound associated with UXO clearance is not considered further in this HRA. Seabed disturbance impacts on supporting habitat and prey species. Impacts to prey species from discharges to sea.	Yes	Within the project boundary.
Humber Estuary SAC	4	River lamprey (*Lampetra fluviatilis*)	Seabed disturbance (see details below). Underwater sound (see details above).	No	No impact will derive to their fluvial or estuarine habitat. During their sea-going life stage they have access to the open seas and all stresses therein. They are at no especial risk from sources of underwater noise from the Development.
		Sea lamprey (*Petromyzon marinus*)	Loss of habitat from seabed disturbance. Injury from underwater noise.	No	No impact will derive to their fluvial or estuarine habitat.

European Site	Distance from the Project (km)	Features	Potential Impact	LSE	Reasoning
					During their sea-going life stage they have access to the open seas and all stresses therein. They are at no especial risk from sources of underwater noise from the Development.
		Grey seal (*Halichoerus grypus*)	Disturbance at haul out sites. Underwater sound (see details above). Collision risk.	No	The closest haul out site is more than 4 km from the Development. Brasseur and Reijnders (1994, in Scottish Executive, 2007) suggest vessels more than 1,500 m from hauled out grey or harbour seals would be unlikely to evoke any reaction. Seals are discounted from the assessment of disturbance from piling operations due to low densities at the Endurance Store. The area has a baseline of moderate levels of vessel traffic. Increases in vessel traffic will be temporary and will mostly be travelling slowly. Collision risk is expected to be low and is not expected to result in LSE to the grey seal population of the Humber Estuary SAC.
		Annex I 'Sandbanks which are slightly covered by seawater all the time' Annex I 'Coastal lagoons'	Seabed disturbance.	No	There will be no direct or indirect impact to any of these features.

European Site	Distance from the Project (km)	Features	Potential Impact	LSE	Reasoning
		Annex I 'Salicornia and other annuals colonizing mud and sand' Annex I 'Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)' 'Embryonic shifting dunes' 'Shifting dunes along the shoreline with *Ammophila arenaria* ('white dunes')' 'Fixed coastal dunes with herbaceous vegetation ('grey dunes')' 'Dunes with *Hippopha rhamnoides'*			
Flamborough Head SAC	19	Annex I 'Reefs' Annex I 'Vegetated sea cliffs of the Atlantic and Baltic Coasts' Annex I 'Submerged or partially submerged sea caves'.	At these distances from the Development, the only potential seabed disturbance impact would be temporary indirect disturbance due to the suspension of sediments during installation activities.	No	There will be no direct impact to any of these features. The suspension of sediments during installation activities will be too far from these features for resettlement of sediments to cause significant effects on the habitats or benthos and fish associated with them.
Dogger Bank SAC	21	Annex I 'Sandbanks which are slightly covered by seawater all the time'			
Inner Dowsing, Race Bank and North Ridge SAC	45	Annex I 'Sandbanks which are slightly covered by seawater all the time' and 'Reefs'			

3.2.1 Conclusions of LSE to Features of Southern North Sea SAC

Appropriate assessment is required to consider potential direct and indirect impacts from the proposed Development alone and in-combination with other projects on the harbour porpoise qualifying feature of the SNS SAC.

Fish species are not qualifying features of the SNS SAC (JNCC, 2019); however, they are the main prey for harbour porpoise, and it is therefore important to understand potential impacts to these species to assess potential impacts on the SAC's integrity.

The AA will consider the following specific impacts (LSEs):

- Seabed disturbance impacting on prey species;
- Underwater sound injury and disturbance to harbour porpoise;
- Discharges to sea impacting on prey species; and
- Collision risk to harbour porpoise.

4 HRA STAGE 2: APPROPRIATE ASSESSMENT

The purpose of this AA is to determine whether or not an adverse effect on the integrity of the features of the sites identified can be ruled out as a result of the Development, alone or in combination with other plans and projects, in view of the site's conservation objectives and using the best scientific evidence available.

Whereas the LSE screening process establishes that a link exists between a source of impact and the conservation features of interest, and that this would likely result in significant impact, the AA considers whether the scale of impact is such that the integrity of the site would be adversely affected. The AA also takes account of relevant features of the project or measures envisaged to avoid, prevent, reduce or offset significant effects which will be subject to conditions of the Storage Permit Consent if granted by the North Sea Transition Authority (NSTA).

The AA for each site is provided separately in the following subsections.

5 APPROPRIATE ASSESSMENT FOR HUMBER ESTUARY SPA

There could be potential for LSE to the little tern feature of the Humber Estuary SPA during the breeding season during installation of the Humber pipeline up to and across the shoreline.

The mechanisms which could result in effects on little tern are:

- Localised reduction in prey density where prey selectively avoid areas where their food chain is impacted by disturbance of the seabed; and
- Reduced foraging effectiveness in areas where sediment loading in the water column is increased by activities which cause disturbance of the seabed thereby reducing visibility through water.

Further consideration has been given to these sources of impact to assess whether they have the potential to adversely affect the integrity of the site.

5.1 Conservation objectives

The site objectives established for the Humber Estuary SPA is that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

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

5.2 Assessment of the Development Alone

Little tern feed on highly mobile small fish (e.g. sandeel) or crustaceans in the upper water column. They are considered to have a high sensitivity to impacts associated with seabed disturbance given their relatively short foraging range, restricted foraging habitat and a low habitat flexibility.

Site-specific foraging range data for little tern suggests that little terns from the Easington Lagoons colony will forage up to 5 km along the shore. In addition, birds will forage up to 3 km seaward from the colony. This could therefore represent an area of up to 30 km^2, assuming a foraging rectangle extending 5 km north and south from the colony and 3 km seaward.

The Humber Pipeline makes landfall 3 km to the north of Easington Lagoon, passing through areas potentially used by little terns for foraging.

5.2.1 Seabed disturbance causing changes to little tern prey availability

There are a number of construction techniques under consideration for the Humber landfall including HDD, direct pipe, micro tunnel or micro tunnel and cofferdam. Of these, the option with the largest potential to impact the foraging area of little tern is micro tunnel and cofferdam. The cofferdam will be constructed on the foreshore above MLWS with trenching across the intertidal beach area into the subtidal. The cofferdam would be composed of two rows of sheet piles, approximately 7 m apart, from the low mark to the seaward end of the work platform, a length of approximately 100 m. This landfall option also involves a beach access route of 6 x 400 m and beach work platform of 40 x 25 m, resulting in a total area of potential habitat loss on the beach of 0.004 km^2.

This landfall option would involve a pre-cut shore approach trench from the end of the cofferdam to 8 m LAT (700 x 52 m), potentially disturbing an area of 0.036 km^2.

An additional 0.64 km^2 has been estimated to be directly affected by the landfall working area which includes the jack-up barge legs, pipelay vessel anchor spread and trench. This gives a total of 0.68 km^2 impacted seabed area. It is not considered necessary to include an additional buffer around this impacted footprint since little tern are not considered sensitive to disturbance and are likely therefore to forage around any construction activity.

The affected seabed area would therefore represent approximately 2.3% of the foraging area.

Landfall works may require the jack-up barge to be present for up to 12 months, and any impact to little tern is therefore assumed to cover a complete breeding season.

Little tern typically spends the majority of time foraging close to their breeding colonies (Parsons *et al*., 2015), and therefore disturbance occurring 3 km from the colony will have a proportionately lower impact.

Neither little tern, nor their prey, are explicitly tied to the 0.68 km^2 of habitat that could be affected. The response of prey species if they were affected by seabed disturbance would be to move away from, or avoid, the impacted zone. Reduction of prey in the area impacted could consequently lead to a commensurate increase in the adjacent area with little overall effect on availability for breeding little tern.

Little tern productivity at the Easington Lagoons colony was recorded to be above the five-year average in each of the two years following the construction of the York pipeline in 2012 (Austin, 2014), indicating that little tern productivity has not previously been adversely affected by pipeline construction in nearby, similar habitat.

It is therefore considered highly unlikely that seabed disturbance due to the proposed installation activities will affect productivity of the local little tern population in the year of pipeline installation or result in noticeable long-term effects.

5.2.2 Suspended sediments impairing feeding success

Increased sediment load in the water column due to the re-suspension of sediment from trenching, pipelay and seabed installation activities may affect the feeding behaviour of seabirds by reducing visibility and the ability of birds to find food, both within the Development area and down-current as far as the increased sediment load is present.

These impacts are likely to be temporary in nature, during the construction and installation activities within the foraging area of little tern of the Easington Lagoons colony.

The area over which seabed disturbance may lead to high suspended sediment concentrations is assumed to be twice the calculated are of direct seabed disturbance. This assumption is informed by the review of BERR (2008) which summarises modelled and observed indirect impact extents from sediment re-settlement following cable trenching operations in the southern North Sea.

The area where little tern may find foraging more difficult overlaps with the area from which they may be excluded due to seabed disturbance activities. The cumulative area of impact could therefore be 1.36 km^2, or 4.5% of the nominal foraging area available.

Loss of 4.5 % of the area does not equate to loss of 4.5 % of prey available as prey will move rather than be lost and there is a much larger area that remains available to little tern for feeding, including those more favourable areas within close proximity of the colony.

There is not anticipated to be an effect on the productivity of the Easington Lagoons colony of little tern and the Development is not expected to adversely affect the population of the Humber Estuary SPA or the extent, distribution, structure and function of supporting habitats of little tern.

Whereas foraging habitat is important to the status of the colony, the availability of prey to breeding little terns will not be significantly diminished even if a portion of the prey will be temporarily displaced. The greater concern to the viability of the SPA population of little tern relates to the availability of undisturbed nesting habitat both at the Easington Lagoons and at formerly occupied sites along the Holderness peninsula and within the Humber estuary including its south bank.

The Secretary of State is satisfied that the Development alone will not give rise to adverse effects on the integrity of the little tern feature of the Humber Estuary SPA.

5.3 Assessment In Combination with Other Developments

No projects have been identified that will act cumulatively with the Development to impact little tern of the Humber Estuary SPA.

6 Consequently, no adverse effect on integrity of the Humber Estuary SPA is concluded for the Development including in-combination with other developments.APPROPRIATE ASSESSMENT FOR GREATER WASH SPA

In Stage 1 it was not possible to rule out potential for LSE to the little tern feature of the Greater Wash SPA due to potential effects on the breeding colony of little tern at Easington Lagoons. All other breeding colonies that utilise the Greater Wash SPA were outside the range of impacts from the Development. The appropriate assessment for the little tern feature of the Humber Estuary SPA concluded that there would be no adverse effect on the Easington Lagoons colony, and it can consequently **be concluded that there will be no adverse effect on the integrity of this feature of the Greater Wash SPA.**

The Stage 1 assessment concluded that there could be potential for LSE to the red-throated diver feature of the Greater Wash SPA due to activities for the installation of the Development during the non-breeding season.

The mechanisms which could result in effects on red-throated diver are:

- Reduced access to preferred foraging areas in response to being disturbed by the physical presence of vessels associated with the installation of the Development;
- Localised reduction in prey density where prey selectively avoid areas where their food chain is impacted by disturbance of the seabed by activities related to the installation of the Development; and
- Reduced foraging effectiveness in areas where sediment loading in the water column is increased by activities related to the installation of the Development which cause disturbance of the seabed thereby reducing visibility when diving.

Further consideration has been given to these sources of impact to assess whether they have the potential to adversely affect the integrity of the site for red-throated diver.

6.1 Conservation objectives

The site objectives established for the Greater Wash SPA is that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

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

6.2 Assessment of the Development Alone

Red-throated diver is a non-breeding feature of the Greater Wash SPA through which the Humber pipeline passes for a distance of 11.4 km on its approach to landfall on the Holderness coast.

Construction activities associated with the Humber Pipeline landfall may occur during the period July 2025 to January 2026 and installation of the nearshore part of the Humber Pipeline may occur between March and September 2026. Both activities could therefore overlap with the period during which red-throated diver will be present in the Greater Wash SPA.

6.2.1 Disturbance due to physical presence of vessels

Red-throated divers are considered to have a high vulnerability to disturbance and have a low habitat flexibility meaning they are restricted in terms of the habitats they are able to exploit.

Red-throated divers are known to be displaced by marine industry activities, but the energetic, physiological and demographic consequences of displacement are currently unknown. If divers are already energetically constrained, they may struggle to meet the additional energetic demands following displacement (JNCC, 2020a).

6.2.1.1 Disturbance due to vessel activity from the Development alone

Lawson *et al.* (2016) suggests that the area through which the nearshore section of the Humber Pipeline will pass supports moderate densities of the species. Beyond 20 km offshore densities drop below 0.05 individuals per km^2 and it is assumed that there are unlikely to be significant numbers of red-throated diver in other sea areas through which the Humber Pipeline route or Teesside Pipeline route will pass or at the Endurance Store.

Works at the landfall will involve the use of a jack-up barge which will be located in the nearshore for 360 days and it is assumed for the purposes of this assessment that this will occur during one full season when red-throated divers are present in UK waters (i.e. October to March).

A 2 km buffer is generally used when assessing disturbance impacts from vessels and it is considered appropriate for use in this assessment. If this buffer is applied to the jack-up barge the zone of influence would cover approximately 12.6 km^2, although a proportion of this buffer will occur over land depending on the exact location of the barge. This represents only 0.4% of the total Greater Wash SPA area.

The average density in the area affected within a 2 km buffer around the jack-up barge is approximately 0.6 birds/km^2. When multiplied by the area affected (12.6 km^2) provides an affected population of approximately seven birds. The SPA population of red-throated diver is 1,407 birds. An affected population of seven birds therefore represents 0.5% of the SPA population.

Mortality rates associated with the disturbance of birds due to construction activities are unknown with no evidence that displacement by vessels will result in direct mortality of individual birds. Mortality as a consequence of displacement is more likely to occur as a result of increased densities outside of the impacted area, which may lead to increased competition for resources. Displacement of birds from low-density areas (e.g. the area associated with the cable route) is less likely to result in mortality as these areas are likely to be of lower habitat quality. As such, the use of a 1% mortality rate is considered appropriate for this assessment.

Applying a 1% mortality rate to the seven birds potentially displaced results in a displacement mortality of less than one bird and suggests a low likelihood even of one bird suffering. This level of impact is considered to be of an insignificant magnitude in relation to the SPA population of red-throated diver. If a single bird suffered displacement mortality this would represent 0.07% of the SPA population of red-throated diver. It is therefore considered that activities associated with the landfall installation do not have the potential to result in an adverse effect on the integrity of the SPA.

Other vessels will be involved in the Development installation operating along the Humber pipeline route within the Greater Wash SPA, albeit operating for a shorter period at any one location than is the case for the jack-up barge. The full sequence of vessel operations is not known, however a worst-case disturbance of red-throated divers would be provided if vessels were positioned along the Humber pipeline route such that the zone of influence extended as a 2 km buffer along all of the pipeline length within the Greater Wash SPA. This would give a total affected area of 45.6 km^2, approximately four times that assumed for the jack-up barge. Applying the same average density, approximately 27 birds could be affected, representing 2% of the SPA population.

It is noted that this would not be a realistic case given that the non-breeding season is not best suited to offshore construction activities and that the presence of any vessels along this section of the route will be short lived, let alone vessels along the full length of the section. Once a vessel has moved on from a position, the source of disturbance is removed, and birds are anticipated to return at any time.

Even for this unrealistic ‘bookend’ case, assuming a 1% mortality rate would imply less than one bird could be affected due to disturbance by vessels.

A single individual represents 0.07% of the population, as previously noted for the jack-up barge in isolation, and it is concluded that disturbance from all vessels operating for the installation of the **Development will not cause an adverse effect on the integrity of the red-throated diver feature of the Greater Wash SPA.**

6.2.1.2 Disturbance due to vessel activity in combination with other developments

There are a number of projects that could act in-combination with the Development to impact the red-throated diver feature of the Greater Wash SPA. These include developments for the installation of transmission infrastructure associated with OWFs, operational vessel movements to oil and gas infrastructure and OWFs and vessel movements associated with aggregate extraction.

In the wider regional context, a significant number of vessels transit the Greater Wash SPA to ports along the Norfolk, Lincolnshire and Yorkshire coasts, providing a significant baseline background of activity.

The addition of a small number of construction vessels associated with the pipeline installation will not be distinguishable above existing baseline vessel presence. The baseline level of shipping is already relatively high, and the presence of installation vessels associated with the Development will not cause a discernible or lasting increase in the potential disturbance arising from vessels in this area.

The Scroby Sands and Humber Gateway offshore wind farms are both partly located within the Greater Wash SPA. Scroby Sands wind farm comprises 30 turbines and the Humber Gateway wind farm comprises 73 turbines. The Greater Wash SPA covers an area of 3,535.8 km^2. The area occupied by these offshore wind farms within the SPA is very small in proportion to the remaining habitat available to birds. The potential disturbance associated with the proposed temporary vessel activity during the construction phase of the Development is smaller still. There is the potential that cumulative impacts could arise with other projects in the vicinity of the Development with overlapping construction timelines, however, it is expected that vessel routes to and from nearby projects will already be well used, and therefore, there will not be a discernible increase in the potential disturbance caused. Potential impacts to red-throated divers from other developments in isolation will be subject to separate assessment, the conclusion of which will depend on the number and duration of vessels required. Whether these developments alone result in tangible impacts to red-throated diver or not, the insignificant level of disturbance caused by the Development would have a negligible in-combination addition.

6.2.2 There is uncertainty when the Humber pipeline will be installed which means it is not currently possible to meaningfully ascertain what other projects or activities will also be underway at the time of construction. A full evaluation of the total disturbance in the SPA is therefore not possible until closer to the construction date, whereupon a more comprehensive in-combination assessment can be undertaken. Prior to the installation of the pipeline a further pipeline specific habitats regulations assessment (including a detailed in-combination assessment of other projects) will be undertaken at the time of a pipeline Screening Direction being submitted to the Department. At this point it will be clearer what other plans and projects will be in their operational or construction phases and a more accurate assessment will be undertaken. Further consideration of condition requirements will be considered as part of the decision-making process..Reduction in prey density

6.2.2.1 Displacement due to locally reduced prey density from the Development alone

The applicant has estimated the area of seabed within the Greater Wash SPA that could be impacted during installation of the Humber pipeline as being 1.47 km^2. This includes a 0.83 km^2 footprint of the trenching works and 0.64 km^2 associated with the landfall working area described above.

The estimated area represents approximately 0.04% of the total Greater Wash SPA area.

The seabed within the Development area is dominated by sandy and mobile sediments. Such seabed sediment types are typically rapidly recolonised by benthic fauna and flora following disturbance, particularly if disturbance is not frequent (National Research Council, 2002; Newell *et al*., 1998).

Evidence of these fast recovery rates of benthic communities was observed and reported by Salmon (2011) following installation of the nearby Langeled pipeline.

If seabed disturbance were to reduce the density of prey species along the pipeline route to the extent that red-throated diver avoided the area until it has been recolonised, the extent of foraging area within the Greater Wash SPA would be reduced, resulting in a higher density of birds in the remaining areas.

The average density of red-throated divers in the Greater Wash SPA that is expected to be affected by activities associated with the Development is 0.28 birds/km^2. When multiplied by the area affected (1.47 km^2), this provides a potentially affected population of less than one bird (approximately 0.4 birds).

The SPA population of red-throated diver is 1,407 birds and the potentially affected population therefore represents less than 0.03% of the SPA population.

Mortality rates associated with habitat loss due to construction activities are unknown, with no evidence that habitat loss will result in direct mortality of individual birds. Mortality as a consequence of displacement is more likely to occur as a result of increased densities outside of the impacted area, which may lead to increased competition for resources. As acknowledged for impacts from disturbance by vessels, the use of a 1% mortality rate is considered appropriate for this assessment.

Applying a 1% mortality rate results in a displacement mortality of less than one bird. Statistically this would be 0.004 birds which suggests that the likelihood of even one mortality is remote. This level of impact is considered to be of an insignificant magnitude in relation to the SPA population of red-throated diver (1,407 birds).

It is noted that the area of seabed disturbance is completely within the area assessed for vessel disturbance and so displacement mortality has effectively already been accounted for. The cumulative impact of the two mechanisms is therefore no more than the greater of the two.

Given the expected rapid recovery of benthic habitats following pipeline installation and the relatively small footprint of construction activities associated with the Development relative to the total area of the SPA, **it is concluded that the impact of direct loss of seabed habitat used by red-throated diver associated with the Greater Wash SPA will not result in an adverse effect on the integrity of the SPA.**

6.2.2.2 Displacement due to reduced prey in combination with other developments

There are a number of projects that could act in-combination with the Development on the red-throated diver feature of the Greater Wash SPA, including the presence of OWFs, the installation of transmission infrastructure associated with OWFs and the installation of other subsea cables and aggregate extraction.

The impact from the Development alone is considered to be negligible and that disturbance of the seabed for the Development would have a negligible addition to any impact resulting from seabed disturbance from any other development. **It is therefore concluded that the Development alone or**

in-combination with other developments will not have an adverse effect on the integrity of the Greater Wash SPA in relation to the red-throated diver feature.

6.2.3 Reduction in foraging effectiveness

Red-throated divers tend to perform shallow dives of 2–6 metres depth, rarely diving deeper than 20 metres. Total time spent in foraging behaviour each day is relatively consistent throughout the breeding and non-breeding season, at around 3–5 hours per day, with no evidence of foraging at night.

Where seabed disturbance causes suspension of sediments in the water column at concentrations that impair the feeding ability of red-throated divers, birds may avoid such areas, reducing the foraging habitat available within the Greater Wash SPA.

Following suspension, sediments are anticipated to resettle nearby, with some sediment dispersing further afield on sea currents or tidal streams. The residence time of suspended sediment in the water column at concentrations that could impact red throated divers are short.

The zones of impact from the suspension of sediment within the areas used by red-throated diver are estimated to be approximately double those areas of direct impact of seabed disturbance, as identified in the assessment of little tern.

The impacted area follows the Humber pipeline corridor within the Greater Wash SPA and is substantially smaller than the area of impact assumed for disturbance from vessel activity along this corridor. As such no additional disturbance would result above and beyond that assessed for vessel activity and it is concluded that reduction in foraging effectiveness on account of suspended sediments from the Development alone or in-combination with other developments would not have an adverse effect on the integrity of the Greater Wash SPA in relation to the red-throated diver feature.

6.2.4 Conclusion of assessment for the Greater Wash SPA

None of the mechanisms of impact assessed are considered to have a significant effect on the red-throated diver population of the Greater Wash SPA nor to have a significant effect on the extent, distribution, structure and function of supporting habitats for this species.

The Secretary of State is satisfied that there will be no adverse effect on the integrity of the Greater Wash SPA from the Development alone and that the Development will have a negligible contribution to any impacts from other developments in-combination.

7 APPROPRIATE ASSESSMENT FOR TEESMOUTH AND CLEVELAND COAST SPA

There could be potential for LSE to the knot and redshank features of the Teesmouth and Cleveland Coast SPA during the breeding season during installation of the Teesside pipeline across the shoreline.

The mechanisms which could result in effects on knot and redshank is:

- Disturbance due to in-air noise generated by hydraulic hammers used in the piling of trestles.

Further consideration has been given to this source of impact to assess whether they have the potential to adversely affect the integrity of the site.

7.1 Conservation objectives

The site objectives established for the Teesmouth and Cleveland Coast SPA is that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

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

7.2 Assessment of the Development Alone

The applicant is evaluating which of three techniques would be most feasible for achieving the shoreline crossing for the Teesside pipeline. All three options include boring under the shoreline. The HDD option would drill a 1 m diameter bore from within the NZT site emerging on the seabed at a depth of 5 mLAT approximately 800 m to seaward of the MLWS. The pipeline would then be pulled through the drilled bore from the seaward side. During this activity, the pipeline would be through a temporary casing pipe supported on a trestle close to the drill punch out point at 5 mLAT. The trestle would be secured on the seabed either by gravity-based structures or by a set of eight pin piles that would be inserted using an impact piling hammer. The hammer would also be used for installation of the casing pipe. If piling is required for the trestles this will occur further from the shore than the punch out point, approximately 1 km seaward of MLWS. The eight piles and the casing pipe would each be installed within a 12-hour shift.

During foraging knot utilise intertidal parts of the Coatham Sands and Redcar Rocks and redshank feed on the intertidal mudflats and saltmarsh areas and intertidal rocky shores within the SPA. Shorebirds that use intertidal habitats feed within the area exposed during low tides (Goss-Custard, 1977; Gils *et al*., 2006). As the tide rises, they follow the rising tide and return to roost during high tide.

Both knot and redshank are highly sensitive to noise disturbance (Cutts *et al*, 2013). However, no reaction would be anticipated from either species to piling noise at a distance of 1 km. **It is consequently concluded that there would be no adverse effect to either knot or redshank features of the Teesmouth and Cleveland Coast SPA from the Development alone.**

7.3 Assessment in combination with other projects

Construction of the Net Zero Teesside (NZT) combined cycle gas power generation plant and compression facilities on land to the south of the Coatham Sands is planned to overlap with the landfall construction for the Teesside pipeline.

The Secretary of State has published an assessment of the potential impacts of the NZT development (DESNZ, 2024) which concludes that there will be no adverse effect on integrity of the Teesmouth and Cleveland Coast SPA due to noise impacts.

It is concluded that there would be no adverse effects on the integrity of the Teesmouth and Cleveland Coast SPA due to impacts from piling noise of the Development alone and in-combination with other developments.

8 APPROPRIATE ASSESSMENT FOR FLAMBOROUGH AND FILEY COAST SPA

There could be potential for LSE to the guillemot and the razorbill features of the Flamborough and Filey Coast SPA due to activities for the installation of the Development at any time of year.

The mechanism which could result in effects on guillemot and razorbill is:

- Reduced access to preferred foraging areas in response to being disturbed by the physical presence of vessels associated with the installation of the Development;

Further consideration has been given to this source of impact to assess whether it has the potential to adversely affect the integrity of the site.

8.1 Conservation objectives

The site objectives established for the Flamborough and Filey Coast SPA is that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the aims of the Wild Birds Directive, by maintaining or restoring:

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

8.2 Assessment of the Development Alone

Disturbance from vessel activity may displace birds from an area of sea, effectively amounting to habitat loss during the period of disturbance (Drewitt and Langston, 2006). Development activities may directly disturb birds leading to displacement from foraging or loafing areas, causing birds to move elsewhere and potentially affecting breeding productivity or survival rates at an individual or population level. A single, localised disturbance event does not have an immediate effect on the survival or productivity of an individual bird. However, repeated disturbance events could lead to displacement affecting the survival and productivity of a bird.

The foraging ranges for guillemot and razorbill (Woodward *et al*, 2019) suggest connectivity of both species with all parts of the Development.

The density layers associated with Waggitt *et al*. (2019) suggest limited usage of the Endurance Store area by guillemot and razorbill in those months during which installation activities will occur with the exception of August and September when fledged birds and their accompanying adults are dispersing away from breeding colonies.

More detailed utilisation data, presented as part of Cleasby *et al*. (2020) does suggest that the pipelines will run through areas of moderate to high usage for both species, although the Cleasby *et al*. (2020) data shows no connectivity with the Endurance Store.

Disturbance could also occur in the non-breeding season, with a large proportion of the regional population of guillemot remaining in the southern North Sea during that period and a smaller, but still significant proportion of the regional razorbill population also doing so.

The Development is located in an area highly utilised by existing shipping with a total of 49,320 AIS vessel movements recorded across the study area for the NRA between March 2021 and February 2022 (Xodus Group, 2023a).

The total number of vessels to be used during the construction and installation phase of the Development has been planned and presented by the Applicant. However, not all of these vessels will be present at the same time and will be focussed on specific parts of the pipelines at any given time. Construction activity is likely to proceed at several work fronts with clusters of vessels operating at pipeline landfalls, at points along pipeline routes and at the Endurance store.

At landfalls, up to four vessels, including a jack-up barge, will potentially be on station for up to 360 days depending on the method of shoreline crossing selected.

During pipeline installation, vessel activity will occur in discrete sections of the pipeline corridors while large areas of each pipeline route will be undisturbed for prolonged periods of time during the overall construction programme.

Of the activities occurring at the Endurance Store, drilling activities will be undertaken for 370 days and will require the highest number of vessels (four) and the highest number of vessel days (907) although activity will be focused in a small area.

The effects of disturbance on both guillemot and razorbill during the installation of infrastructure within the marine environment is unclear from published records.

During construction surveys at the Lynn and Inner Dowsing OWF there appeared to be no significant patterns of change in guillemot abundance between the OWF and control sites (ECON, 2012). Leopold *et al*. (2010) found indications of disturbance to auks during some surveys at Egmond aan Zee (Netherlands) but numbers were too low to reach statistical significance.

It is noted that activity at an OWF during construction is significantly greater than that associated with the installation of pipelines, involving many more vessels across much larger spatial and temporal scales and therefore it can be expected that if limited disturbance has been noted during construction of an OWF, then it is highly unlikely that significant disturbance will be noted during the installation of pipelines.

Wade *et al*. (2016) report that auks may be disturbed by boats at several hundreds of metres distance although survey vessels have often approached to less than ten of metres before eliciting an evasion response, for example many birds are recorded within fifty metres during boat-based surveys at OWFs.

If, for example, the presence of vessels at a work front were to cause displacement of auks from a 500 m radius around the activity it may reduce the available foraging area by approximately 0.8 km^2. With a foraging range of 95.2 km (Woodward *et al*, 2019), razorbill could have a seaward area of over 14,000 km^2 available for foraging. Even assuming multiple work fronts, the combined area of displacement would constitute a negligible fraction of the foraging area available to razorbill. Guillemot, having a longer foraging range, would be displaced from an even smaller proportion of their foraging grounds.

As a result, it is considered unlikely that disturbance events on guillemot and razorbill that may result from activities associated with the Development will result in an adverse effect on the integrity of the Flamborough and Filey Coast SPA.

8.3 Assessment in combination with other projects

The reported vessel movements quoted for 2021/2 across the Development area would largely be made up of goods transport fleets, fishing fleets, passenger and vehicle ferries and marine industry and supply shipping. On top of this would be an increment of vessels for developments being constructed at that time, and which would most likely be completed before construction of the Development begins.

The Applicant has identified a list of developments that could be in construction or being operated at the time of construction of the Development. Whether these, in-combination with the Development, will lead to an overall increase in vessel activity in the area from present baseline levels is unclear, there being limited information on the vessel routes for these other developments in the area. If there were a net increase in vessel activity, it is not likely to be a significant increase and would not give rise to a significant increase in the proportions of foraging areas from which razorbill or guillemot are displaced.

Colonies of razorbill and guillemot on the east coast of England generally show high breeding success and populations at the SPA have shown increasing population trends in recent decades, implying that foraging opportunities are good.

If any increased vessel activity in the Development area, due to construction of the Development in-combination with other developments, were to cause displacement of razorbill and guillemot from very small parts of their foraging areas, it is unlikely to cause significant pressure on their foraging success if foraging opportunities are generally favourable.

Vessel activity associated with construction of the Development is therefore not considered likely to give rise to an adverse effect on the integrity of the Flamborough and Filey Coast SPA either alone or in-combination with other developments.

9 APPROPRIATE ASSESSMENT FOR SOUTHERN NORTH SEA SAC

There could be potential for LSE to the harbour porpoise feature of the Southern North Sea SAC due to activities for the installation of the Development.

Fisheries bycatch, underwater noise and pollution have been identified as the main threats to harbour porpoise (JNCC, 2019, 2020; IAMMWG *et al.,* 2015). The widescale distribution of harbour porpoise prey species can also be affected by trends associated with climate change (IAMMWG *et al.*, 2015).

The mechanisms which could result in effects on harbour porpoise as a result of the proposed Development are:

- Killing or injuring harbour porpoise (directly or indirectly).
- Preventing harbour porpoise use of significant parts of the site (disturbance / displacement).
- Significantly damaging relevant habitats.
- Significantly reducing the availability of prey.

Further consideration has been given to these sources of impact to assess whether they have the potential to adversely effect the integrity of the relevant site.

9.1 Conservation objectives

Conservation Objectives constitute a necessary reference for identifying site-based conservation measures and for carrying out HRAs of the implications of plans or projects (JNCC and NE 2019). They outline the desired state for any European site, in terms of the features for which it has been designated. If these features are being managed in a way which maintains their nature conservation value, they are assessed as being in a 'favourable condition'. An adverse effect on the integrity of a site is likely to be one which prevents the site from making the same contribution to favourable conservation status for the relevant feature as it did at the time of its designation (English Nature, 1997).

The purpose of an AA is to determine whether a plan or project adversely affects a site's integrity. The critical consideration in relation to site integrity is whether the plan or project affecting a site, either individually or in-combination, affects the site's ability to achieve its conservation objectives and favourable conservation status (JNCC 2015).

The Southern North Sea SAC was designated as a SAC in 2019. The site covers an area of 36,951 km^2 and is designated for harbour porpoise.

Harbour porpoises are also protected throughout European waters under the provisions of Annex IV and Article 12 of the Habitats Directive. Harbour porpoise in UK waters is considered part of a wider European population and the mobile nature of this species means that the concept of a 'site population' is not thought to be appropriate for this species. Site based conservation measures therefore aim to complement wider ranging measures that are in place for the harbour porpoise (JNCC and NE 2019).

The Conservation Objectives for Southern North Sea SAC are:

To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status for Harbour Porpoise in UK waters. In the context of natural change, this will be achieved by ensuring that:

- Harbour porpoise is a viable component of the site,
- There is no significant disturbance of the species, and
- The condition of supporting habitats and processes, and the availability of prey is maintained.

Harbour porpoises are considered to be a 'viable component' of the site if they are able to survive and live successfully within it. The first Conservation Objective aims to minimise the risk from activities that cause unacceptable levels of impact on harbour porpoise using the site, specifically those that could impact on the Favourable Conservation Status of harbour porpoise (JNCC and NE, 2019).

The '*integrity of the site*' is not defined in the Conservation Objectives. However, UK Government guidance defines the integrity of a site as ''*the coherence of the site's ecological structure and function, across its whole area, or the habitats, complex of habitats and/or populations of species for which the site is or will be classified*' (Defra 2012). Therefore, the integrity of the site applies to the whole of the site, and it is the potential impacts across the whole of the site that are required to be appropriately assessed. Pressures that would affect site integrity include:

- killing or injuring harbour porpoise (directly or indirectly),
- preventing their use of significant parts of the site (disturbance / displacement),
- significantly damaging relevant habitats,
- significantly reducing the availability of prey (JNCC and NE 2019).

The second Conservation Objective states that there should be '…*no significant disturbance of the species'* and that '*Disturbance is considered significant if it leads to the exclusion of harbour porpoise from a significant portion of the site'* (JNCC and NE 2019).

'Supporting habitats and processes' relate to the seabed and water column along with the harbour porpoise prey.

JNCC advise that it is not appropriate to use the site population estimates in any assessments of effects of plans or projects (i.e. HRAs), as it is necessary to take into consideration population estimates at the Management Unit (MU) level to account for daily and seasonal movements of the animals (JNCC 2017c; JNCC and NE 2019).

There are no formal thresholds at which impacts on site integrity are considered to be adverse. However, a threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS), with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra 2003; ASCOBANS, 2015). This threshold relates to impacts from fisheries by-catch on harbour porpoise where the impact on the harbour porpoise is permanent, i.e. up to 1.7% of the population may be caught as by-catch before a population decline is inevitable. An equivalent level of impact from disturbance, which is temporary and non-lethal, on a population will have a lower level of impact on the population compared to that from a fisheries by-catch.

The lack of agreed population thresholds either at the MU level or site level, below which evidence demonstrates there would not be an adverse effect, does not prevent objective judgements to be made on site integrity.

Thresholds to assess and manage the effects of noise on site integrity have been proposed by the JNCC and NE (JNCC 2017d, 2017e; JNCC and NE 2019; JNCC 2020). The proposed approach is not based on a population level impact but is instead based on a temporal and spatial level where a proportion of the area within the SAC may be affected over a period of time.

The JNCC and NE advice is that *'noise disturbance within the site should not exclude harbour porpoise from more than 20% of the site on any given day. Over a season, the advice is that an average loss of access to more than 10% of the SAC should be considered significant, recognising that within the SAC the abundance of harbour porpoise per unit habitat is generally higher than the equivalent sized habitat in the rest of the relevant Management Unit. Management of temporary habitat 'loss' to below defined area/time thresholds is therefore designed to ensure that it continues to contribute in the best possible way to the maintenance of the species at Favourable Conservation Status (FCS).'* (JNCC, 2020).

The potential extent of noise causing disturbance that would meet these proposed thresholds and therefore impact on the integrity of the site is presented in Table 4. The results indicate that should the impact occur wholly inside the SAC that, within the 'summer' area a sound source alone or in-combination causing disturbance for one day over an area of 7,390 km^2 would risk impacting site integrity. This is equivalent to a circular radius of noise out to 41.5 km. To exceed the threshold for the 'winter' area, noise in any one day should not extend over an area of more than 2,537 km^2: equivalent to a circular radius of 28.4 km.

Over the course of a season the total extent of potential disturbance on average per day should, in the 'summer' area, not extend over an area of more than 3,695 km^2; equivalent to a radius of noise of 29.3 km and in the 'winter' area should not extend over an area of more than 1,269 km^2, equivalent to a radius of 20.1 km.

Table 4: Estimated extent sound levels capable of causing displacement disturbance occur in order to impact on site integrity.

Site	Area (km^2)	1 day threshold		Seasonal threshold	
		20% of area (km^2)	Distance to threshold (km)	10% of area (km^2)	Distance to threshold (km)
Southern North Sea SAC	36,951	7,390	48.5	3,695	34.3
'summer' area April - September	27,028	5,406	41.5	2,701	29.3
'winter' area October - March	12,696	2,539	28.4	1,270	20.1

The 'Distance to threshold' presumes sound propagation is circular in shape, i.e. the distance is the equivalent to a radius of circular noise.

Unlike the daily threshold, the area of the SAC that can be affected over the course of a season is an average over the season. The seasonal average is calculated by summing the proportion of the site impacted (for the relevant season) over the number of days the impact will occur and then averaging across the total number of days within that season, i.e. 183 days in the summer period and 182 days in the winter period. This provides a seasonal average spatial effect.

This assessment is based on both the potential impact on the North Sea MU population using both the ASCOBANS thresholds and the proposed SNCB threshold approach.

In order to undertake any meaningful assessment using the threshold approach, accurate information on the timing, duration and extent of activities being undertaken is required. Where this information is lacking or where speculative 'worst-case' scenarios are used there is little or no confidence that the results will bear any resemblance to the true extent of impact within the SAC on any single day or across the course of a season.

The HRA has been carried out in light of best scientific knowledge with reference to the Conservation Objectives of the SAC and the potential impacts on the integrity of the site (EC, 2018).

9.2 Species Accounts

9.2.1 Harbour porpoise

The harbour porpoise is the smallest and most abundant cetacean species in UK waters. They occur widely across shelf waters predominantly either individually or in small groups, but larger aggregations have been reported (Department for Environment Food and Rural Affairs (Defra) 2015), with group sizes varying with season (Clark 2005). Harbour porpoises have a very broad distribution occurring predominantly over the continental shelf. Higher densities occur in areas of up-welling and strong tidal currents and in water depths of predominantly between 20 and 40 m (Clark 2005, Whaley 2004). Their distribution may also be strongly correlated with seabed type, with areas of sandy gravel being preferred and this may be linked to prey availability (Clark 2005). Harbour porpoises occur widely across the North Sea.

The latest estimated harbour porpoise population for the northeast Atlantic region is 409,244 (CV 298,194 – 578,505) (Gilles *et al.,* 2023) and has remained relatively stable since at least 1994 (Hammond *et al*., 1995, Hammond *et al.,* 2017, Hammond *et al*., 2021). Within this region, the North Sea itself is considered as a separate management unit (MU) for which the latest harbour porpoise population estimate is 346,601 individuals (IAMMWG, 2022). This figure has been used for this assessment.

There may be some evidence to suggest a southward shift in the distribution of harbour porpoise in the North Sea, possibly attributed to changes in prey availability (IAMMWG *et al.* 2015).

The Southern North Sea SAC is an area of importance for harbour porpoise, supporting an estimated 7.5% of the UK North Sea MU population (JNCC, 2023).

Harbour porpoise densities vary seasonally and across the Southern North Sea SAC (Evans and Teilmann, 2009). Site-specific surveys undertaken by wind farm developers have shown considerable variation in the spatial and temporal distribution of harbour porpoises across years (e.g. Forewind 2013, SMart Wind 2017). Typically, peak abundance has been reported to occur between May and July at sites across the Dogger Bank area and between September and April at sites further south (e.g. Forewind 2014, SMart Wind 2015, EAOWL 2015). Lowest reported abundance across nearly all wind farm surveyed areas occurs between November and February, although the poorer survey conditions that occur predominantly during the winter months may be a contributing factor in the lower number of harbour porpoise recorded during this period.

Highest densities in the central and northern area of the SAC occur during the summer period with modelled harbour porpoise densities greater than 3.0 per km^2 occurring widely (Paxton *et al.,* 2016). During the winter period the distribution of harbour porpoise in the southern North Sea changes, with reduced densities over the central and northern area but an increase in densities in nearshore waters and the southern part of the SAC (Heinänen and Skov 2015).

Alternative estimates of densities have been derived from other survey data (Gilles *et al.* 2023, TKOWFL 2011; SMart Wind 2017) but none provide conclusive evidence to divert from the JCP value.

Tagging studies undertaken in Denmark indicate that harbour porpoises are highly mobile and range widely in the North Sea, with individuals tagged in the Skagerrak travelling up to 100 km per day, with a mean distance of 24.5 km per day (Sveegaard, 2011).

Harbour porpoise swimming speeds vary with the highest recorded swimming speeds being 4.3 m/s (Otani *et al.,* 2000). Mean recorded speeds are typically around 1 m/s (Otani *et al.,* 2000, Kastelein *et al.,* 2018). When disturbed by noise harbour porpoise can increase swimming speeds with increasing sound levels. Studies using playback experiments of pile-driving sounds have reported increases in swimming speed from an average of 1.2 m/s to 2.0 m/s at sound levels of 154 dB re 1 μPa that were sustained for at least 30 minutes (Kastelein *et al*., 2018).

Although harbour porpoises may dive to depths of up to 226 m and remain submerged for up to five minutes, they more frequently undertake relatively shallow dives of a short duration, with a mean depth of 14 m and duration of 44 seconds (Santos and Pierce 2003; Otani *et al*., 1998, 2000). Studies undertaken on 14 tagged harbour porpoise in Danish and adjacent waters reported that on average harbour porpoise spend 55% of the time in the upper 2 m of the surface waters.

Harbour porpoise use echolocation to detect and track individual prey and are opportunistic feeders, foraging close to the seabed or near the sea surface, preying on a wide range of fish species including, herring (*Clupea harengus*), whiting (*Merlandius merlangus*), Gadoids spp. sprats (*Sprattus sprattus*), gobi (*Pomatoschistus minutus*) and sandeels (*Ammodytes* spp.), and their prey will vary during and between seasons (DeRuiter 2008; Santos and Pierce 2003; IAMMWG *et al.,* 2015). The prey of harbour porpoise may change over time with a reported long-term shift in prey from clupeid species to sandeels and gadoid species (IAMMWG *et al*., 2015), indicating that harbour porpoise may be opportunistic feeders capable of feeding on a variety of species.

Studies undertaken in Denmark indicate that their local distribution may be correlated with prey availability (Sveegaard, 2011). Due to the relatively high metabolic rate of harbour porpoise and the relatively small size of their predominant prey it has been suggested that harbour porpoise require a reliable source of food and frequent food consumption in order to maintain their body weight, with increased consumption in cooler environments (Kastelein *et al*., 1997; Wisniewska *et al*., 2016; 2018).

Harbour porpoise have a maximum life expectancy of 24 years, with an average life expectancy of around 12 years in UK waters (Lockyer 2003; Learmouth *et al.,* 2014). Females become sexually mature at between three and five years old (Lockyer 2003; Learmouth *et al*., 2014). Breeding is thought to occur primarily during the summer months between May and September, particularly in August, with calving 10 months later. Calves are nursed for eight to ten months but may remain with the mother until a new calf is born (Defra 2015, Lockyer 2003, Weir *et al*. 2007).

The range at which marine mammals, including harbour porpoise, may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. Other factors that can affect the potential impact include ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and existing sources of human produced sound can also reduce the auditory range.

Porpoises are generally considered to be ‘high frequency’ or ‘very high frequency’ specialists with a relatively poor ability to detect lower frequency sounds (Southall *et al.* 2007, 2019). Studies undertaken on captive harbour porpoises indicate that porpoises have a functional hearing range of between 250 Hz and 180 kHz with their best hearing between 16 to 140 kHz and their maximum sensitivity between 100 and 140 kHz. It is within the frequency range of 130 to 140 kHz that harbour porpoise echolocates (Miller and Wahlberg 2013).

Their ability to detect sound below 16 kHz or above 140 kHz falls sharply (Kastelein *et al.* 2012, 2015, Southall *et al*. 2007). Harbour porpoise are therefore most sensitive to sound sources between 16 to 140 kHz and, although potentially audible, they are unlikely to be sensitive to sound either above or below those frequencies.

Reported sound levels produced by harbour porpoise for echolocation, to communicate and to detect prey range from between 166 to 194 re: 1 μPa (rms SPL) and between 178 and 205 dB re. 1 μPa (peak – peak SPL), with a mean level of 191 dB re. 1 μPa (peak – peak SPL) and within the peak frequency range of 110 to 150 kHz (Villadsgaard, *et al*. 2007, Miller and Wahlberg 2013, MMO 2015).

9.2.2 Prey species

Fish are not qualifying species for the Southern North Sea SAC, however, potential impacts on fish that are prey for harbour porpoise could affect the integrity of the site by reducing their prey base (JNCC and NE 2019).

Sandeels are one of the main prey items for harbour porpoise and are also an important prey species for predatory fish such as whiting, cod and haddock, some of which may also be prey for harbour porpoise (Greenstreet *et al*., 2006).

Sandeels are one of the most abundant fish in the North Sea occurring widely over suitable sandy substrates where, once the larvae have settled, they remain in the area (Heath *et al.,* 2011). Although widespread, sandeel distribution is highly substrate specific as they depend on seabed habitat comprising a high proportion of medium and coarse sands (particle size 0.25 - <2 mm) with low silt content (Holland *et al*., 2005).

Between September and April sandeels remain largely buried in the seabed except when spawning during December and January (Greenstreet *et al.,* 2006, Van der Kooij *et al*., 2008).

Within the Southern North Sea SAC sandeels occur across the site with their main spawning area over the Dogger Bank and have a wider nursery area across most of the SAC (Judd *et al.* 2011).

Fish hearing is based on detecting particle motion directly stimulating the inner ear. However, those with swim bladders are also able to detect pressure waves and can detect a wider range of frequencies and sounds of lower intensity than fishes without swim bladders (Popper, 2003). Fish with swim bladders that possess a coupling mechanism between the swim bladder and the auditory system, e.g. herring and sprats, are recognised to be hearing specialists. Fish that have swim bladders but lack a mechanised coupling mechanism or do not have swim bladders, e.g. sandeel spp. are considered hearing generalists and have a relatively lower sensitivity to sound than fish that have swim bladders and a coupling mechanism.

Studies on the behaviour of fish in response to noise, largely using play-back experiments, have reported a range of behavioural responses including avoidance behaviour, changes in swimming speed and direction (e.g. Hawkins *et al.,* 2014; Mueller-Blenkle *et al.,* 2010) and reduced antipredator responses (Everley *et al.,* 2016).

Sandeels are not considered to have sensitive hearing (Popper *et al.,* 2014). Studies undertaken using airguns indicate that sandeels have distinct but weak reactions to seismic airguns with initial startle responses reducing in frequency with on-going noise, and no increased mortality was detected (Hassel *et al.,* 2004).

There are limited studies assessing potential impacts on eggs and larvae. Results indicate that there is potential for increase in mortality when larvae are exposed to an airgun sound source with peak sound pressure levels of 220-242 dB re 1 μPa^2 (unknown measure), but only within 5 m of the airgun (Popper *et al*., 2014).

9.3 Potential impacts

9.3.1 Seabed disturbance impacting on prey species

The maintenance of supporting habitats and processes contributes to ensuring that prey is maintained within the site and is available to harbour porpoises using the site. Habitat degradation, increased levels of suspended sediments and sedimentation may affect epibenthic and infaunal communities, leading to indirect effects on harbour porpoise through changes in prey availability. However, these effects are not generally considered to present a significant pressure on the conservation objectives, and the relative level of risk to the SAC from these types of impact is low.

Since the potential impacts on benthos and fish arising from the planned construction and installation activities are temporary and not expected to be significant, this section focusses on the long-term placement of structures (rock protection) on the seabed.

There will be several subsea equipment and protection structures that will have a permanent seabed footprint, including a 6 km long pipeline, rock placement, a wellhead tree, concrete mattresses, concrete plinths, and seabed landers. In addition, approximately 32.9 km of the Teesside Pipeline and 36.8 km of the Humber Pipeline are expected to lie within the SNS SAC; these sections will be surface laid. Within the SAC, the Teesside Pipeline route and Teesside – Store cable route cross the Langeled gas pipeline and the cable corridor for the proposed Dogger Bank A transmission asset; these crossings will be covered by protective rock berms. The Humber Pipeline route does not cross any other seabed assets within the SAC area. The installation of subsea infrastructure and protection structures will introduce additional hard substrata to the predominantly sandy seabed in this area.

The seabed footprint for the structures proposed to be installed on the seabed within the SAC amounts to a worst case of 0.1683 km^2, representing 0.0006% of the overall Summer SAC seabed area. Given the relatively small areas affected and the very widespread distribution of similar habitat type within the SAC, no significant negative effects are expected to occur on the supporting habitats or the availability of sandeel or any other harbour porpoise prey species.

Overall, the minor changes to the seabed substratum associated with the Development are on a small scale and not likely to have a significant effect on any of the harbour porpoise prey species and will not affect the ability of prey species to reproduce. The presence of the structures on the seabed may result in minor changes to benthic epifauna and fish distribution, which could be negative or positive. It is unlikely that the Development would result in any loss of benthic biomass or availability of prey for fish species, or in turn to any reduction in the availability or distribution of harbour porpoise prey species.

In-Combination Effects

The applicant has identified four proposed developments for which there may be potential for impacts related to permanent changes to seabed habitats in the SNS SAC in-combination with the Development. The in-combination developments are:

- Kumatage gas field development (projected first gas in September 2028 but currently in an early stage of engineering development);
- Proposed Dogger Bank A transmission asset;
- Existing Langeled gas export pipeline; and
- Proposed Hornsea Project Four OWF (construction planned for 2026).

The extent of seabed disturbance within the SNS SAC from these developments is currently not published. If these are to be extensive they will be subject to appropriate assessment, alone and in-combination with the NEP Development, at the time of their submission.

Given the extremely low proportion of the seabed of the SAC that will be permanently changed due to the Development alone, it is not expected to significantly increase any impact conclusions from the in-combination developments identified.

As the Development will cause no significant change to the habitats of the SNS SAC alone and will not cause a significant increase to any change caused by other developments, **the supporting processes of these habitats and availability of prey species for harbour porpoise will not be adversely affected by the Development alone or in-combination.**

9.3.2 Underwater sound

There is a substantial volume of literature describing the potential effects of sound on marine mammals, and summarised in e.g. Thomsen *et al.* (2006), Southall *et al.* (2007, 2019), and OSPAR (2009).

There are four main types of potential effect from noise that are recognised within the marine environment:

- *Fatal effects* caused by significant levels of noise in close proximity to the receptor.
- *Physical injury*, specifically hearing impairment, which can be permanent or temporary. These effects can impact on the ability of marine mammals to communicate, forage or avoid predators.
- *Behavioural effects* such as avoidance, resulting in displacement from suitable feeding or breeding areas, and changes in travelling routes.
- *Secondary impacts* caused by the direct effects of noise on potential prey causing a reduction in prey availability.

The range at which marine mammals may be able to detect sound arising from offshore activities depends on the hearing ability of the species and the frequency of the sound. For example, pinnipeds (seals) are potentially more sensitive to low frequency sounds than cetaceans and harbour porpoise may be more sensitive to relatively high frequencies. Other factors which may affect the potential impact of sound on marine mammals includes ambient background noise, which can vary depending on water depth, seabed topography and sediment type. Natural conditions such as weather and sea state and other existing sources of human produced sound, e.g. shipping, can also reduce the auditory range.

Fatal effects

If source peak pressure levels from the proposed operations are high enough there is the potential for a lethal effect on marine mammals. Studies suggest that potentially lethal effects can occur to marine mammals when the peak pressure level is greater than 246 or 252 dB re. 1 µPa (Parvin *et al*. 2007). Damage to soft organs and tissues can occur when the peak pressure level is greater than 220 dB re. 1 µPa.

Physical injury

Underwater sound has the potential to cause hearing damage in marine mammals, either temporarily resulting in a shift in hearing threshold (Temporary Threshold Shift, TTS) or permanently (PTS). The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al*., 2019, OSPAR 2009).

There are two primary and different metrics for measuring the effect of sound on marine mammals: sound pressure level (SPL) and sound exposure level (SEL).

SPL is the result of the pressure variations in the water achieved by the sound waves. Sound travels through the water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). In water the sound source strength is defined by its SPL in dB re 1µPa, referenced back to a representative distance of 1 m from an assumed (infinitesimally small) point source. This allows calculation of sound levels in the far-field.

SEL is used as a measure of the total sound energy of an event or a number of events (e.g. over the course of a day) and is normalised to one second. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis, meaning multiple events can be taken into account.

Behavioural Change

Potential changes in behaviour may occur depending on the sound source levels and the species and individuals' sensitivities. Behavioural changes can include changes in swimming direction, diving duration, avoidance of an area and reduced communication.

Masking effects may also cause changes in the behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey, thus causing them to alter their behaviour.

Secondary Effects

There is potential for impacts on prey species to affect marine mammals, in particular possible impacts of noise on fish species.

Effective Deterrent Radius / Range

The Effective Deterrent Radius / Range (EDR) is proposed by the Statutory Nature Conservation Bodies (SNCBs) as a means to measure potential impacts on harbour porpoise within the SAC (JNCC, 2017d, 2017e; JNCC, 2020). The EDR is an empirically derived generic distance within which deterrence, i.e. displacement, of harbour porpoise is predicted to occur. The EDR are based on published studies that have monitored the effects on harbour porpoise from various activities and reflects the overall loss of habitat if all animals vacate the area (e.g. Defra 2015). It is an area of displacement as opposed to disturbance, which may be greater.

The published precautionary EDRs are presented in Table 5 (JNCC, 2020). Relevant to the assessment of the proposed Development are the EDRs for pin-pile activities and seismic surveys which are published as being 15 km and 12 km, respectively.

Other EDR in Table 5 have been used in the assessment of the impact of the Development in combination with other activities taking place within the SAC.

The SNCBs recognise that future data may require the suitability of the EDR to be reconsidered if it is found to be inappropriate (JNCC 2017e).

Table 5: Precautionary Effective Deterrent Ranges (EDR) (Source: JNCC, 2020).

Activity	Effective Deterrent Range (km)
Monopile	26
Unexploded Ordnance	26
Pin-pile [1]	15
Monopile with noise abatement	15
Conductor piling	15
Seismic survey	12
High Resolution Geophysical Surveys	5

[1] Pin-piles are '*smaller diameter piles that secure jacket structures'* although no definition as what diameter a pin-pile should be has been provided in published advice (JNCC 2020).

Noise Modelling

The following activities associated with the proposed Development have been identified as key sound sources:

- Piling during installation of:
  - Manifolds in the Endurance Store area;
  - SSIV on the Teesside Pipeline; and

  - HDD trestles at Teesside and Humber landfalls;
- Seismic surveys as part of monitoring activity during the life cycle of the Development;
- Seabed preparation, pre-lay and post-lay surveys during subsea installation;
- Presence of the jackup vessels during drilling of the wells, landfall construction and installation of subsea infrastructure;
- Dredging activities through the use of BHD, grab dredger, trailing head suction dredger, cut suction dredger, plough and jet trencher; and
- Vessels.

Of the activities listed above, only piling activities (manifolds, SSIV and HDD trestles), during installation of the Development, and the use of seismic sources (4D), during the operational phase, are considered to have the potential to impact on the hearing of sensitive marine species as they represent the greatest sound sources in both power (i.e. pressure levels) and in character (i.e. as an impulsive sound).

The sound levels emitted by the equipment for the pre and post-lays surveys (i.e. MBES, SSS etc.) will be highly directional, with sound levels transmitted perpendicularly from the beam which are typically 25 to 35 dB lower than sound emitted by airguns (Lurton and DeRuiter, 2011). Therefore, the pre and post-lay surveys are not anticipated to have any adverse effect on the local environment and in particular marine mammals. In addition, based on the frequency of the sound emitted by typical MBES and SSS, it is unlikely fish species will be affected by these surveys. JNCC (2017a) considers that sound emitted by MBES (and SSS) in shallow waters (i.e. < 200 m) typically fall outside of the hearing frequency of cetaceans. The sound produced is likely to attenuate quickly due to the high frequencies of the sounds. For this reason, piling and seismic activities constitute the worst-case activities which form the focus of this assessment.

These activities will be undertaken during different periods of the Development and at discrete intervals, i.e. piling will be undertaken during the installation phase, while seismic surveys, will be undertaken during the operational phase of the Development. Seabed preparation and pre/post-lay surveys are planned to occur during the installation phase.

For the purposes of noise modelling, survey parameters used for piling are shown in Table 6.

Table 6 Modelled piling parameters

Hammer energy (kJ)	Duration (minutes)	Strike rate (blows/minute)	Source level: Zero-to-peak sound pressure level (SPL) (dB re 1 µPa-m)	Source level: Sound exposure level (SEL) (dB re 1 µPa²s-m)
Manifold piling				
24	**20**	44	200.0	226.3
120	**100**	44	207.2	233.2
SSIV piling				
24	**20**	44	200.0	226.3
120	**100**	44	207.2	233.2
HDD trestle piling				
47	20	44	203.2	229.2
235	220	44	210.2	236.2

The survey parameters used for modelling of seismic surveys are shown in Table 7.

Table 7 Modelled seismic equipment parameters

Parameter		480 cu in array
Array elements		Six 1900-LLXT airguns
Total volume		480 cu in.
Source level	Zero-to-peak sound pressure level (SPL)	247.7 dB re 1 µPa-m
	Peak-to-peak SPL	253.2 dB re 1 µPa-m
	SEL	220.6 dB re 1 µPa²s-m
Peak frequency		*c*. 80 Hz

[1] Source levels have been computed using Gundalf array modelling software (Oakwood Computing, 2022) over a frequency range of 0 – 50 kHz.

Noise Modelling Results

Physical Injury

Underwater sound has the potential to cause hearing damage in marine mammals, either temporarily resulting in a shift in hearing threshold (Temporary Threshold Shift, TTS) or permanently (PTS). The potential for either of these conditions to occur is dependent on the hearing bandwidth of the animal, the duty cycle of the sound source and duration of the exposure (Southall *et al.,* 2019, OSPAR 2009).

There are two primary and different metrics for measuring the effect of sound on marine mammals: sound pressure level (SPL) and sound exposure level (SEL).

SPL is the result of the pressure variations in the water achieved by the sound waves. Sound travels through the water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). In water the sound source strength is defined by its SPL in dB re 1μPa, referenced back to a representative distance of 1 m from an assumed (infinitesimally small) point source. This allows calculation of sound levels in the far-field.

SEL is used as a measure of the total sound energy of an event or a number of events (e.g. over the course of a day) and is normalised to one second. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like for like basis, meaning multiple events can be taken into account.

Noise modelling undertaken by the applicant for piling showed the potential to injure harbour porpoise (HF cetaceans) was limited to a maximum injury range of 360 m (cumulative SEL with soft-start for HDD trestle piling at Humber). The assessment using the cumulative SEL thresholds determined that when soft-start was applied, impacts to marine mammals over a 24 hour period were still acceptable as they are limited to within the 500 m monitoring zone.

Similarly, the underwater sound modelling determined that the potential injury from seismic surveys is very limited and will be mitigated by the implementation of mitigation measures. The worst case injury range was assessed as 150 m for HF cetaceans (zero-to-peal SPL). This means that the application of mitigations, including a soft-start procedure, and the inclusion of an MMO and PAM for pre-operational and operational monitoring of a 500 m zone will negate the risk of injury to harbour porpoise.

Bp, as operator of NEP, is committed to implement the JNCC protocols for piling and seismic surveys, which both include soft-start.

The SCANS-IV density for harbour porpoise within the Development area is 0.6027 individuals per km^2 in SCANS block NS-C (Gilles *et al.,* 2023). Harbour porpoise density estimates from Heinänen and Skov (2015) suggest that densities in the vicinity of the Development could be higher than those from SCANS-IV data. Harbour porpoise densities according to Heinänen and Skov (2015) are 3 individuals per km^2. Based on densities reported by Gilles *et al.,* 2023, less than one animal is likely to be within encountered within the 500 m monitoring zone at any given time, further decreasing the likelihood of injury impacts to harbour porpoise from the piling or seismic activities associated with the Development. Using the higher Heinänen and Skov (2015) estimates, 2.3 animals may be within the monitoring zone.

Considering the small number of individuals estimated to be within the injury range and the proposed mitigation measures, no injury impacts to harbour porpoise are expected to result in LSE on harbour porpoise at this SAC from either piling or seismic activities. Underwater sound associated with the Development is not expected to lower the reproductive capacity or survivability of harbour porpoise (Thompson *et al.,* 2013; Nabe-Nilsen *et al.,* 2018) and as such, are not expected to adversely affect Conservation Objective 1 of the SAC.

Behavioural Disturbance

Potential changes in behaviour may occur depending on the sound source levels and the species' and individuals' sensitivities. Behavioural changes can include changes in swimming direction, diving duration, avoidance of an area and reduced communication.

Masking effects may also cause changes in the behaviour as the level of sound may impair the detection of echolocation clicks and other sounds that species use to communicate or detect prey, thus causing them to alter their behaviour.

To manage disturbance impacts on harbour porpoise associated with the SNS SAC, guidance provided by the JNCC (2020a) proposes an assessment of number of individuals disturbed as well as an assessment of temporary habitat loss via sound deterrence. Subsea installation is expected to take place in Q2/Q3 2026 and, as a worst case, seismic surveys are assumed to occur during the summer. As such, potential disturbance is assessed herein for piling and seismic activities (generating impulsive sound to which cetaceans are most sensitive) taking place during the spring/summer months (when highest abundances of harbour porpoise occur) in order to present a worst-case scenario. When considering if any significant disturbance could arise from the piling and seismic activities, constituting as going against Conservation Objective 2 for this site, it is necessary to assess whether the disturbance caused by the piling and seismic activities could result in an exclusion of harbour porpoise from either:

- 20% of the relevant area (summer or winter areas) in any given day; or
- An average of 10% of the relevant area of the site over a season.

For the purpose of the assessment, the potential loss of habitat from the sound emissions have been assessed against the SNS SAC's entire area (36,951 km^2) (JNCC, 2019) and against the SNS SAC's summer area (27,028 km^2) (JNCC, 2020). Piling operations are likely to each be completed within two to three days. Each seismic surveys are expected to occur over a period of 75 day (including downtime). Therefore, loss of habitat from piling and seismic activities should be both considered over a day but also over an entire season.

Piling

Piling would occur at four locations (manifolds, SSIV, HDD trestle at Humber and Teesside). The SSIV piling location and Teesside HDD trestle piling locations are located approximately 94 km and 100 km from the SNS SAC boundary, respectively. As such they will not impact the SNS SAC and are not considered further in this assessment. However, the manifold piling locations are located within the 'Summer Area' of the SNS SAC and the Humber HDD trestle piling locations are located within 15 km of the 'Winter Area' of the SNS SAC. It should be noted that subsea installation is planned in Q2/Q3 2026. The summer area is defined as April to September (inclusive) and the winter area is from October to March (inclusive) (JNCC, 2020). As the Humber HDD trestle piling location is located within 15 km of the Winter Area, this means that the harbour porpoise population number is expected to be lower during the subsea installation between Q2 and Q3 2026.

It is recommended that a conservative disturbance range (i.e. EDR) of 15 km be used when considering impacts to harbour porpoise from piling activities in the SNS SAC (Graham *et al*., 2019; JNCC, 2020). Within the 15 km EDR, there is the potential for up to 628 – 2,121 and 478 – 1,614 harbour porpoises to be disturbed during manifold piling and HDD trestle piling at Humber respectively, based on measured densities across the Development. When considering the population of the North Sea MMMU (i.e. 346,601 individuals), this equates to a maximum of 0.612% of the MMMU population

The 15 km EDR is considered highly conservative as only 25% of harbour porpoise were found to be deterred across this radius (Graham *et al.,* 2019). Rather, it is likely that disturbance impacts would be limited to within 3.8 km – 7.2 km from the piling activities (worst case), based on the sound modelling data (Section 7.5). With this disturbance range (as per Tougaard, 2015), a maximum of 201 individuals might experience disturbance at the HDD trestle piling location at Humber, equating to < 0.1% of the North Sea MMMU population. When taking the conservative 15 km EDR range for the piling activities into account, it is expected that the area of potential disturbance surrounding the manifold piling impact would be 707 km^2 in a day or 0.2 km^2 in a day at the HDD trestle piling location at Humber.

For the SNS SAC, the daily and seasonal disturbances have been calculated by comparing the modelling result with the NOAA ‘Level B harassment’ (NMFS, 2018) and Tougaard (2015) threshold for disturbance to marine mammals, as well as using the 15 km EDR suggested by JNCC (2020a). The disturbance associated with the Development’s piling operations alone will not exceed the daily and seasonal thresholds for the SAC suggested by JNCC (2020a).

The 15 km EDR would equate to a worst case (i.e. manifold piling as shown above) impact of 2.62% over a day and 0.029% of the Summer SAC area over an entire season. This percentage is lower than the maximum loss of habitat threshold for significant disturbance, as established by the JNCC (2020a) and stated above. In addition, based on the timing and character of the piling activities, the potential area of exclusion for harbour porpoise is expected to be considerably lower than this estimate. It is therefore considered that there is no potential for underwater sound associated with the piling activities alone to result in significant disturbance to harbour porpoise, that would result in a LSE to the SAC’s designated feature or adversely affect the SAC’s Conservation Objectives.

Seismic

For the seismic survey in the SNS SAC, daily and seasonal disturbances have been calculated by comparing the modelling result with the NOAA ‘Level B harassment’ (NMFS, 2018) and Tougaard (2015) threshold for disturbance to marine mammals, as well as using the 12 km EDR suggested by JNCC (2020a). It is predicted that the disturbance associated with the Development’s survey operations alone will not exceed the daily and seasonal disturbance thresholds for the SAC suggested by JNCC (2020a).

To estimate potential disturbance to marine mammals over a 24-hour period, the survey vessel has been modelled completing two seismic lines spaced approximately 8 km apart. The two lines were selected to be two of the longest lines in the survey area and will be indicative of the maximum disturbance area that could occur over a 24-hour period. The single-pulse SELs have also been aggregated over all source points over the entire survey area to demonstrate the cumulative disturbance areas over the entire survey duration.

The 12 km EDR would equate to 7.86% of the SAC impacted on a single given day and 2.41% impacted over a season. As the seismic survey will be transient, with the survey vessel covering several kilometres per day at least, it is important to consider the maximum area to be surveyed in a day in association with the EDR, both over a single day and over the season. The area to be surveyed by each survey during the life cycle of the Development is currently not known, therefore a recent survey undertaken by bp at the NEP Endurance Store area has been used as a comparison.

It has been assumed, for the purpose of this assessment, that the survey area reported in DESNZ (2022) and the findings are applicable to this assessment. DESNZ (2022) assessed the area in which harbour porpoise could experience disturbance using the daily and seasonal threshold, with the following assumptions/areas:

- Three survey lines of 41 to 78 km will be surveyed per day, equating to an area of 2,190 km^2 assuming a 12 km EDR; and
- The survey will last up to 92 days, during which airguns would be used for 64 days.

It was concluded that the maximum area of daily impact from the survey on the seasonal on the daily threshold represented 8.1% of the summer area of the SAC, with up to 1,945 harbour porpoises potentially experiencing disturbance, so 0.56% of the North Sea MMMU. Based on the seasonal threshold, it was concluded the survey represented between 2.9% and 4.2% of the summer area of the SAC during the summer period (DESNZ, 2022).

Both the modelling results and the JNCC (2020) EDR methodology suggest that the seismic surveys associated with the Development on their own will not result in impact areas being above the thresholds suggested by the JNCC (2020) guidelines. Similarly, the AA assessment undertaken by DESNZ (2022) for a recent bp survey at the Store concluded that the operations were not affecting the Conservation Objectives of the SAC and did not result in LSE.

However, the thresholds could potentially be exceeded if other activities occur in the area at the same time as seismic survey. Projects within 50 km of the Development have been considered and the potential for cumulative impacts was considered to be minor. This conclusion is believed to be applicable and similar to each of the six surveys bp, as operator of NEP, is planning to undertake over the life cycle of the Development. Prior to undertaking either the seismic surveys or piling activities a geological survey application will need to be submitted to the Department to further assess the impact of the work.

Through this process a cumulative impact assessment will be undertaken with up-to-date information on other activities in the area. The assessment will reveal if the daily or seasonal thresholds have the potential to be exceeded cumulatively. If it is needed coordination of activities will ensure that the SAC thresholds are not exceeded.

Whilst there may be temporary effects on behaviours (as demonstrated by the underwater sound modelling and subsequent assessment of impact), there is not expected to be a change as a result of the proposed activities in the long-term functioning or status of any populations to which they belong.

Overall impact

The SSIV piling location and Teesside HDD trestle piling locations are located approximately 94 km and 100 km from the SNS SAC boundary, respectively. As such they will not impact the SNS SAC. However, the manifold piling locations are located within the ‘Summer Area’ of the SNS SAC and the Humberside HDD trestle piling locations are located within 15 km of the ‘Winter Area’ of the SNS SAC.

The predicted daily percentages of the SNS SAC and the average percentages of the SNS SAC impacted over the season are shown in Table 8 for the manifold piling and HDD trestle piling at Humberside. The daily and seasonal disturbances have been calculated by comparing the modelling result with the NOAA ‘Level B harassment’ (NMFS, 2018) and Tougaard (2016) threshold for disturbance to marine mammals, as well as using the 15 km EDR suggested by JNCC (2020). It is predicted that the NEP CCS Project piling operations will not exceed the daily and seasonal thresholds for the SAC suggested by JNCC (2020).

Table 8 Predicted areas of the SNS SAC that may be impacted by the NEP CCS Project piling operations

Method	Predicted Daily Disturbance Area (km^2) [1]	Daily % of SNS SAC Impacted [2]	Average % of SNS SAC Impacted Over the Season [3]
Manifold piling at Endurance			
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	45	0.17%	0.002%
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	163	0.60%	0.007%
JNCC (2020) 15 km EDR	707	2.62%	0.029%
HDD trestle piling at Humberside			
Comparison of modelling results with NOAA 'Level B harassment' threshold for disturbance to marine mammals	0	0%	0%
Comparison of modelling results with Tougaard (2016) threshold for disturbance to marine mammals	0	0%	0%
JNCC (2020) 15 km EDR	0.2	0.002%	0.00002%

[1] The predicted daily disturbance areas refer to the areas of the SNS SAC impacted over 24 hours.
[2] The percentage of the SNS SAC 'Summer Area' impacted (which is applicable to the manifold piling) has been calculated based on the predicted disturbance areas for each disturbance threshold and an area of 27,028 km^2 for the SNS SAC 'Summer Area' as per the JNCC (2020) guidance. The percentage of the SNS SAC 'Winter Area' impacted (which is applicable to the HDD trestle piling) has been calculated based on the predicted disturbance areas for each disturbance threshold and an area of 12,696 km^2 for the SNS SAC 'Winter Area' as per the JNCC (2020) guidance.
[3] The average percentage of the SNS SAC impacted over the season (183 days) has been calculated assuming that the manifold piling will be completed within two days and the HDD trestle piling at Humberside will be completed within two days. For example, for the manifold piling assessment using the 15 km EDR disturbance threshold, the average percentage of SNS SAC impacted over the season is calculated as 2.62*2/183 = 0.029%.

Prey Availability

There is the potential for the prey species of harbour porpoise (fish) to be impacted by underwater sound.

The most relevant criteria for the potential impact on fish from seismic airguns and pile driving activities are considered to be those provided in the Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al*., 2014).

In relation to the potential for physical injury or behavioural effects, fish species are grouped into categories defined by a number of factors such as their anatomy for detecting sound pressure and particle motion, the use of sound during navigation or mating and the presence or absence of a swim bladder. Swim bladders, and their anatomical location within the body, make fish more susceptible to adverse sound impacts than species lacking swim bladders. Thresholds for fish mortality, injury and disturbance are provided in Popper *et al.* (2014).

Piling

The modelling predicts that sound levels will be below threshold values associated with injury to fish species beyond a maximum distance of 80 m from the piling location (zero-to-peak SPL at HDD trestle piling at Teesside). It is expected that the soft-start of the hammer during piling will likely disperse any mobile fish away from the piling locations to further distances where injury impacts are unlikely to occur. However, fish eggs and larvae that cannot move away from the source array are more susceptible to injury. For static eggs and larvae, injury is estimated within a maximum of 240 m from the piling location (SEL cumulative, HDD trestle piling at Teesside).

The radius of potential injury from the piling source using the Popper *et al*. (2014) criteria is relatively small and range between 10 m and 80 m depending on the type of hearing mechanism of the fish and piling activities. Based on this, it can be concluded that the piling activities will not result in any significant effect on fish populations within the Development area. Any effects will be short-term and highly localised.

There are no quantitative threshold criteria for assessing behavioural disturbance on fish from sound sources. The qualitative criteria established by Popper *et al.* (2014) suggest that any disturbance to fish species from piling will likely be localised with higher levels of disturbance only occurring in regions near to the piling location (e.g. within a few hundred metres). At further distances from the piling locations (e.g. beyond one kilometre), the risk of behavioural disturbance to fish is likely to be low.

Seismic surveys

The modelling predicts that sound levels will be below threshold values associated with injury to the most sensitive fish beyond a maximum distance of 80 m (zero-to-peak SPL) from the source arrays. Predicted distances are lower for less sensitive fish species. It is expected that the soft -start of the source arrays will likely disperse any mobile fish away from the sound source to distances where injury impacts are unlikely to occur.

Fish eggs and larvae are static, cannot move away from the source array, and are more susceptible to injury. The modelling predicts that fish eggs and larvae that cannot move away from the seismic source may by injured at distances of 400 m from the source.

The qualitative criteria established by Popper *et al*. (2014) suggest that any disturbance to fish species will likely be localised with higher levels of disturbance only occurring in areas near to the source (e.g.

within a few hundred metres). At further distances from the source (e.g. beyond one kilometre), the risk of behavioural disturbance to fish is likely to be low.

Overall impact on prey availability

Injury impacts on fish species resulting from underwater sound generated by activity associated with the Development are highly localised and will not result in an impact at population level. Piling activities will be of short duration and the seismic survey vessel will be constantly moving. Fish eggs and larvae will not be able to move away from the piling location or the airgun array and will therefore be more susceptible to injury. It is unlikely that fish will be displaced from the Development area during either piling or seismic activities. Given the small, predicted areas where fish eggs and larvae may suffer damage, relative to the large spawning areas across the North Sea, it is not expected that the piling or seismic survey will have a significant effect on spawning fish. In addition, DESNZ (2022) also concluded that impacts on fish from seismic surveys indicate that the disturbance would be localised and temporary and that any impacts would be inconsequential.

Any impacts on prey availability are therefore considered to be very limited and would not affect the Conservation Objectives of the SAC.

In-combination effects

The Applicant has identified four developments that could be undergoing construction at the same time as the Development and which could contribute to the in-combination noise effects on harbour porpoise of the SNS SAC.

Consideration of these is given below.

The Hornsea Project Four OWF is scheduled to start construction in 2026 and will include piling for the foundations of 180 turbines. The OWF will partially overlap with the Endurance store and construction will be concurrent with the Development. The maximum seasonal average area of disturbance from piling for the Hornsea Project Four OWF has been presented as being 7.87% of the summer area of the SNS SAC.

The Hornsea Project Four Transmission Asset project will install an electricity cable linking the OWF to shore, with landfall near Bridlington. The project includes installation of a High Voltage Alternating Current booster station within 2 km of the Development's Humber pipeline. Whereas this is located outside of the SNS SAC it may be possible that installation noise, for example from piling, may penetrate into the SNS SAC and thereby contribute to noise impacts on harbour porpoise within the SAC.

The Sofia Transmission Asset project will install an electricity transmission cable from the Sofia OWF to shore close to Redcar. Noise generating activities in the SNS SAC are limited to vessel activity and therefore not deemed to have an effect on harbour porpoise.

Piling at the Development is considered to represent as a worst case 0.029% of the SNS SAC over a season. In combination with noise from installation of the Hornsea Project Four OWF this would not exceed the seasonal threshold for disturbance of Harbour Porpoise.

The noise modelling undertaken by the Applicant demonstrates that piling for the Development alone will not cause exceedance of the daily threshold.

In order to enable activities to be undertaken in a way which does not cause an adverse effect on the integrity of the Southern North Sea SAC, OPRED and the MMO have introduced requirements which mean that operators must demonstrate that they only undertake their permitted activities in such a way that the daily threshold will not be exceeded.

The threshold verification will be achieved through inter-operator liaison which will plan activities such that the major sources of impulsive noise do not take place at the same time causing an exceedance of the thresholds.

This co-ordination takes place via a cross sector, industry led, simultaneous operations (sim ops) working group where all operators producing impulsive noise within the SAC meet regularly. The record of daily activity and cumulative disturbance will be displayed on a live, shared document visible to industry and overseen by the relevant regulators.

Adherence to the liaison, planning and reporting requirements of this scheme is a mandatory requirement included in the permitting of installation activities.

9.3.3 Discharges to sea impacting on prey species

Harbour porpoises are not expected to be impacted by discharges to sea (such as drill cuttings, mud and pipeline chemicals) or by the Formation Water displacement. Impact on prey availability is considered in this section.

Drilling discharges

Sandeel individuals present within the immediate vicinity of the well may be impacted by smothering. However, the modelling of cuttings and discharges above demonstrate that the maximum spread of thickness of cuttings above 10 mm is restricted to 550 m from the well locations, which represents a minute portion of the SNS SAC. While localised impact to fish species is expected at the well locations from the drill cuttings and mud discharges, **it can be concluded that any impacts on prey availability is considered to be very limited and would not result in a LSE or affect the Conservation Objectives of the SNS SAC.**

Aqueous discharges

In terms of discharges of pipeline chemicals, it was concluded that changes to water quality will be localised. In particular, the modelling indicated that the dilution required to achieve a PEC/PNEC of less than 1 for the pipeline chemicals is predicted to be achieved within a maximum of 568 m from the discharge location. With the dynamic environment at the Development, it is therefore unlikely that fish species will be impacted by these discharges. **As such, discharges of chemicals during the pipeline dewatering are not expected to affect the designated features of the SAC and no LSE is expected.**

Outcrop formation water displacement

Displacement of formation water would occur at the Bunter Sandstone Outcrop. Modelling was conducted to assess impacts from Formation Water displacement, concluding that a localised increase in metals and salinity may be detected; however, this was limited to 150 m from the displacement location. In addition, the majority of metals were expected to remain in the sediment and any metals passing through the sediment are expected to remain in solution which limits the potential for impacts to fish species via changes to water quality. Formation water displacement is spatially limited, and it is believed the majority of metals would be retained within the sediments. **Therefore, impacts would be limited to a very small portion of the SNS SAC and are not expected to affect the designated features of the SAC. No LSE is therefore expected.**

9.3.4 Collision risk

Increased vessel traffic during installation and construction presents an increased risk of collision with marine mammals. Vessels travelling at 7 m/s or faster are those most likely to cause death or serious injury (Wilson *et al*., 2007). Vessels involved in the Development are likely to be travelling considerably slower than this, and therefore collision risk is expected to be lower than that posed by commercial shipping activity.

The Development will not result in long-term changes to the functioning of any marine mammal population. The risk of collision arising from the Development is expected to be greatest during the construction phase. However, vessels will likely be travelling at slow speeds, meaning the collision risk is low. **Considering the area already contains moderate levels of vessel traffic, this is not expected to result in any LSEs on the harbour porpoise population designated in the SNS SAC.**

In-combination effects

Considering the fact that the any collision risk to marine mammals will be highly localised to the vicinity of the Development, there is expected to be a limited potential for cumulative impacts with other projects to arise, when the mitigations are considered. It is expected that projects will implement similar mitigations in order to reduce any potential collision risk or disturbance to marine mammals (e.g. Vessel Management Plan) to reduce any potential collisions with marine mammals.

With regards to disturbance during the drilling and installation works, there is the potential that cumulative impacts could arise with other projects in the vicinity of the Development with overlapping construction timelines. It is expected that vessel routes to and from nearby projects will already be well used, and therefore, there will not be a discernible increase in the potential disturbance caused. Furthermore, construction vessels will likely be moving slowly, reducing the potential impacts to marine mammals. **Considering this, in combination with the short-term nature of the disturbance caused, the potential for a significant cumulative impact to arise is low.**

10 APPROPRIATE ASSESSMENT - CONCLUSIONS

The Secretary of State has carefully considered all of the information available in order to undertake a Habitats Regulations Assessment. The Secretary of State considers that the proposed NEP Development to have the potential to cause a Likely Significant Effect alone and in-combination with other plans or projects on the qualifying species of the following sites:

- Greater Wash SPA
- Humber Estuary SPA
- Flamborough and Filey Coast SPA
- Teesmouth and Cleveland Coast SPA.
- Southern North Sea SAC

The Secretary of State has undertaken an Appropriate Assessment in respect of the sites' Conservation Objectives to determine whether the project, either alone or in-combination with other plans or projects, will result in an adverse effect on integrity.

The Secretary of State has undertaken a robust assessment using all of the information available.

Having considered all of the information available, the Secretary of State has concluded that the proposed NEP Development alone or in-combination with other plans and projects will not have an adverse effect on the integrity of the sites considered.

Having concluded that there will be no likely significant effect and no adverse effect on the integrity of any site no further assessment is required.

11 REFERENCES

ASCOBANS (2015). *Recommendations of ASCOBANS on the Requirements of Legislation to Address Monitoring and Mitigation of Small Cetacean Bycatch*. October 2015.

Austin, M. (2014). SEC7964 Tolmount Pipeline Onshore Ornithology Review. RPS, Edinburgh.

BERR (2008). Review of cabling techniques and environmental effects applicable to the offshore wind farm industry. Technical Report. Available online at: https://tethys.pnnl.gov/sites/default/files/publications/Cabling_Techniques_and_Environmental_Effects.pdf [Accessed 11/07/2023].

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G. and Hume, D. (2014). Mapping Seabird Sensitivity to Offshore Wind Farms. PLOS ONE. 12 (1):1-17.

Clark, N. (2005). The Spatial and Temporal Distribution of the Harbour Porpoise (*P. phocoena*) in the Southern Outer Moray Firth, NE Scotland. Unpublished Master of Science Thesis. University of Bangor.

Cleasby, I., Owen, E., Wilson, L., Wakefield, E., O'Connell, P., & Bolton, M. (2020). Identifying important at-sea areas for seabirds using species distribution models and hotspot mapping. Biological Conservation, 241, 108375.

Coull, K.A., Johnson, R. and Rodgers, S.I. (1998). Fisheries sensitivity Maps in British Waters. Published Distribution by UKOOA Ltd.

Cutts, N., Hemingway, K. and Spencer, J., (2013). Waterbird Disturbance Mitigation Toolkit Informing Estuarie Planning and Construction Projects. [Online]. Available at: https://www.tide[1]toolbox.eu/tidetools/waterbird_disturbance_mitigation_toolkit/

Defra (2003). UK small cetacean bycatch response strategy. Department for Environment, Food and Rural Affairs. March 2003

Defra (2012). The Habitats and Wild Birds Directives in England and its seas. Core guidance for developers, regulators & land/marine managers. December 2012.

Defra (2015). *An analysis of potential broad-scale impacts on harbour porpoise from proposed pile driving activities in the North Sea*. Report of an expert group convened under the Habitats and Wild Birds Directives – Marine Evidence Group.

Defra (2021) North East Inshore and North East Offshore Marine Plan. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1004484/FINAL_North_East_Marine_Plan__1_.pdf

DeRuiter, S.L. (2008). *Echolocation-based foraging by harbor porpoises and sperm whales, including effects of noise and acoustic propagation*. PhD Thesis. Massachusetts Institute Of Technology and the Woods Hole Oceanographic Institution. September 2008.

DESNZ (2021). Technical Note: Review of rock and other protective material use in offshore oil and gas operations in the UK Continental Shelf. Available online at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1050281/Technical_Note__Review_of_rock_and_other_protective_materials.pdf

DESNZ (2022). Record Of The Habitats Regulations Assessment Undertaken Under Regulation 5 Of The Offshore Petroleum Activities (Conservation Of Habitats) Regulations 2001 (As Amended). BP Greater NEP 3D Towed-streamer (Endurance + BC39). Available online at:

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1066603/BP_NEP_3D_Survey_HRA_Rev_2.0.pdf.

DESNZ (2024). Habitats Regulations Assessment for an Application under the Planning Act 2008. Net Zero Teesside Project. Available online at: HRA - Net Zero Teesside Project (planninginspectorate.gov.uk)

Drewitt A.L. and Langston R.H.W. (2006). Assessing the impacts of wind farms on birds. Ibis, 148, 29–42.DTI (2001). Strategic Environmental Assessment of the Mature Areas of the Offshore North Sea. SEA 2 September 2001. Department of Trade and Industry.

EAOWL (2015). *East Anglia Three offshore wind farm. Environmental Statement.* Scottish Power Renewables, Vattenfall.

EC (2018). Managing Natura 2000 sites: The provisions of Article 6 of the 'Habitats' Directive 92/43/CEE. Commission Note. Brussels, 21.11.2018 C(2018) 7621 final. Luxembourg: Office for Official Publications of the European Communities.

ECON (2012). Boat-based ornithological monitoring at the Lynn and Inner Dowsing Wind Farms: Year 3 (2011) post-construction report. Report for Centrica Renewable Energy Limited.

English Nature (1997). *Habitats Regulations Guidance Note, HRGN 1.*

Evans, P.G.H. and Teilmann, J. (editors). (2009). Report of ASCOBANS/HELCOM Small Cetacean Population Structure Workshop. ASCOBANS/UNEP Secretariat, Bonn, Germany. 140pp.

Everley, K.A., Radfod, A.N., Simpson, S.D. (2016). Pile-Driving Noise Impairs Antipredator Behavior of the European Sea Bass *Decentrarchus labrax*. In: Popper A.N., Hawkins, A.D. (eds). The effects of noise on aquatic life, II. Springer Science Business Media, New York. pp. 273 – 279.

Forewind (2013). *Dogger Bank: Creyke Beck offshore wind farm Environmental Statement.* Forewind.

Forewind (2014). *Dogger Bank: Teesside A & B offshore wind farm Environmental Statement*. Forewind

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters. [Online]. Available online at: http://publications.naturalengland.org.uk/publication/6427568802627584]

Gardline (2022). Environmental Survey Habitat Assessment (Project number: 11711, April 2022)

Gilles, A, Authier, M, Ramirez-Martinez, NC, Araújo, H, Blanchard, A, Carlström, J, Eira, C, Dorémus, G, Fernández Maldonado, C, Geelhoed, SCV, Kyhn, L, Laran, S, Nachtsheim, D, Panigada, S, Pigeault, R, Sequeira, M, Sveegaard, S, Taylor, NL, Owen, K, Saavedra, C, Vázquez-Bonales, JA, Unger, B, Hammond, PS (2023). Estimates of cetacean abundance in European Atlantic waters in summer 2022 from the SCANS-IV aerial and shipboard surveys. Final report published 29 September 2023. 64 pp. https://www.tiho-hannover.de/fileadmin/57_79_terr_aqua_Wildtierforschung/79_Buesum/downloads/Berichte/20230928_SCANS-IV_Report_FINAL.pdf

Gils, J.A.V., Spaans, B., Dekinga, A. and Piersma, T. (2006). Foraging in a tidally structured environment by red knots (Calidris canutus): ideal, but not free. Ecology, 87(5), pp.1189-1202.

Goss-Custard, J.D., Jones, R.E. and Newbery, P.E. (1977). The ecology of the Wash. I. Distribution and diet of wading birds (Charadrii). Journal of Applied Ecology, pp.681-700.

Graham, I.M., Merchant, N.D., Farcas, A., Candido Barton, T.R., Cheney, B., Bono, S., & Thompson, P.M. (2019). Harbour porpoise responses to pile-driving diminish over time. Royal Society Open Science, 6(6), 190335.

Greenstreet, S., Armstrong, E., Mosegaard, H., Jensen, H., Gibb, I., Fraser, H., Scott, B., Holland, G. and Sharples, J. (2006). Variation in the abundance of sandeels *Ammodytes marinus* off southeast Scotland: an evaluation of area-closure fisheries management and stock abundance assessment methods. *ICES Journal of Marine Science* 63: 1530-1550.

Hammond, P. S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M. B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2021). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys.

Hammond, P.S., Benke, H., Borchers D.L., Buckland S.T., Collet A., Hiede-Jørgensen, M.P., Heimlich-Boran, S., Hiby, A.R., Leopold, M.F. and Øien, N. (1995). *Distribution and abundance of the harbour porpoise and other small cetaceans in the North Sea and adjacent waters*-Final report. Life 92-2/UK/027.

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Börjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vingada, J. and Øien, N. (2017). *Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys*. University of St Andrews. https://synergy.st-andrews.ac.uk/scans3/category/researchoutput/.

Hammond, P.S., Macleod, K., Berggren, P., Borchers, D.L., Burt, M.L., Cañadas, A., Desportes, G., Donovan, G.P., Gilles, A., Gillespie, D., Gordon, J., Hiby, L., Kuklik, I., Leaper, R., Lehnert, K., Leopold, M., Lovell, P., Øien, N., Paxton, C.G.M., Ridoux, V., Rogan, E., Samarra, F., Scheidat, M., Sequeira, M., Siebert, U., Skov, H., Swift, R., Tasker, M.L., Teilmann, J., Van Canneyt, O. & Vázquez, J.A. (2013). Cetacean abundance and distribution in European Atlantic shelf waters to inform conservation and management. *Biological Conservation* 164: 107-122.

Hassel, A., Knutsen, T., Dalen, J., Skaar, K., Løkkeborg, S., Østensen, Ø., Fonn, M. and Haugland, E.K. (2004). Influence of seismic shooting on the lesser sandeel (*Ammodytes marinus*). *ICES Journal of Marine Science* 61 (7), pp.1165-1173.

Hawkins, A.D., Roberts, L., and Cheesman, S. (2014). Responses of free-living coastal pelagic fish to impulsive sounds. *Journal of the Acoustical Society of America* 135: 3101 - 3116. PMID: 24926505.

Heath, M.R., Rasmussen, J., Bailey, M.C., Dunn, J., Fraser, J., Gallego, A., Hay, S.J., Inglis, M. and Robinson, S. (2011). Larval mortality rates and population dynamics of Lesser Sandeel (Ammodytes marinus) in the northwestern North Sea. *Journal of Marine Systems* 93, pp. 47- 57.

Heinänen, S. and Skov, H. (2015). *The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area*. JNCC Report No.544 JNCC, Peterborough.

Holland, G.J., Greenstreet, S.P.R., Gibb, I.M., Fraser, H.M. and Robertson, M.R. (2005). Identifying sandeel *Ammodytes marinus* sediment habitat preferences in the marine environment. *Mar. Ecol. Prog. Ser.* 303, 269– 282.

IAMMWG (2022). Updated abundance estimates for cetacean Management Units in UK waters. JNCC Report No. 680, JNCC, Peterborough.

IAMMWG, Camphuysen, C.J. and Siemensma, M.L. (2015). *A Conservation Literature Review for the Harbour Porpoise (Phocoena phocoena).* JNCC Report No. 566, Peterborough. 96pp.

JNCC (2015). *Harbour Porpoise (Phocoena phocoena) possible Special Area of Conservation: Southern North Sea. Draft Conservation Objectives and Advice on Activities*. Version 4 (November 2015).

JNCC (2017a). *JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys*. Joint Nature Conservation Committee, Aberdeen. April 2017.

JNCC (2017b). *Species abbreviations and Management Units (MU) abundance values, in “Instructions.doc”.* Available from: http://jncc.defra.gov.uk/page-7201.

JNCC (2017c). SAC Selection Assessment: Southern North Sea. January 2017. Joint Nature Conservation Committee, UK. Available from: https://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-SAC-selection-assessment-document.pdf

JNCC (2017d). *A potential approach to assessing the significance of disturbance against conservation objectives of the harbour porpoise cSACs. Version 3.0.* Discussion document 14/02/2017. Workshop Noise management in harbour porpoise cSACs. The Dome Room, New Register House, 3 West Register Street, Edinburgh, Scotland EH1 3YT. 27th February 2017.

JNCC (2017e). *Noise assessment and management in harbour porpoise SACs. Briefing note: Use of thresholds to assess and manage the effects of noise on site integrity*. Workshop Noise management in harbour porpoise cSACs. The Dome Room, New Register House, 3 West Register Street, Edinburgh, Scotland EH1 3YT. 27th February 2017.

JNCC (2020). Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs. (England, Wales & Northern Ireland). June 2020.

JNCC (2020a). Greater Wash SPA. Available online at: https://jncc.gov.uk/our-work/greater-wash-spa/ [Accessed 23/07/2021]

JNCC (2023). Southern North Sea MPA. Available at: https://jncc.gov.uk/our-work/southern-north-sea-mpa/

JNCC and NE (2019). *Harbour Porpoise (Phocoena phocoena) Special Area of Conservation: Southern North Sea Conservation Objectives and Advice on Operations*. March 2019. Joint Nature Conservation Committee and Natural England. Available online at: https://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea[1]conservation-advice.pd

Judd, A., Warr, K. and Pacitto, S. (2011). *Fisheries Sensitivity Maps in British Waters – Guidance for Pile-driving.* Cefas contract report <ME5403 Mod13>.

Kastelein, R.A., van den Belt, I., Helder-Hoek, L., Gransier, R. and Johansson, T. (2015). Behavioral responses of a harbor porpoise (Phocoena phocoena) to 25-kHz FM sonar signals. Aquatic Mammals, 41(3), p.311.

Kastelein, R. A., Gransier, R., Hoek, L. and Olthuis, J. (2012). Temporary threshold shifts and recovery in a harbor porpoise (*Phocoena phocoena*) after octave-band noise at 4 kHz. *Journal of the Acoustical Society of America.* 132(5): 3525–3537.

Kastelein, R.A., Hardeman, J. and Boer, H. (1997). *Food consumption and body weight of harbour porpoises (Phocoena phocoena).* In: The biology of the harbour porpoise (1997). Eds. Read, A.J., Wiepkema, P.R. and Nachtigall, P.E. pp.217-233. DeSpil Publishers, Woerden, The Netherlands, ISBN90-72743-07-5.

Kastelein, R.A., Van de Voorde, S. and Jennings, N. (2018). Swimming Speed of a Harbor Porpoise (*Phocoena phocoena*) During Playbacks of Offshore Pile Driving Sounds. *Aquatic Mammals* 2018, *44*(1), 92-99, DOI 10.1578/AM.44.1.2018.92.

Kober, K., Webb, A., Win, I., Lewis, M., O'Brien, S., Wilson, L.J. and Reid, J.B. (2010). An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs. JNCC Report No. 431, November 2010. Available online at: https://data.jncc.gov.uk/data/7db38547-5074-4136-8973-fd7d97666120/JNCC-Report-431-Full-FINAL-WEB.pdf

Lawson, B., Petrovan, S. O., & Cunningham, A. A. (2015). Citizen science and wildlife disease surveillance. EcoHealth, 12(4), 693-702. https://doi.org/10.1007/s10393-015-1054-z.

Lawson, J., Kober, K., Win, I., Allcock, Z., Black, J. Reid, J.B., Way, L. and O'Brien, S.H. (2016). An assessment of the numbers and distribution of wintering red-throated diver, little gull and common scoter in the Greater Wash. Available online at: http://jncc.defra.gov.uk/pdf/Report_574_final_web.pdf

Learmonth, J.A., Murphy, S., Luque, P.L., Reid, R.J., Patterson, I.A.P., Brownlow, A., Ross, H.M., Barley, J.P., Begoña Santos, M. and Pierce, G.J. (2014). Life history of harbor porpoises (Phocoena phocoena) in Scottish (UK) waters. Marine Mammal Science,30(4), pp.1427-1455.

Leopold, M.F., Dijkman, E.M., Teal, L. and the OWEZ-team, (2010). Local birds in and around the Offshore Wind Farm Egmond aan Zee (OWEZ). NoordzeeWind rapport OWEZ_R_221_T1_20100731_local_birds. Imares / NoordzeeWind, Wageningen / IJmuiden.

Lockyer C. (2003). Harbour porpoises (*Phocoena phocoena*) in the North Atlantic: biological parameters. *NAMMCO Scientific Publications*, 5, 71–89.

Lurton, X., & DeRuiter, S. (2011). Sound radiation of seafloor-mapping echosounders in the water column, in relation to the risks posed to marine mammals. International Hydrographic Review, No. 6, pp. 7-17.

MacDonald, A., Heath, M. R., Greenstreet, S. P., & Speirs, D. C. (2019). Timing of sandeel spawning and hatching off the east coast of Scotland. Frontiers in Marine Science, 6, 70.

Miller, L. A., and Wahlberg, M. (2013). Echolocation by the harbour porpoise: life in coastal waters. *Frontiers in Physiology*, 4, 52. http://doi.org/10.3389/fphys.2013.00052.

MMO (2015). *Modelled mapping of continuous underwater noise generated by activities.* A report produced for the Marine Management Organisation, pp50. MMO Project No. 1097. ISBN 978-1-909452-87-9.

Mueller-Blenkle, C., McGregor, P. K., Gill, A. B., Andersson, M. H., Metcalfe, J., Bendall, V., Sigray, P., Wood, D. T. and Thomsen, F. (2010). *Effects of Pile-driving Noise on the Behaviour of Marine Fish.* COWRIE Ref: Fish 06-08, Technical Report.

Nabe-Nielsen, J., van Beest, F. M., Grimm, V., Sibly, R. M., Teilmann, J., & Thompson, P. M. (2018). Predicting the impacts of anthropogenic disturbances on marine populations. Conservation Letters, 11(5), e12563.

National Research Council (2002). Effects of Trawling and Dredging on Seafloor Habitat. Available at: https://www.nap.edu/read/10323/chapter/1

Natural England, (2018). Departmental Brief: Teesmouth and Cleveland Coast potential Special Protection Area (pSPA) and Ramsar. [Online]. Available at: https://consult.defra.gov.uk/natural[1]england-marine/teesmouth-and-cleveland-coast-potential[1]sp/supporting_documents/Teesmouth%20and%20Cleveland%20Coast%20pSPA%20Departmental% 20Brief.pdf nmfs

Newell, R. C., Seiderer, L. J. and Hitchcock, D. R. (1998). The impact of dredging works in coastal waters: a review of the sensitivity to disturbance and subsequent recovery of biological resources on the seabed. Oceanogr. Mar. Biol. Annu. Rev., 36, 127–178.

NMFS (National Marine Fisheries Service) (2018). 2018 Revision to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing: underwater acoustic thresholds for onset of permanent and temporary threshold shifts (Version 2.0). U.S. Dept. of Commer. NOAA. NOAA Technical Memorandum NMFS-OPR-55, 178 pp.

OSPAR (2009) *Overview of the impacts of anthropogenic underwater sound in the marine environment*. OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic (www.ospar.org).

Otani S. Naito Y., Kato A. and Kawamura A. (2000). Diving behaviour and swimming speed of a free ranging harbor porpoise, *Phocoena phocoena*. *Marine Mammal Science*, 16, 811– 814.

Otani S., Naito Y., Kawamura A., Kawasaki M., Nishiwaki S., and Kato A. (1998) Diving behavior and performance of harbor porpoises, *Phocoena phocoena*, in Funka Bay, Hokkaido, Japan. *Marine Mammal Science*, 14, 209–220.

Parsons, M., Lawson, J., Lewis, M., Lawrence, R. and Kuepfer, A., 2015. Quantifying foraging areas oflittle tern around its breeding colony SPA during chick-rearing. Peterborough: JNCC.

Parvin, S.J, Nedwell, J.R. and Harland. E. (2007). *Lethal and physical injury of marine mammals and requirements for Passive Acoustic Monitoring.* Subacoustech Report.

Paxton, C.G.M., Scott-Hayward, L., Mackenzie, M., Rexstad, E. & Thomas, L. (2016) Revised Phase III Data Analysis of Joint Cetacean Protocol Data Resource, JNCC Report No. 517, JNCC, Peterborough, ISSN 0963-8091.

Popper, A. N. Hawkins, A. D., Fay, R. F., Mann, D. A., Bartol, S., Carlson, T. J., Coombs, S., Ellison, W. T., Gentry, R. L., Halvorsen, M. B., Løkkeborg, S., Rogers, P. H., Southall, B. L., Zeddies, D. G., and Tavolga, W. N. (2014). *Sound Exposure Guidelines for Fishes and Sea Turtles*: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. ASA S3/SC1.4 TR-2014.

Popper, A.N. (2003). Effects of anthropogenic sounds on fishes. *Fisheries 28*(10):24-31.

Salmon, K. (2011). York Field Development Project Offshore Environmental Statement Addendum. RPS Energy, Woking.

Santos, M.B. and Pierce, G.J. (2003). The diet of harbor porpoise (*P. phocoena*) in the Northeast Atlantic. *Oceanography and Marine Biology: an Annual Review 2003*, 41, 355–390.

Scottish Executive (2007). Scottish marine SEA. Environmental report section C SEA assessment: Chapter C9 marine mammals. Available online at http://www.gov.scot/Publications/2007/03/seawave [Accessed 22/04/2022].

SMart Wind (2015). *Hornsea offshore wind farm. Project two environmental statement.*

SMart Wind (2017). *Hornsea Project Three Offshore Wind Farm. Preliminary Environmental Information*.

Southall, B., Bowles, A., Ellison, W., Finneran, J., Gentry, Ro., Greene Jr., C., Kastak, D., Ketten, D., Miller, J., Nachtigall, P., Richardson, W., Thomas, J. and Tyack, P. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific recommendations. *Aquatic Mammals*. 33(4), 411-521.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L. (2019). Marine mammal noise exposure criteria: Updated Scientific recommendations for residual hearing effects. *Aquatic Mammals* 2019, *45*(2), 125-232, DOI 10.1578/AM.45.2.2019.125.

Stone, C.J., Webb, A., Barton, C., Ratcliffe, N., Reed, T.C., Tasker, M.L., Camphuysen, C.J., Pienkowski, M.W. (1995). An atlas of seabird distribution in northwest European waters. Available online at: http://jncc.defra.gov.uk/page-2407

Sveegaard, I. (2011). *Spatial and temporal distribution of harbour porpoises in relation to their prey*. Unpublished PhD Thesis, Aarhus University.

Teilmann, J., Larsen, F. and Desportes, G. (2007). Time allocation and diving behaviour of harbour porpoises (*Phocoena phocoena*) in Danish and adjacent waters. *J. Cetacean Res. Manage*. 9(3):201–210, 2007.

Thompson, P.M., Brookes, K.L., Graham, I.M., Barton, T.R., Needham, K., Bradbury, G. and Merchant, N.D. (2013). Short-term disturbance by a commercial two-dimensional seismic survey does not lead to long-term displacement of harbour porpoises. *Proc R Soc Lond B Biol SAC* 2013, 280:20132001.

Thomsen, F., Lüdemann, K., Kafemann, R. and Piper, W. (2006). *Effects of offshore wind farm noise on marine mammals and fish*. Cowrie Report.

TKOWFL (2011). Triton Knoll Offshore Wind Farm Environmental Statement. RWE npower renewables.

Tougaard, J., Wright, A. J., & Madsen, P. T. (2015). Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. Marine pollution bulletin, 90(1-2), 196-208.

Tougaard J, Wright AJ & Madsen PT (2016). Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. -Marine Pollution Bulletin 90:196-208.

Van der Kooij, J., Scott, B.E. and Mackinson S. (2008). The effects of environmental factors on daytime sandeel distribution and abundance on the Dogger Bank. *Journal of Sea Research* 60: 201–209.

Villadsgaard A., Wahlberg M., Tougaard J. (2007). Echolocation signals of wild harbour porpoises, *Phocoena phocoena J. Exp. Biol.* 210 56–64.

Wade H.M., Masden. E.A., Jackson, A.C. and Furness, R.W. (2016). Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Marine Policy, 70, pp. 108–113.

Waggitt, J., Evans, P., Andrade, J., Banks, A., Boisseau, O., Bolton, M., Bradbury, G., Brereton, T., Camphuysen, C., Durinck, J., Felce, T., Fijn, R., Garcia-Baron, I., Garthe, S., Geelhoed, S., Gilles, A., Goodall, M., Haelters, J., Hamilton, S., Hartny-Mills, L., Hodgins, N., James, K., Jessopp, M., Kavanagh, A., Leopold, M., Lohrengel, K., Louzao, M., Markones, N., Martínez-Cedeira, J., Ó Cadhla, O., Perry, S., Pierce, G., Ridoux, V., Robinson, K., Santos, M., Saavedra, C., Skov, H., Stienen, E., Sveegaard, S., Thompson, P., Vanermen, N., Wall, D., Webb, A., Wilson, J., Wanless, S. and Hiddink, J. (2019). Distribution maps of cetacean and seabird populations in the North-East Atlantic. Journal of Applied Ecology, 57(2), pp.253-269.

Wakefield, E.D., Bodey, T.W., Bearhop, S., Blackburn, J., Colhoun, K., Davies, R., Dwyer, R.G., Green, J.A., Grémillet, D., Jackson, A.L., Jessopp, M.J., Kane, A., Langston, R.H.W., Lescroël, A., Murray, S., Le Nuz, M., Patrick, S.C., Péron, C., Soanes, L.M., Wanless, S., Votier, S.C. and Hamer, K.C. (2013). Space Partitioning Without Territoriality in Gannets. Science, 341 (6141), 68-70.

Ward, R., Evans, E. and O'Connell, M., (2003). Study of long term changes in bird usage of the Tees Estuary. Slimbridge: WWT.

Weir, C.R., Stockin, K.A. and Pierce, G.J., 2007. Spatial and temporal trends in the distribution of harbour porpoises, white-beaked dolphins and minke whales off Aberdeenshire (UK), north-western North Sea. *Journal of the Marine Biological Association of the United Kingdom*, *87*(1), pp.327-338.

Whaley, A.R., 2004. *The distribution and relative abundance of the harbour porpoise (P. phocoena L.) in the southern outer Moray Firth, NE Scotland*. Unpublished Bachelor of Science thesis, School of Geography, Birbeck College.

Wilson B., Batty R.S., Daunt F. & Carter C. (2007). Collision risks between marine renewable energy devices and mammals, fish and diving birds. Report to the Scottish Executive. Scottish Association for Marine Science, Oban.

Wilson, L.J., Black, J., Brewer, M.J., Potts, J.M., Kuepfer, A., Win, I., Kober, K., Bingham, C., Mavor, R.and Webb, A., 2014. Quantifying usage of the marine environment by terns Sterna sp. around theirbreeding colony SPAs. JNCC Report 500. Peterborough: JNCC.

Wisniewska, D.M., Johnson, M., Teilmann, J., Rojano-Donate, L., Shearer, J., Sveegaard, S., Miller, L.A., Siebert, U. and Madsen, P.T. (2016). Ultra-high foraging rates of harbor porpoises make them vulnerable to anthropogenic disturbance. *Current Biology*, *26*(11), pp.1441-1446. Elsevier Ltd.

Wisniewska, D.M., Johnson, M., Teilmann, J., Siebert, U., Galatius, A., Dietz, R. and Madsen, P.T., (2018). *High rates of vessel noise disrupt foraging in wild harbour porpoises (Phocoena phocoena)*. *Proceedings of the Royal Society B: Biological Sciences*, *285*(1872), p.20172314. http://dx.doi.org/10.1098/rspb.2017.2314.

Woodward, I., Thaxter, C.B., Owen, E. and Cook, A.S.C.P. (2019). Desk-based revision of seabird foraging ranges used for HRA screening. [Online]. Available at: http://www.marinedataexchange.co.uk/

Xodus Group (2023). Offshore Environmental Statement for the Northern Endurance Partnership: Navigational Risk Assessment (Doc no: NS051-HS-REP-219-00007).