RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Preliminary Environmental Information Report

Chapter 9 – Benthic Habitats

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Dogger Bank South Offshore Wind Farms

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Glossary

Term	Definition
Accommodation Platform	An offshore platform (situated within either the DBS East or DBS West array area) that will provide accommodation and mess facilities for staff when carrying out maintenance activities for the Projects.
Array Areas	The DBS East and DBS West offshore array areas, where the wind turbines and array cables will be located. The array areas do not include the offshore export cable corridor.
Array Cables	Cables which link the wind turbine generators to the offshore substation/converter/collector platform(s).
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Electrical Switching Platform (ESP)	The electrical switching platform (if required) will provide a link to a co-ordinated east coast transmission system which is planned to run from Scotland to England, as per National Grid ESO's Holistic Design Network. This platform may be located either within one of the array areas (alongside a converter station) or mid-way along the export cable corridor (likely next to the Reactive Compensation Platform if required).
Inter-Platform Cables	Cables linking offshore platforms.
Offshore Converter Platforms (OCPs)	Offshore Converter Platforms (OCPs) will be required for the HVDC option. The OCPs are fixed structures located within the array area that collect the AC power generated by the wind turbines and convert the power to DC, before transmission through the offshore export cables to the Project's onshore grid connection points

Term	Definition
Offshore Development Area	The Offshore Development Area encompasses the wind farm site and the options for the offshore transmission works.
Offshore Export Cable Corridor	This is the area which will contain the offshore export cables (and potentially the ESP and / or RCP) between the offshore substation/converter platforms and Transition Joint Bays at the landfall
Offshore Substation Platforms (OSPs)	Offshore Substation Platforms (OSPs) will be required for the HVAC option. These are fixed structures located within the array areas that contain electrical equipment to aggregate the power from the wind turbines, followed by conversion into a more suitable voltage for transmission through the offshore export cables to the Project's onshore grid connection points.
Reactive Compensation Platform	A Reactive Compensation Platform (RCP) will be required for a HVAC solution. The RCP will host the shunt reactors required to provide reactive compensation, in order to limit the electrical losses which occur with HVAC transmission over long distances..
Safety Zones	A statutory marine zone demarcated for the purposes of safety around a possibly hazardous installation or works/construction area..
Scoping Report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Scoping Opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.

Term	Definition
The Applicant	RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited as the owners of DBS West and DBS East respectively are the named undertakers that will have the benefit of the Development Consent Order. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of RWE Renewables UK Dogger Bank South (West) Limited and RWE Renewables UK Dogger Bank South (East) Limited.
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South offshore wind farms).

Acronyms

Term	Definition
AC	Alternating Current
AL1	Action Level 1
BAP	Biodiversity Action Plan
BGS	British Geological Survey
BTO	British Trust for Ornithology
BWMC	International Convention for the Control and Management of Ships' Ballast Water and Sediments
CEA	Cumulative Effects Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
DBS	Dogger Bank South
DBT	Dibutyltin
DC	Direct Current
DCO	Development Consent Order
EMF	Electromagnetic Fields
EPP	Evidence Plan Process
ERM	Effects Range Median
ES	Environmental Statement
ESP	Electrical Switching Platform
ETG	Expert Topic Group
EUNIS	European Nature Information System

Term	Definition
FERA	Food and Environment Research Agency
FOCI	Features of Conservation Interest
GBS	Gravity Based Structures
HDD	Horizontal Directional Drill
HRA	Habitats Regulations Assessment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
INNS	Invasive / Non-Native Species
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
MarESA	Marine Evidence based Sensitivity Assessment
MarLIN	The Marine Life Information Network
MARPOL	International Convention for the Prevention of Pollution from Ships
MCZ	Marine Conservation Zone
MMO	Marine Management Zone
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MPS	Marine Policy Statement
MREDs	Marine Renewable Energy Devices
NERC	Natural Environment and Rural Communities
NOAA	National Oceanic and Atmospheric Administration

Term	Definition
NPL	National Physical Laboratory
NPS	National Policy Statement
O&M	Operation and Maintenance
OCP	Offshore Convertor Platform
OSP	Offshore Substation Platform
PAH	Poly-Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyls
PEIR	Preliminary Environmental Information Report
PEL	Probable Effects Level
PEMP	Pollution Environmental Management Plan
PLGR	Pre-Lay Grapnel Run
RCP	Reactive Compensation Platform
SAC	Special Area of Conservation
SMRU	Sea Mammal Research Unit
SQG	Sediment Quality Guidelines
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
ST	Station
TBT	Tributyltin
TEL	Threshold Effects Level
THC	Total Hydrocarbon Content

Term	Definition
UXO	Unexploded Ordnance
ZOI	Zone of Influence

9 Benthic and Intertidal Ecology

9.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) considers the likely significant effects of the Projects on benthic and intertidal ecology. The chapter provides an overview of the existing environment for the proposed offshore development area, followed by an assessment of likely significant effects for the construction, operation, and decommissioning phases of the Projects.

2. The assessment should be read in conjunction with the following linked chapters:

- **Chapter 8 Marine Physical Environment**
- **Chapter 10 Fish and Shellfish Ecology**

3. Additional information to support the benthic and intertidal ecology assessment include:

- **Appendix 9-1 Intertidal Survey Report**
- **Appendix 9-2 Draft Benthic Ecology Characterisation Report**
- **Appendix 9-3 Environmental Features Report**

9.2 Consultation

4. Consultation with regard to benthic and intertidal ecology has been undertaken in line with the general process described in **Chapter 6 EIA Methodology**. The key elements of consultation to date have included scoping and the ongoing Evidence Plan Process (EPP) via the Seabed Expert Topic Group (ETG). The feedback received has been considered in preparing the PEIR. **Table 9-1** provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

5. This chapter will be updated following consultation on PEIR in order to produce the final assessment that will be submitted with the Development Consent Order (DCO) application. Full details of the consultation process will also be presented in the Consultation Report alongside the DCO application.

Table 9-1 Consultation Responses

Comment	Project Response
PINS, Scoping Responses 02/09/2022	
Underwater noise from other sources aside from piling and UXO clearance (construction, not considered for other project phases) – This matter (for the construction phase) is not stated in Table 2-15, however the supporting text in Paragraph 233 states that all other underwater noise sources (e.g., vessel traffic) are unlikely to cause significant effects on benthic receptors and are therefore scoped out of the ES. The matter is not addressed at all for the operation or decommissioning phases. No justification or evidence is provided for scoping out underwater noise from sources other than piling and UXO clearance during construction or decommissioning, or underwater noise from any sources during operation. The Inspectorate considers that an assessment should be provided in the ES, supported by a description of how the EPP described in Section 1.6 of the Scoping Report has informed the Applicant's reasoning.	The scope of underwater noise impacts has been expanded to include potential impacts from unexploded ordnance clearance, pile driving for the installation of some foundation types, cable installation and other construction activities including seabed preparation, rock placement and vessel activity (see section 9.6.1.6).
Introduction of marine non-native species due to vessel traffic - Based on the information provided on the proposed mitigation and control measures, the Inspectorate agrees that significant effects are unlikely. The ES should detail the proposed mitigation measures, such as the Project Environmental Management Plan, for all project phases. The ES should describe how the mitigation and control measures are to be secured.	Proposed embedded mitigation measures relating to the introduction of marine non-native species due to vessel traffic are detailed in section 9.3.3 of this chapter.
Long term habitat loss during construction and decommissioning - Paragraph 234 notes that impacts which span the life of the projects, like habitat loss, will be considered for the operational phase assessment. The ES should address temporal scope when it addresses the likely significant effects with reference to temporary, long-term, and permanent habitat loss across relevant phases of the Proposed Development. Terms such as 'temporary'	Timeframes for the Projects lifespan are provided where relevant in the assessment, with the terms 'temporary' and 'long-term' defined in section 9.4.3.

Comment	Project Response
and 'long-term' should be defined in the ES where they are used.	
Pollution events resulting from the accidental release of pollutants (all project phases) - Based on the information provided on the proposed mitigation and control measures, the Inspectorate agrees that significant effects from accidental release of pollution during construction are unlikely. The Scoping Report does not discuss the risks of this impact during operation; however, the Inspectorate considers that a similar rationale applies. The ES should detail the proposed mitigation measures, such as the Project Environmental Management Plan, for all project phases. The ES should describe how the mitigation and control measures are to be secured.	Proposed embedded mitigation measures relating to pollution events are detailed in section 9.3.3 of this chapter.
Remobilisation of contaminated sediments (all phases) - The Scoping Report does not provide a discussion of this matter for the operation or decommissioning phases; however, it is denoted as scoped out in Table 2-15. As noted in Table 3.2 above, the Inspectorate does not consider that sufficient information has been provided to scope out mobilisation of contaminants at this stage and therefore, the resulting effects on benthic ecology cannot be scoped out. The ES should assess this matter or demonstrate that no pathway for significant effects exists, drawing from the marine sediment and water quality assessment as appropriate.	Relevant impacts have been included in the assessment for construction (see section 9.6.1.5) and decommissioning (see section 9.6.3). In addition, based upon the conclusion of the assessment during construction, justification is provided for the operational phase of the Projects.
Increased suspended sediment concentrations during operation - As noted in Table 3.2 above, the Inspectorate does not consider that increases in suspended sediment can be scoped out at this stage and therefore, the resulting effects on benthic ecology cannot be scoped out. The ES should assess this matter or provide evidence to demonstrate that no pathway for significant	Impact has been included in this assessment (see section 9.6.1.4).

Comment	Project Response
effects exists, drawing from the marine sediment and water quality assessment as appropriate.	
Interactions of Electromagnetic Fields (EMF) (including potential cumulative EMF effects) during construction and decommissioning - The Inspectorate agrees that this impact-effect pathway should be assessed for the operational phase only where likely significant effects could occur.	Noted.
Interactions of heat generated by (operational) cables - The Inspectorate understands from the information in Paragraph 248 that heat emissions from operational cables are likely to be negligible. The Inspectorate agrees that likely significant effects are unlikely and that this matter can be scoped out of the ES.	Noted.
Colonisation of introduced substrate, including non-native species (operation) - The Inspectorate accepts that this impact is restricted to the operational phase and can be scoped out of construction and decommissioning.	Noted.
Underwater noise and vibration from piling and UXO clearance during operation - No discussion of the need for unexpected/ emergency UXO clearance during operation is provided, and no information on other operational/maintenance activities which would be sources of underwater noise is provided. The Inspectorate advises that the ES should provide an assessment of the likely significant effects of underwater noise during operation or provide justification that significant effects are unlikely supported by the evidence highlighted above.	Any UXO would be identified and then avoided or cleared in construction. Activities during operation will all be localised around existing infrastructure (foundations and cables) which have been located away from UXO or where UXO have been previously cleared during construction. There would be no need to enter areas where UXO could be present, therefore no pathway for effect. Discussion of underwater noise in relation to the operational phase of the Projects is detailed in section 9.6.2.

Comment	Project Response
Data collection - As well as the types of investigations undertaken, the ES needs to set out the methodologies used and to what extent these have been agreed with relevant stakeholders, for example via the EPP described in Section 1.7 of the Scoping Report.	Section 9.4.2.1 outlines the site-specific surveys undertaken for the Projects, and how the method statements for each survey was agreed with stakeholders.
Environment Agency, Scoping Responses 02/09/2022	
Surveys - We agree with the potential impacts to marine sediment and water quality and benthic/intertidal ecology which have been identified in the Scoping report and we are happy with proposed approach to assessment for these habitats. We will need to see the results of the intertidal surveys at the landfall location, due to take place in 2022, as referred to in paragraph 224.	Noted. See **Appendix 9-1** of this chapter for the results of the intertidal surveys conducted.
Marine Management Organisation, Scoping Responses 02/09/2022	
Section 2.5.4 of the report (referenced in paragraph 5) encouragingly states “The assessment of the potential impacts upon the benthos will be cross referenced where relevant to the assessments for marine physical processes and marine water and sediment quality”. The MMO welcomes this commitment to better predict the physical impact of the installation more accurately and agree that the relevant assessments (and resulting datasets e.g., from acoustic survey of the seabed) should be included during benthic characterisation and monitoring stages of the developments.	Noted.
The MMO agrees with the current proposals around mitigation. Additional mitigations, e.g., micro siting to avoid Annex I habitats and monitoring, will be developed further as the application progresses.	The current embedded mitigation measures proposed for the Projects are detailed in section 9.3.3 of this chapter.
A separate Cumulative Impacts Assessment (CIA) will be considered temporally and spatially overlapping impacts and will be informed using the results of the marine physical processes assessment. The report	**Chapter 6 EIA Methodology** of this report provides further details of the general framework and approach to the CIA, with

Comment	Project Response
(referenced in paragraph 5) states that any benthic impacts are anticipated to be localised and temporary. However, until the CIA is reviewed, the MMO cannot comment specifically on potential cumulative impacts to the benthic assemblage as a consequence of the Dogger Bank South OWFs.	preliminary assessment being presented in section 9.7.
While the potential impact of temporary increases in suspended sediment concentrations has been scoped in for all stages of the development (construction, operation and maintenance, and decommissioning), the only reference to Annex I *Sabellaria spinulosa* reef within the report is in reference to the effect of electromagnetic fields on this receptor. Annex I reef within the Dogger Bank South Offshore Wind Farms will be identified through subsequent characterisation surveys (planned for 2022) and no further assessment is required at this stage.	The draft benthic characterisation survey conducted (see **Appendix 9-2**) for the Projects found the presence of *Sabellaria spinulosa* individuals in seven of the 179 stations sampled. No reef formations were found across the survey area however.
Regarding the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWMC) and the potential impact of harmful aquatic organisms being introduced from increased vessel traffic; the UK acceded to the BWMC on 26 May 2022. The UK domestic regulations (The Merchant Shipping (Control and Management of Ships' Ballast Water and Sediments) Regulations 2022) which implement the BMWC requirements, entered into force on 29 July 2022 and the applicant should include reference to these regulations subsequently.	The new UK regulations have been referenced in section 9.3.3 of this chapter.
Natural England, Scoping Responses 02/09/2022	
Rock protection has now been included with a commitment to minimise its use within the Dogger Bank SAC - Whilst Natural England welcome this, external cable protection should be fully considered in impact assessments including for the full length of the export cable corridor. Within the ES thorough consideration should be given to how the use of external protection will be minimised, in order to provide the ExA and regulators the necessary	The assessment of long-term habitat loss along the offshore export cable corridor (see section 9.6.2.2) has considered that external protection measures may be utilised at any point along its length. As detailed in section 9.3.3 the use of scour protection and external cable protection will

Comment	Project Response
confidence in the success of any proposed mitigation measures.	be minimised by following best practice guidance measures.
Approach to data collection - We recommend that benthic survey scopes are discussed with Statutory Nature Conservation Bodies (SNCBs) in advance and advise that as a minimum best practice guidance should be followed. Following recent discussions with developers and stakeholders about the importance of sharing data, existing datasets can and should be used to inform the marine environment whenever practically possible.	Method statements for the benthic characterisation survey (issued on the 14th of April 2022) and intertidal survey (issued on the 8th of June 2022) were shared and agreed with SNCBs prior to these surveys being undertaken.
Potential impacts - Given the wide scope we would recommend caution as Likely Significant Effect (LSE) cannot be ruled out for any features at this stage. We note that there is no mention of the requirement for rock deposits as a result of scour. We would expect all activities and impacts to be clearly assessed in Section 2.5.3. We suggest that benthic habitat disturbance and loss is scoped in as a potential impact of UXO clearance.	The potential impacts of rock placement and UXO clearance are detailed in section 9.6.2.2 and 9.6.1.2.2 of this chapter respectively.
Overall comments - We are unable to agree at this stage if all benthic impacts have been identified owing to the very wide study area and unknown grid connection location. We note that there is very little information included on how the assessment to designated sites will be undertaken, what information will be needed to inform these and what impacts should be taken into account. We highlight that impacts on Dogger Bank SAC, how these are assessed and how the steps in the habitats regulations are followed are a key risk for this project. Where it is not possible to rule out an adverse effect on integrity early conversations should be held on potential compensation proposals as per BEIS H3 decision letter and draft NPS policies. Additional discussion will also be needed in relation to export cable route, landfall and potential considerations as scoping has been undertaken without a defined landfall location and grid connection	Noted, details of the effect on designated sites will be included in the Habitats Regulations Assessment (HRA) and Marine Conservation Zone (MCZ) assessment and summarised in the final ES. A copy of these assessments will be provided for consultation prior to consent application.

9.3 Scope

9.3.1 Study Area

6. The benthic and intertidal ecology study area (see **Figure 9-1**) has been defined based on the potential zone of influence (ZoI) of the Projects. Construction, operation and maintenance and decommissioning activities for the Projects will result in the disturbance of sediment. The redeposition of this sediment has the potential to impact receptors that are distant from the source of the disturbance and is therefore the effect with the largest (worst-case) ZoI. - Based on evidence from EIAs for the nearby Dogger Bank C and Sofia (formerly Teesside A & B) offshore wind farms, the majority of sediment plumes created from array area installation works are expected to settle rapidly and within 10km of the point of disturbance (Forewind, 2014). On this basis, the ZoI for works in the Projects array areas has been set as 10km from the origin of disturbance. The use of this ZoI is supported by the assessment provided in **Chapter 8 Marine Physical Environment**, which describes that outside the area of foundation installation, sediment deposition reduces to an average of 1-5mm within 10km of the disturbance.

7. In relation to the offshore export cable corridor, other projects in the nearby area (such as Hornsea Project Four) have utilised the tidal ellipse distance to determine the ZoI of sediment dispersion resulting from installation activities in the offshore cable corridor. As site specific data for the Projects is not available at PEIR stage for the Projects, in line with other projects in the region a ZoI of 15km has been set for the offshore export cable corridor. This ZoI will be reviewed following the availability of site-specific data.

8. The study area for the intertidal assessment is focused on the two potential landfall areas under consideration for the Projects. As detailed in section 9.3.3, trenchless techniques will be used to install the export cables at the landfall for the Projects. There is however the potential for exit pits to be located in the intertidal zone. As such, impacts on the intertidal have been assessed in relation to the installation of exit pits within the two landfall areas.

9.3.2 Realistic Worst Case Scenario

9.3.2.1 General Approach

9. The realistic worst case design parameters for likely significant effects scoped into the EIA for the benthic and intertidal ecology assessment are summarised in **Table 9-2**. These are based on the project parameters described in **Chapter 5 Project Description**, which provides further details regarding specific activities and their durations.

10. In addition to the design parameters set out in **Table 9-2**, consideration is also given to the different development scenarios still under consideration and the possible phasing of the construction as set out in sections 9.3.2.2 to 9.3.2.5.

Table 9-2 Realistic Worst Case Design Parameters

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Construction In the instance of **sequential** development of the two Projects, up to a **two-year lag** between construction activities is possible, final overall footprint would be **identical** to the **concurrent** design scenario.				
Temporary physical disturbance (including sediment deposition and smothering)	Total array area – 494.5km² **Cables** <u>Array and Inter-platform Cables</u> Array cable trench area (325km x 18m jetting disturbance width) - 5,850,000m² Inter-platform cable trench area (55km x 18m disturbance width) – 990,000m² Maximum seabed footprint disturbed by sandwave levelling – 950,000m²	Total array area – 494.5km² **Cables** <u>Array and Inter-platform Cables</u> Array cable trench area (325km x 18m jetting disturbance width) - 5,850,000m² Inter-platform cable trench area (99km x 18m disturbance width) – 1,782,000m² *Note - DBS West HVAC built in isolation would require inter-platform cables between the four OSPs required.*	Total array area – 989km² **Cables** <u>Array and Inter-platform Cables</u> Array cable trench area (650km x 18m jetting disturbance width) - 11,700,000m² Inter-platform cable trench (385km x 18m disturbance width) – 6,930,000m² *Note - Concurrent design assumes HVAC + HVDC design scenario as the worst-case. Requires inter-platform cables between the*	Assumes even split of the total 650km array cable length between DBS East and DBS West. Pre-lay grapnel run (PLGR) activities will fall within the footprint of the cable trench disturbance width of 18m. Two export cable circuits required for HVDC, up to four required for HVAC.

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Maximum sandwave material to be dredged/relocated – 384,750m³ Maximum area disturbed – 7,790,000m² Offshore Export Cable Corridor Total offshore cable length per circuit –198km Number of cable circuits required – Two Max. offshore cable length for all cable circuits – 396km *Note - Assuming two separate cable trenches, for each cable circuit, 50m apart,* Maximum temporary disturbance for cable installation – 7,128,000m² (based on 396km distance x	Maximum seabed footprint disturbed by sandwave levelling – 1,060,000m² Maximum sandwave material to be dredged/relocated – 429,300m³ Maximum area disturbed – 8,692,000m² Offshore Export Cable Corridor Total offshore cable length per circuit – 158km Number of cable circuits required – Four Max. offshore cable length for all cable circuits – 632km *Note - Assuming four separate cable trenches, for each cable circuit, 50m apart,* Maximum temporary disturbance for cable installation –	*Projects to connect the OSPs, hence the increase from 99km to 385km.* Maximum seabed footprint disturbed by sandwave levelling – 2,587,500m² Maximum sandwave material to be dredged/relocated – 1,047,938m³ Maximum area disturbed – 21,217,500m² Offshore Export Cable Corridor Total offshore cable length per circuit – 198km for DBS East, 158km for DBS West. Number of circuits required – Six Max. offshore cable length for all cables – 1,028km *Note - Assuming six separate cable trenches, for each cable circuit, 50m apart,*	Maximum export cable length assumes worst case that cable circuits are laid and buried in separate trenches rather than bundled.

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	18m width of temporary disturbance) Maximum seabed footprint disturbed by sandwave levelling – 2,047,002m² Maximum sandwave material to be dredged/relocated – 33,121,800m³ Maximum total impacted area by anchoring – 22,045m² *Note - 10km stretch along the offshore export cable corridor <10m Lowest Astronomical Tide (LAT), may require use of anchoring* Total temporary area disturbed for export cable installation (trenching, sandwave levelling and anchoring) – 9,188,229m²	11,376,000m² (based on 632km distance x 18m width of temporary disturbance) Maximum seabed footprint disturbed by sandwave levelling – 4,094,004m² Maximum sandwave material to be dredged/relocated – 66,243,600m³ Maximum total impacted area by anchoring – 44,091m² *Note - 10km stretch along the offshore export cable corridor <10m LAT, may require use of anchoring* Total temporary area disturbed for export cable installation (trenching, sandwave levelling and anchoring) – 15,496,459m²	Maximum temporary disturbance for cable installation – 18,504,000m² (based on 1028km distance x 18m width of temporary disturbance) Maximum seabed footprint disturbed by sandwave levelling – 6,141,005m² Maximum sandwave material to be dredged/relocated – 99,365,402m³ Maximum total impacted area by anchoring – 66,136m² *Note - 10km stretch along the offshore export cable corridor <10m LAT, may require use of anchoring* Total temporary area disturbed for export cable installation (trenching, sandwave levelling and anchoring) – 15,496,459m²	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Foundations and Vessel Impacts Seabed footprint for 100 small turbine suction bucket jacket foundations – 70,686m² Four offshore converter platforms (OCP) gravity-based structure (GBS) seabed preparation (HVDC only) – 15,394m² Two other platform foundations (Electrical Switching Platform (ESP) + Accommodation Platform) (HVDC only, GBS foundation) -7,697m² Vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per turbine x 100 small turbines) - 660,000m²	**Foundations and Vessel Impacts** Seabed preparation area for 100 small turbine suction bucket jacket foundations – 70,686m ² Four offshore substation platforms (OSP) foundations (HVAC only, gravity based structure (GBS) foundation) – 15,394m² *Note - HVAC project in isolation requires 4 OSPs.* Two other platform foundations (Reactive Compensation Platform + Accommodation Platform) (HVAC only, GBS foundation) - 7,697m² *Note - HVAC project in isolation requires a reactive compensation platform (RCP) accommodation*	**Foundations and Vessel Impacts** Seabed preparation area for 200 small turbine suction bucket jacket foundations – 141,372m² Eight offshore OSP/OCP platforms GBS seabed preparation (HVAC + HVDC) – 30,794m² *Note - HVAC/HVDC Solution = Four HVAC + Four HVDC = Eight platforms on GBS* Three other platform foundations (ESP + Reactive Compensation Platform) + Accommodation Platform) (HVAC only, GBS foundation) -11,545m² Vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per turbine x 200 small turbines) - 1,320,000m²	In situations where a number does not divide equally between DBS East and DBS West (e.g. 95 large turbines), rounded up to higher number (e.g. 48 large turbines as opposed to 47.5). While the seabed footprint for the large turbine scenario is greater than that of the small scenario, due to the increased vessel jack-up and anchoring footprint required for the greater number of turbines the small turbine scenario has

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Vessel jack-up footprint for all platforms (1,100m² combined leg area x five operations per platform x six platforms) – 33,000m² Anchoring (116m² footprint x four anchors per activity x five activities requiring the deployment of anchors x 100 small turbines) – 232,000m² Maximum area disturbed – 1,018,777m²	*platform, HVDC in-isolation does not require a RCP* Vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per turbine x 100 small turbines) - 660,000m² Vessel jack-up footprint for all platforms (1100m² combined leg area x five operations per platform x six platforms) – 33,000m² Anchoring (116m² footprint x four anchors per activity x five activities requiring the deployment of anchors x 100 small turbines) – 232,000m² Maximum area disturbed – 1,018,777m²	Vessel jack-up footprint for all platforms (1,100m² combined leg area x five operations per platform x 11 platforms) – 60,500m² Anchoring (116m² footprint x four anchors per activity x five activities requiring the deployment of anchors x 200 small turbines) – 464,000m² Maximum area disturbed – 2,028,205m²	a greater seabed footprint. One project HVDC Solution = two platforms on GBS (or four platforms on other foundation types) Anchoring events assumes four activities per turbine foundation installation + one activity for topside installation per turbine.
	Landfall	**Landfall**	**Landfall**	Total HDD number includes one spare

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	No. of horizontal directional drills (HDDs) – Five Indicative depth of water at drill exit – 8m Indicative HDD length – 1400m Exit pits may be located within the intertidal area	No. of HDDs – Five Indicative depth of water at drill exit – 8m Indicative HDD length – 1400m Exit pits may be located within the intertidal area	No. of HDDs – Nine Indicative depth of water at drill exit – 8m Indicative HDD length – 1400m Exit pits may be located within the intertidal area	for the in isolation scenarios, and two spare for the concurrent/sequential scenario.
	Totals Total disturbance within Array Areas – 8,800,228m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 9,206,411m²	**Totals** Total disturbance within Array Areas – 9,702,228m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 15,523,443m²	**Totals** Total disturbance within Array Areas – 23,228,608m² (Array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts) Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 24,729,838m²	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Increased suspended sediment concentrations	**Displaced sediment during array and inter-platform cable trenching** Array cable – 1,950,000m³ (325km length x 6m width x 1m depth) Inter-platform cables – 330,000m³ (55km length x 6m width x 1m depth) Maximum sandwave material to be dredged/relocated (array cables) – 329,063m³ Maximum sandwave material to be dredged/relocated (inter-platform cables) – 55,688m³ **Displaced sediment during offshore export cable corridor trenching**	**Displaced sediment during array and inter-platform cable trenching** Array cable – 1,950,000m³ (325km length x 6m width x 1m depth) Inter-platform cables – 594,000m³ (99km length x 6m width x 1m depth) Maximum sandwave material to be dredged/relocated (array cables) – 329,063m³ Maximum sandwave material to be dredged/relocated (inter-platform cables) – 100,238m³ **Displaced sediment during offshore export cable corridor trenching**	**Displaced sediment during array and inter-platform cable trenching** Array cable – 3,900,000m³ (650km length x 6m width x 1m depth) Inter-platform cables – 2,310,000m³ (385km length x 6m width x 1m depth) Maximum sandwave material to be dredged/relocated (array cables) – 658,125m³ Maximum sandwave material to be dredged/relocated (inter-platform cables) – 389,813m³ **Displaced sediment during offshore export cable corridor trenching**	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Export cable – 2,376,000m³ (396km length x 6m width x 1m depth) *Note – 6m width based on worst-case pre-lay ploughing width* **Displaced sediment during sandwave levelling** Maximum sandwave material to be dredged/relocated – 33,121,800m³ **Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum % of locations using drilling – 5% Max volume of arisings (48 turbines) – 42,751m³	Export cable – 3,792,000m³ (632km length x 6m width x 1m depth) *Note – 6m width based on worst-case pre-lay ploughing width* **Displaced sediment during sandwave levelling** Maximum sandwave material to be dredged/relocated – 66,243,600m³ **Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum % of locations using drilling – 5% Max volume of arisings (48 turbines) – 42,751m³	Export cable – 6,168,000m³ (1,028km length x 6m width x 1m depth) *Note – 6m width based on worst-case pre-lay ploughing width* **Displaced sediment during sandwave levelling** Maximum sandwave material to be dredged/relocated – 99,365,402m³ **Increase in suspended sediment concentrations due to drill arisings** Maximum volume arisings per pile (large turbines) – 17,813m³ Maximum % of locations using drilling – 5% Max volume of arisings (95 turbines) – 84,611m³	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Underwater noise and vibration	See worst-case parameters table presented in **Chapter 11 Marine Mammals**			
Operation				
Temporary physical disturbance (including sediment deposition and smothering)	**Array Area** Seabed disturbance from jacking-up activities over Projects lifetime – 306,900m² (10,230m² per year x 30 year lifespan) *Note- 10,230m² is half of total 20,460m² area disturbed per year for 200 turbines)* Array cable repairs - seabed disturbance over Projects lifetime – 42,000m² (Seven events x 6,000m² per event)	**Array Area** Seabed disturbance from jacking-up activities over Projects lifetime – 306,900m² (10,230m² per year x 30 year lifespan) *Note- 10,230m² is half of total 20,460m² area disturbed per year for 200 turbines)* Array cable repairs - seabed disturbance over Projects lifetime – 42,000m² (Seven events x 6,000m² per event) **Export Cable Route** Export cable repairs - seabed disturbance over Projects lifetime	**Array Areas** Seabed disturbance from jacking-up activities over Projects lifetime – 613,800m² (20,460m² per year x 30 year lifespan) Array cable repairs - seabed disturbance over Projects lifetime – 78,000m² (13 events x 6,000m² per event) **Export Cable Route** Export cable repairs - seabed disturbance over Projects lifetime – 36,000m² (Six events x 6,000m² per event)	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Export Cable Route Export cable repairs - seabed disturbance over Projects lifetime – 18,000m² (Three events x 6,000m² per event)	– 18,000m² (Three events x 6,000m² per event)		
Long term habitat loss	**Array Area** Total worst case turbine footprint with scour protection - 2,667,456m² (48 large turbines x 55,572m² total protection per turbine) Total worst-case scour protection for OCPs and other platforms in array areas – 282,052m² Total array and inter-platform cable protection – 656,512m² (488,400m² array cable protection + 168,112 inter platform cable protection)	**Array Area** Total worst case turbine footprint with scour protection - 2,667,456m² (48 large turbines x 55,572m² total protection per turbine) Total worst-case scour protection for OSPs and other platforms in array areas – 282,052m² Total array and inter-platform cable protection - 790,515m² (488,400m² array cable protection + 302,115m² inter-platform cable protection)	**Array Areas** Total worst case turbine footprint with scour protection – 5,279,340m² (95 large turbines x 55,572m² total protection per turbine) Total worst-case scour protection for OSPs and other platforms in array areas – 507,694m² Total array and inter-platform cable protection - 2,139,904m² (976,800m² array cable protection + 1,163,104m² inter-platform cable protection)	Total scour protection per turbine includes structure footprint area. Predicted no. of cable crossings for Projects in isolation: - DBS East – 40 - DBS West - 70

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
	Total footprint of pipeline / cable crossing material (array cables) – 61,310m² Total habitat loss within the array area – 3,667,330m² **Offshore Export Cable Corridor** Total export cable protection – 1,089,660m² Total worst case scour protection for ESP in offshore export cable corridor – 56,410m² Total footprint of pipeline / cable crossing material – 122,611m² Total habitat loss within the offshore export cable corridor – 1,268,681m²	Total footprint of pipeline / cable crossing material (array + inter-platform cables) – 73,539m² *Note - Four predicted inter-platform cable crossings for HVAC only scenario.* Total habitat loss within the array area – 3,813,562m² **Offshore Export Cable Corridor** Total export cable protection – 1,642, 872m² Total worst case scour protection for ESP in offshore export cable corridor – 56,410m² Total footprint of pipeline / cable crossing material – 294,267m² Total habitat loss within the offshore export cable corridor – 1,993,549m²	Total footprint of pipeline / cable crossing material (array + inter-platform cables) - 244,915m² Total habitat loss within the array area – 8,171,853m² **Offshore Export Cable Corridor** Total export cable protection – 2,701,040m² Total worst case scour protection for ESP & RCP in offshore export cable corridor – 112,821m² Total footprint of pipeline / cable crossing material – 441,400m² Total habitat loss within the offshore export cable corridor – 3,255,261m²	

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
Interactions of EMF (including potential cumulative EMF effects)	Minimum target burial depth – 0.5m *Note - In exceptional circumstances, there may be lengths of cable where it will not be possible to achieve the minimum target burial depth.*			
Colonisation of introduced substrate, including non-native species	**Vessels** Maximum number of operation & maintenance (O&M) vessels on site at any one time – 11 (See long-term habitat loss row for infrastructure that could be colonised)	**Vessels** Maximum number of O&M vessels on site at any one time – 11 (See long-term habitat loss row for infrastructure that could be colonised)	**Vessels** Maximum number of O&M vessels on site at any one time – 21 (See long-term habitat loss row for infrastructure that could be colonised)	The risk of introducing INNS during construction is primarily related to vessel activities should vessels come from other marine bioregions. Based on simultaneous presence of jack-up vessels, service operations vessels,

	Parameter			
	DBS East in isolation (HVDC only)	**DBS West in isolation (HVAC only)**	**DBS West and DBS East concurrently and / or in sequence (HVAC + HVDC)**	**Notes and rationale**
				accommodation vessels, small CTV vessels, lift vessels, cable maintenance vessels and auxiliary vessels.
Landfall	All cables will be buried below landfall, assumed no maintenance activities required during the operational stage. As such no operational impacts predicted to occur at landfall.			
Decommissioning				
No final decision regarding the final decommissioning policy for the onshore project infrastructure including landfall, onshore cable route and onshore substation has yet been made. It is also recognised that legislation and industry best practice change over time. However, it is likely that offshore project infrastructure will be removed above the seabed and reused or recycled where practicable. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the worst case scenario, the impacts will be no greater than those identified for the construction phase.				

9.3.2.2 Development Scenarios

11. There are currently two possible electrical solutions being considered for DBS West, HVAC or HVDC. Due to the distance of the array area offshore DBS East will be an HVDC project. Therefore, there are two possible electrical solutions for the Projects:

- One HVDC project and one HVAC project; or
- Two HVDC projects.

12. Offshore the most significant difference between an HVAC solution and an HVDC solution is that if an HVAC electrical solution is used an additional platform (reactive compensation platform (RCP)) will be required along the offshore export cable. In addition, a HVAC solution will require two additional offshore export cable, over and above the four export cables that would be required for two HVDC projects.

13. In order to ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst-case scenario for each topic has been assessed. Further details are provided in **Chapter 5 Project Description**.

9.3.2.3 Construction Scenarios

14. The following principles set out the framework for how the Projects may be constructed (relating to both onshore and offshore works):

- DBS West and DBS East may be constructed at the same time, or at different times;
- If built concurrently, both Projects could be constructed in five years;
- If built non-concurrently, either Project could be built first;
- If built non-concurrently, each Project would require a five year period of construction;
- If built non-concurrently, it is anticipated that there would be up to a two year lag between the start of construction for the first project and the start of construction for the second project; and
- Assuming a maximum construction period per Project of five years, and taking the above into account, the maximum construction period over which the construction of both Projects could take place is seven years.

15. In order to determine which construction scenario presents the realistic worst case for each receptor and impact, the assessment considers both maximum duration effects and maximum peak effects, in addition to each Project being developed in isolation, drawing out any differences between each of the two Projects.

16. The three construction scenarios considered by the benthic and intertidal ecology assessment are therefore:

- Build DBS East or build DBS West in isolation;
- Build DBS East and DBS West concurrently – reflecting the maximum peak effects; and
- Build the Projects sequentially with a lag of up to two years – reflecting the maximum duration of effects.

17. The individual, concurrent and sequential construction scenarios all allow for flexibility to build out the Projects using a phased approach. This will allow the Projects to adapt to National Grid Electricity Transmission Operator's development plans for the onshore grid connection points. Under a phased approach the maximum timescales for individual elements of the construction have been assessed.

18. Any differences between the Projects, or differences that could result from the manner in which the first and the second Projects are built (concurrent or sequential and the length of any gap) are identified and discussed where relevant in section 9.6. For each potential impact, only the worst case construction scenario for two Projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst case is provided, where necessary, in section 9.6.

9.3.2.4 Operation Scenarios

19. Operation scenarios are described in detail in **Chapter 5 Project Description**. The assessment considers the following scenarios:

- Only DBS East in operation;
- Only DBS West in operation; and
- The two projects operating concurrently, with or without a lag of up to two years between each Project commencing operation.

20. If the Projects are built out using a phased approach, there would also be a phased approach to starting the operational stage. The worst case scenario for the operational phases for the Projects have been assessed. See section 5.1.1 of **Chapter 5 Project Description** for further information on phasing scenarios for the Projects.

21. The operational lifetime of each Project is expected to be 30 years.

9.3.2.5 Decommissioning Scenarios

22. Decommissioning scenarios are described in **Chapter 5 Project Description**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction, however for the purpose of this assessment it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

9.3.3 Mitigation Embedded in the Design

23. This section outlines the embedded mitigation relevant to the benthic and intertidal ecology assessment, which has been incorporated into the design of the Projects (**Table 9-3**). Where other mitigation measures are proposed, these are detailed in the impact assessment (section 9.6).

Table 9-3 Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
Export cable route	The offshore cable corridor was selected in consultation with key stakeholders to select route options which minimised impacts on designated sites, such as minimising its length within the Dogger Bank Special Area of Conservation (SAC) and Holderness Inshore MCZ, and avoiding overlap with the Flamborough Head SAC, Outer Holderness MCZ and reducing overlaps with the Smithic Bank sandbank. See **Chapter 4 Site Selection and Assessment of Alternatives**.
Scour and external cable protection	Following industry best-practice the Applicant will seek to minimise the use of scour protection and external cable protection for any stretches of unburied cables and cable crossings. This will be secured through a Scour Protection and Cable Protection Plan that will be submitted for approval post consent.
Electromagnetic Fields (EMF)	The Applicant is committed to burying offshore export cables to 0.5-1m where practicable (subject to a cable burial risk assessment). This will increase the distance between the offshore export cables and the seabed surface, resulting in a lower field strength and area affected by EMF at the seabed surface.
Invasive Non-Native Species (INNS)	The risk of spreading INNS will be reduced by employing biosecurity measures in accordance with the following requirements: • International Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL sets out appropriate vessel maintenance;

Parameter	Mitigation Measures Embedded into the Project Design
	• The Merchant Shipping (Control and Management of Ships' Ballast Water and Sediments) Regulations 2022), which implements the International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWMC) under UK law and provides regulations to control the transfer of potentially invasive species; and • The Environmental Damage (Prevention and Remediation (England) Regulations 2015, which set out a polluter pays principle where the operators who cause a risk of significant damage or cause significant damage to land, water or biodiversity will have the responsibility to prevent damage occurring, or if the damage does occur will have the duty to reinstate the environment to the original condition.
Pollution Prevention Measures	Due to the presence and movements of construction and operation and maintenance vessels/equipment there is the potential for spills and leaks which could result in changes to water quality. All vessels involved will be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. An outline Pollution Environmental Management Plan (PEMP) will also be produced and implemented to cover the construction and, operation and maintenance and decommissioning phases of the Project. This will set out all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed during construction and, operation and maintenance and decommissioning phases to minimise the risk of, and effects in the event of an accidental spill. The PEMP will identify all potential sources and types of accidental pollution for all project phases and set out the proposed mitigation measures and will be developed in consultation with key stakeholders for approval by the MMO.
Horizontal Directional Drilling (HDD)	HDD will be used to install the export cables at the landfall for the Projects. As the exit pit locations could be located within the intertidal zone, there exists the potential for impacts from cable trenching in the lower intertidal zone to occur. However, the use of HDD will prevent any impacts from occurring in the upper intertidal zone and minimise impacts in the lower intertidal zone.

9.4 Assessment Methodology

9.4.1 Policy, Legislation and Guidance

9.4.1.1 National Policy Statements

24. The assessment of potential impacts upon benthic and intertidal ecology has been made with specific reference to the current NPS EN-3 for Renewable Energy Infrastructure and draft for Renewable Energy Infrastructure. No specific provisions relevant to benthic and intertidal ecology are found in NPS EN-1, NPS EN-5 or the draft versions of these NPSs. The specific assessment requirements for benthic and intertidal ecology, as detailed in the NPS, are summarised in **Table 9-4** together with an indication of the section of this chapter where each is addressed.

25. Following the consultation in 2021 on the draft energy NPS, a new consultation opened on the 30th March 2023 on revised drafts of the energy NPSs, including EN1, EN3 and EN5. Due to the timing of this consultation, and finalisation of this PEIR we have been unable to review and take these revised draft NPS into account within these documents. However, these will be reviewed and incorporated into the final ES where relevant.

Table 9-4 NPS Assessment Requirements

NPS Requirement	NPS Reference	PEIR Section Reference
NPS EN-3 for Renewable Energy Infrastructure		
An assessment of the effects of installing cable across the intertidal zone should include information, where relevant, about: • Any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice; • Any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice; • Potential loss of habitat; • Disturbance during cable installation and removal (decommissioning);	2.6.81	**Chapter 4 Site Selection and Assessment of Alternatives** provides the rationale for the location of the offshore development area. The potential impact of temporary physical disturbance on the intertidal zone as a result of the construction of a HDD exit pit is assessed in section 9.6.1.3.

NPS Requirement	NPS Reference	PEIR Section Reference
• Increased suspended sediment loads in the intertidal zone during installation; and • Predicted rates at which the intertidal zone might recover from temporary effects.		
Applicants are expected to have regard to guidance issued in respect of FEPA (now Marine Licence) requirements.	2.6.83	Other relevant guidance, including Marine Licencing, are outlined below.
Where necessary, assessment of the effects on the subtidal environment should include: • Loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes; • Environmental appraisal of inter-array and cable routes and installation methods; • Habitat disturbance from construction vessels' extendible legs and anchors; • Increased suspended sediment loads during construction; and • Predicted rates at which the subtidal zone might recover from temporary effects.	2.6.113	Assessment of the following impacts have been carried out in the following sections: • Loss of habitat – section 9.6.2.2; • Temporary disturbance – sections 9.6.1.1 and 9.6.2.1 • Increased suspended sediments – section 9.6.1.4; • Recovery of biotopes – the recovery of biotopes is discussed within each impact assessment; and • Site selection – site selection is discussed in **Chapter 4 Site Selection and Assessment of Alternatives**.
Construction and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Mitigation measures which the [Secretary of State] should expect the applicants to have considered may include:	2.6.119	Mitigation measures are set out in section 9.3.3.

NPS Requirement	NPS Reference	PEIR Section Reference
• Surveying and micrositing of the export cable route to avoid adverse effects on sensitive habitat and biogenic reefs; • Burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and • The use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.		
Draft NPS EN-3 for Renewable Energy Infrastructure		
An assessment of the effects of installing cable across the intertidal zone should follow The Crown Estate's cable route protocol and include information, where relevant, about: • Any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice; • Any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice; • Potential loss of habitat; • Disturbance during cable installation, maintenance/repairs and removal (decommissioning); • Increased suspended sediment loads in the intertidal zone during installation and maintenance/repairs; • Predicted rates at which the intertidal zone might recover from temporary effects, based on existing monitoring data; and	2.27.3	**Chapter 4 Site Selection and Assessment of Alternatives** provides the rationale for the location of the offshore development area. The potential impact of temporary physical disturbance on the intertidal zone as a result of the construction of a HDD exit pit is assessed in section 9.6.1.3.

NPS Requirement	NPS Reference	PEIR Section Reference
• Protected sites (e.g. HRA sites, MCZs and Sites of Special Scientific Interest (SSSIs).		
Effects on intertidal habitat cannot be avoided entirely. Review of up-to-date research should be undertaken and all potential mitigation options presented. Landfall and cable installation and decommissioning methods should be designed appropriately to minimise effects on intertidal habitats, taking into account other constraints. Where applicable, use of horizontal directional drilling (HDD) should be considered as a method to avoid impacts on sensitive habitats and species.	2.27.4	**Chapter 4 Site Selection and Assessment of Alternatives** provides the rationale for the location of the offshore development area. The potential impact of temporary physical disturbance on the intertidal zone as a result of the construction of a HDD exit pit is assessed in section 9.6.1.3.
Where cumulative effects on intertidal habitats are predicted as a result of the cumulative impact of multiple cable routes, applicants of various schemes are encouraged to work together to ensure that the number of cables crossing the intertidal zone are minimised and installation and decommissioning phases are coordinated to ensure that disturbance is also reasonably minimised. As identified in EN-1, (paragraphs 3.3.50 - 3.3.58 and Section 4.10), it is expected that a more co-ordinated approach to transmission from multiple offshore windfarms to onshore networks will be adopted in the future, compared with a radial connection approach for single windfarm projects. This will include connection with multi-purpose interconnectors (MPIs).	2.27.5	Embedded mitigation measures are set out in section 9.3.3 and summarised in **Table 9-3** above.
The applicant should follow The Crown Estate's cable route protocol. Assessment of the effects on the subtidal environment should include:	2.30.2	**Chapter 4 Site Selection and Assessment of Alternatives** provides evidence of The Crown Estate's cable route protocol used to minimise

NPS Requirement	NPS Reference	PEIR Section Reference
• Loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes; • Environmental appraisal of inter-array and export cable routes and installation/maintenance methods, including predicted loss of habitat due to predicted scour and scour protection; • Habitat disturbance from construction and maintenance/repair vessels' extendible legs and anchors; • Increased suspended sediment loads during construction and from maintenance/repairs; • Predicted rates at which the subtidal zone might recover from temporary effects; • Potential impacts from EMF on benthic fauna; and • Impacts on protected sites (e.g. HRA sites and MCZs).		impacts to the subtidal environment.
Construction, maintenance and decommissioning methods should be designed appropriately to minimise effects on subtidal habitats, taking into account other constraints. Review of up-to-date research should be undertaken and all potential mitigation options presented. Mitigation measures which the Secretary of State should expect the applicants to have considered may include: • Surveying and micrositing or re-routing of the export and inter-array cables to avoid adverse effects on sensitive habitats, biogenic reefs or protected species; and	2.30.3	Embedded mitigation measures are set out in section 9.3.3 and summarised in **Table 9-3** above.

NPS Requirement	NPS Reference	PEIR Section Reference
• Burying cables at a sufficient depth, taking into account other constraints, to allow the seabed to recover to its natural state; and • The use of anti-fouling paint might be minimised on subtidal surfaces, to encourage species colonisation on the structures.		
Where cumulative impacts on subtidal habitats are predicted as a result of multiple cable routes, applicants for various schemes are encouraged to work together to ensure that the number of cables crossing the subtidal zone is minimised and installation/ decommissioning phases are coordinated to ensure that disturbance is reasonably minimised. As identified in EN-1, (paragraphs 3.3.50 - 3.3.58 and Section 4.10) and EN-5 (Section 2.5), it is expected that more co-ordinated approaches to transmission from multiple offshore windfarms to onshore networks will be adopted, compared with a radial connection approach for single windfarm projects. This will include connection with multi-purpose interconnectors (MPIs).	2.30.4	The offshore cable corridor will not be joint with other projects. However, construction and decommissioning phases may coincide with other offshore wind farms within the Dogger Bank and wider North Sea.

9.4.1.2 Other

26. In addition to the NPS, there are a number of pieces of legislation, policy and guidance applicable to the assessment of benthic ecology. These include:

27. The Marine Policy Statement (MPS) (HM Government, 2011); discussed further in **Chapter 3 Policy and Legislative Context**) provides a high-level approach to marine planning and general principles for decision making that contribute to the NPS objectives. It also sets out the framework for environmental, social and economic considerations that need to be taken into account in marine planning. The high-level objective 'Living within environmental limits' covers points relevant to benthic ecology, and requires that:

- Biodiversity is protected, conserved and where appropriate recovered and loss has been halted;
- Healthy marine and coastal habitats occur across their natural range and are able to support strong, biodiverse biological communities and the functioning of healthy, resilient and adaptable marine ecosystems; and
- Our oceans support viable populations of representative, rare, vulnerable, and valued species.

28. England currently has nine marine plans; those relevant to the Projects are the East Inshore, North East Inshore, East Offshore and North East Offshore Marine Plans. These contain the two objectives stated below, which are of relevance to benthic ecology, as they cover policies and commitments on the wider ecosystem set out in the MPS:

- Objective 6: 'To have a healthy, resilient and adaptable marine ecosystem in the East Marine Plan areas'; and
- Objective 7: 'To protect, conserve and, where appropriate, recover biodiversity that is in or dependent upon the East marine plan areas'.

29. Other guidance on the requirements for wind farm studies are provided in the documents listed below:

- Cefas (2004) Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA requirements: Version 2;
- Cefas (2010) Strategic Review of Offshore Wind Farm Monitoring Data Associated with FEPA licence conditions, with input from the Food and Environment Research Agency (FERA) and the Sea Mammal Research Unit (SMRU);
- Marine Management Organisation (MMO) (2014) Review of Post-Consent Offshore Wind Farm Monitoring Data Associated with Licence Conditions, with input from the British Trust for Ornithology (BTO), National Physical Laboratory (NPL) and the SMRU;
- Defra (2005) Nature Conservation Guidance on Offshore Windfarm Development. A guidance note on the implications of the EC Wild Birds and Habitats Directives for developers undertaking offshore windfarm developments. Version R1.9. 13.

30. The principal guidance documents used to inform the baseline characterisation and the assessment of impacts are as follows:

- Cefas (2012) Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects;
- Wyn & Brazier (2001); Joint Nature Conservation Committee (JNCC) Marine Monitoring Handbook;
- Ware and Kenny (2011) Guidance for the Conduct of Benthic Studies at Marine Aggregate Extraction Sites;
- Chartered Institute of Ecology and Environmental Management (CIEEM) (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine; and
- The British Standards Institution (2015) Environmental impact assessment for offshore renewable energy projects – Guide. PD 6900:2015.

31. Further detail is provided in **Chapter 3 Policy and Legislative Context**.

9.4.2 Data and Information Sources

9.4.2.1 Site Specific Surveys

32. In order to provide site specific and up to date information on which to base the impact assessment, several site-specific surveys were conducted in 2022 to help inform this assessment. **Table 9-5** below provides details of each survey conducted. The method statements outlining the methodology to be followed for each survey were shared with external stakeholders prior to the surveys being undertaken to ensure they were fit for purpose. Comments resulting from these consultations were taken into account prior to the surveys being undertaken. The relevant guidelines to each research area were referenced and followed in each method statement, with the methods for the surveys below being detailed in the relevant appendices to this chapter.

Table 9-5 Site-Specific Data

Data set	Spatial Coverage	Survey Date	Survey Techniques
Geophysical surveys	DBS East and DBS West array areas, and offshore export cable corridor options.	March – October 2022	Multibeam echosounder, side-scan sonar, sub-bottom profiler, magnetometer.
Benthic survey	DBS East and DBS West array areas, and offshore export cable corridor options.	6 – 19th August 2022	Drop-down video, grab sampling (including one macrofaunal sample and one particle size distribution (PSD) sample at each station), sediment chemistry samples and beam trawl.
Intertidal survey	DBS landfall search area	28th September 2022	Phase 1 biotope mapping.

9.4.2.2 Other Available Sources

33. Other sources that have been used to inform the assessment are listed in **Table 9-6**.

Table 9-6 Other Available Data and Information Sources

Data Set	Spatial Coverage	Year	Notes
Hornsea Project Four ES Volume A2 Chapter 2 Benthic and Intertidal Ecology	Hornsea Project Four array area and export cable corridor	2022	Assessment of the impacts of Hornsea Project Four on benthic and intertidal ecology. Of relevance due to the close proximity between the export cable corridor of the Projects and Hornsea Project Four.
Dogger Bank Special Area of Conservation (SAC) MMO Fisheries Assessment	Dogger Bank SAC	2021	Assessment detailing the impacts of fishing activities on the Dogger Bank SAC.
Dogger Bank Teesside A & B Environmental Statement Chapter 12 - Marine and Intertidal Ecology	Dogger Bank Teesside A & B array area	2014	Assessment of the impacts of the Dogger Bank Teesside A & B (now C and Sofia) offshore wind farms on benthic and intertidal ecology.
Dogger Bank Site of Community Importance (SCI) 2014 Monitoring R&D Survey Report	Dogger Bank SCI (now the Dogger Bank SAC)	2014	Report investigating monitoring options in relation to fisheries management measures within the Dogger Bank SCI (now SAC).
Dogger Bank Creyke Beck Environmental Statement Chapter 12 - Marine and Intertidal Ecology	Dogger Bank Creyke Beck array area	2013	Assessment of the impacts of the Dogger Bank Creyke Beck (now Dogger Bank A & B) offshore wind farms on benthic and intertidal ecology.
Dogger Bank SAC Selection Assessment Document	Dogger Bank SAC	2011	Assessment detailing information about the Dogger Bank candidate Special Area of Conservation and evaluates its interest features according to the Habitats Directive selection criteria and guiding principles.

Data Set	Spatial Coverage	Year	Notes
JNCC Report No. 429 - Understanding the marine environment – seabed habitat investigations of the Dogger Bank offshore draft SAC	Boundary of the draft Dogger Bank SAC	2009	Report providing evidence on the distribution and extent of Annex I habitat (including variations of these features) on the Dogger Bank, prior to its designation as an SAC.

9.4.3 Impact Assessment Methodology

34. **Chapter 6 EIA Methodology** provides a summary of the general impact assessment methodology applied. The following sections describe the methods used to assess the likely significant effects on benthic and intertidal ecology.

35. A matrix approach has been used to assess impacts following best practice, EIA guidance and the approach outlined in the Projects Scoping Report. An explanation of how this is applied within the benthic and intertidal ecology assessment is set out below.

36. The data sources summarised in section 9.4.2 were used to characterise the existing environment, the description of which is presented in section 9.5. Each impact, which has been identified using expert judgement and agreed through the Scoping Process, is then assessed in terms of its significance using the methods described below.

9.4.3.1 Definitions

37. For each potential impact, the assessment identifies receptors sensitive to that impact and implements a systematic approach to understanding the impact pathways and the level of impacts (i.e. magnitude) on given receptors. The definitions of sensitivity and magnitude for the purpose of the benthic and intertidal ecology assessment are provided below.

9.4.3.1.1 Sensitivity

38. The assessment identifies receptors for which there is a pathway for effect, and the sensitivity of those receptors to each effect.

39. The definitions of sensitivity are based on The Marine Life Information Network's (MarLIN) Marine Evidence based Sensitivity Assessment (MarESA), (MarLIN, 2021) which determines sensitivity based on resistance (tolerance) and resilience (recoverability) which are defined as (**Table 9-7**):

- **Resistance**: the likelihood of damage (termed intolerance or resistance) due to a pressure; and
- **Resilience**: the rate of (or time taken for) recovery (termed recoverability, or resilience) once the pressure has abated or been removed.

40. The MarESA assessment of sensitivity is guided by the presence of key structural or functional species/assemblages and/or those that characterise the biotope groups. Physical and chemical characteristics are also considered where they structure the community. MarESA has been used in order to determine sensitivity of specific biotopes and dominant macrofauna recorded during the site-specific benthic characterisation surveys.

41. For the purpose of this assessment, 'tolerance' has been used in place of 'resistance' and 'recoverability' has been used in place of 'resilience'. This terminology is in line with the recent Natural England best practice advice for evidence and data standards, which utilises the definitions provided by MarESA (Natural England, 2022).

Table 9-7 Tolerance and Recoverability Scale Definitions

Level	Description
Tolerance (Resistance)	
None	Key functional, structural, characterising species severely decline and/or physicochemical parameters are also affected e.g. removal of habitats causing a change in habitats type. A severe decline/reduction relates to the loss of 75% of the extent, density or abundance of the selected species or habitat component e.g. loss of 75% substratum (where this can be sensibly applied).
Low	Significant mortality of key and characterising species with some effects on the physicochemical character of habitat. A significant decline/reduction relates to the loss of 25-75% of the extent, density, or abundance of the selected species or habitat component e.g. loss of 25-75% of the substratum.
Medium	Some mortality of species (can be significant where these are not keystone structural/functional and characterising species) without change to habitats relates to the loss <25% of the species or habitat component.
High	No significant effects on the physicochemical character of habitat and no effect on population viability of key/characterising species but may affect feeding, respiration and reproduction rates.
Recoverability (Resilience)	
Very Low	Negligible or prolonged recovery possible; at least 25 years to recover structure and function.
Low	Full recovery within 10-25 years.
Medium	Full recovery within 2-10 years.
High	Full recovery within 2 years.

42. MarESA uses a matrix approach using both recovery and resilience to determine sensitivity. The sensitivity matrix used in this assessment, based on Marsa, is presented in **Table 9-8**.

Table 9-8 Sensitivity Matrix

		Tolerance (Resistance)			
		None	**Low**	**Medium**	**High**
Recoverability (Resilience)	**Very Low**	High	High	Medium	Low
	Low	High	High	Medium	Low
	Medium	Medium	Medium	Medium	Low
	High	Medium	Low	Low	Negligible

43. MarESA sensitivities are not available at the habitat level (European Nature Information System (EUNIS)[1] level 3). As such, in instances where biotope identification was not possible and where sensitivity at the habitat level is assessed, it is based on the worst-case sensitivity of biotopes identified within the relevant habitat.

44. It is important to note that where local evidence is available about habitat tolerance and recovery, sensitivities are modified accordingly.

9.4.3.1.2 Value

45. In addition, the 'value' of the receptor forms an important element within the assessment, for instance if the receptor is a protected species or habitat it is considered to be of higher value than a habitat or species that is not protected. It is important to understand that high value and high sensitivity are not necessarily linked within a particular effect. A receptor could be of high value (e.g. Annex I habitat) but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor-by-receptor basis. The value will be considered, where relevant, as a modifier for the sensitivity

[1] *The European Nature Information System (EUNIS) habitat classification is a comprehensive pan-European system for habitat identification. More information is available at:* *https://www.eea.europa.eu/data-and-maps/data/eunis-habitat-classification-1*

assigned to the receptor, based on expert judgement. **Table 9-9** states the definitions of value levels for benthic and intertidal ecology.

Table 9-9 Definition of Value For Benthic And Intertidal Ecology Receptors

Value	Definition
High	Habitats (and species) protected under international law (e.g. Annex I habitats within an SAC boundary).
Medium	Habitats protected under national law (e.g. Annex I habitats within an MCZ boundary). Species/habitat that may be rare or threatened in the UK.
Low	Habitats or species that provide prey items for other species of conservation value.
Negligible	Habitats and species which are not protected under conservation legislation and are not considered to be particularly important or rare.

9.4.3.1.3 Magnitude

46. The definitions of magnitude of impact for the purpose of the benthic and intertidal ecology assessment are provided in **Table 9-10** below.

Table 9-10 Definition of Magnitude of Impacts

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the majority of the receptor, and / or considerable alteration to medium or high value receptors.
Medium	Considerable, long term (throughout the project duration) changes, over the majority of the receptor, and / or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, long term (throughout the project duration) change, over a minority of the receptor, and / or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.

9.4.3.2 Significance of Effect

47. The assessment of significance of an effect is informed by the sensitivity of the receptor and the magnitude of the impact. The determination of significance is guided by the use of an impact significance matrix presented in **Chapter 6 EIA Methodology**. Definitions of each level of significance are provided in **Table 9-11**. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIA terms, whether this be adverse or beneficial. Any effect that has a significance of minor or negligible is not significant.

Table 9-11 Definition of Effect Significance

Significance	Definition
Major	Very large or large change in receptor condition, which is likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which is likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore no change in receptor condition.

9.4.4 Cumulative Effect Assessment Methodology

48. The cumulative effect assessment (CEA) considers other plans, projects and activities that may result in cumulation with the Projects. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the CEA.

49. The final assessment of cumulative effects will be undertaken during the later stages of the EIA, once further information is available on a number of projects such as the Outer Dowsing Offshore Wind Farm, Hornsea Project Four decision and the Sheringham Shoal and Dudgeon Extension Projects examination. However, for the purposes of the PEIR, it is possible to identify a number of projects and plans which are likely to feature in that assessment and consider the extent to which cumulative effects might arise. Section 9.7 presents the following preliminary information regarding cumulative effects:

- Screening for cumulative effects; and
- A preliminary short list of plans and projects considered for CEA, including a brief description as to how projects have been screened in and the initial tier level they have been assigned.

9.4.5 Assumptions and Limitations

50. This preliminary assessment is considered to be an interim stage in the EIA process. The results presented in the following sections are based on early design assumptions, draft characterisation information and initial assessments which will be refined and presented in the final Environmental Statement (ES) to be submitted as part of the DCO application.

51. Large amounts of data have been collected during the 2022 site-specific surveys with this data being used to generate a draft benthic characterisation report, which has been used to inform this chapter. This is in addition to information available from neighbouring wind farms in the wider Dogger Bank area, site designation data for the Dogger Bank SAC and data available on the Cefas OneBenthic data portal. Datasets for the neighbouring projects include those from the characterisation (EIA) stages of development (**Table 9-6**). As a result, the benthic ecology of the project areas has been thoroughly characterised and there is a high degree of confidence in the data for the purpose of informing the impact assessment.

52. During the analysis of benthic habitat maps, the EUNIS habitat classification (EEA, 2022) was used. Classifying benthic communities, biotopes or EUNIS levels may be subject to recorder bias due to the potential for confusion between biotopes which occupy similar habitats e.g. Infralittoral sands (MB523) mapped as Sublittoral sands (MB52) or where the characteristic species could allow classification of multiple biotopes. However, this is a known characteristic of the habitat mapping process and is not considered to materially affect the overall confidence in it for the purpose of informing the assessment.

53. The impact assessments in section 9.6 describe the level of confidence in each assessment. There is high confidence in the understanding of the magnitude of impact based on the worst case scenarios provided in section 9.3.2 and therefore confidence in the conclusions of effect significance is primarily driven by the level of confidence in the sensitivity of receptors. MarLIN provides information on the confidence associate with sensitivity classifications based on the following definitions:

- High confidence - "*based on peer reviewed papers (observational or experimental) or grey literature reports by established agencies on the feature, assessment based on the same pressures acting on the same type of feature in the UK, and studies agree on the direction and magnitude of impact or recovery*".
- Medium confidence - "*based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature or similar features, assessment based on similar pressures on the feature in other areas, and studies agree on the direction but not the magnitude of impact or recovery*".
- Low confidence - "*based on expert judgement, assessment based on proxies for pressures e.g. natural disturbance events, studies do not agree on concordance or magnitude of impact or recovery*".

54. Information from MarLIN, and specifically the MarESA method, provides a solid resource for the fundamentals of the significance of effect assessment. As taken from their online database "*MarLIN provides information to support marine conservation, management and planning. Our resources are based on available scientific evidence and designed for all stakeholders, from government agencies and industry to naturalists and the public. MarLIN hosts the largest review of the effects of human activities and natural events on marine species and habitats yet undertaken.*" It is supported by a number of organisations including Defra, JNCC and Natural England.

9.5 Existing Environment

55. The environmental baseline, including descriptions of sediment type, infauna and epifauna, is presented for the array areas and the offshore export cable corridor. A description of protected areas and important species in the vicinity of the project is also provided. It should be noted that the Benthic Ecology Characterisation Report (**Appendix 9-2**) used to inform this section is a draft version of this report. The final version of this report will be available at ES.

9.5.1 Offshore

9.5.1.1 Sediment Classification

9.5.1.1.1 Seabed Composition

56. Grab samples were successfully acquired at 179 of the 180 grab sampling stations across the array areas and offshore export cable corridor. One sample station (station (ST) 097) was abandoned due to coarse substrate resulting in an insufficient sample being acquired[2]. Sediments were classified using the using The Folk (British Geological Survey (BGS) modified) classification (Long, 2006) and the Wentworth sediment classification (Wentworth, 1922). **Figure 9-2** and **Figure 9-3** detail the spatial variations of percentage of sand, gravel and fines found within the array areas and offshore export cable corridor respectively.

57. The seabed observed across the survey area primarily comprised sand/muddy sand with varying proportions of shell fragments. The sample stations within the array areas were predominantly composed of sand and fine materials. A higher proportion of gravel was found to the west of the DBS West array area however, and in a handful of stations to the south of the DBS East array area. The majority of the area was classified as the EUNIS level 4 habitat type 'Faunal communities of Atlantic circalittoral sand' (MC521), while shallower areas (< 20m depth) were classified as the habitat type 'Faunal communities of full salinity Atlantic infralittoral sand' (MB523) and deeper areas (>50m depth) were classified as the habitat type 'Faunal communities in Atlantic offshore circalittoral sand' (MD521).

[2] The three sampling attempts made failed to recover more than 5 litres of sediment from the Hamon grab, as required by the Benthic Survey Method Statement (document ref: 004177105-02)

58. These results are in line with the results of other surveys undertaken within the Dogger Bank SAC and wider area, such as those for Dogger Bank A and B (formerly Dogger Bank Creyke Beck) (Forewind, 2014) and the recent MMO Dogger Bank SAC Fisheries Assessment undertaken in 2021.

59. Some stations appeared to have a higher proportion of mud and were classified as the EUNIS habitat type 'Faunal communities of circalittoral mud' (MC621). Sediment descriptions are based on the Folk (1954) classification, in which '*sandy mud*' describes sediments comprised of 50% to 90% mud, and muddy sand is comprised of 10% to 50% mud, with the remainder comprised predominantly of sand (Folk, 1954; Long, 2006). These stations were found in deeper areas of the array areas and offshore export cable corridor, in line with the findings of the recent studies (MMO, 2021).

60. Sediments comprising shell fragments, pebbles and occasional cobbles/boulders were classified as the EUNIS habitat type 'Faunal communities of Atlantic circalittoral coarse sediment' (MC321) or its offshore equivalent (MD321) in water depths greater than 50m. In areas comprising muddy, sandy gravel with cobbles and occasional boulders, sediments were classified as 'Faunal communities of Atlantic circalittoral mixed sediment' (MC421).

61. Patches of firm clay were recorded within other sediment types at six stations. These areas were classified as the biotope complex 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251) due to the presence of potential piddock burrows. This biotope has not been commonly identified within the Dogger Bank or the wider North Sea, with the biotope not being noted as present within surveys for the Hornsea Project Four or Dogger Bank A and B offshore wind farms.

62. As detailed in **Figure 9-2** and **Figure 9-3,** sediment composition within the offshore export cable corridor was primarily classified as gravel near the coast. Sand composed 50% of the sediment at ST164, with gravel being absent along the offshore export cable corridor from ST160 onwards (with the exception of ST135).

9.5.1.1.2 Habitat Classification

63. **Table 9-12** presents the classification hierarchy for the biotopes observed within the survey area. It should be noted that the habitat 'Circalittoral coarse sediment' was also identified within the survey area, but could not be identified to the biotope level. **Figure 9-4** and **Figure 9-5** present the biotopes / habitat surveyed within the proposed arrays and along the offshore export cable corridor respectively.

64. The biotopes / habitat identified within the offshore development area were distributed as follows, from most to least commonly identified:

- *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand – Occurred across the entirety of the array areas, with the exception of the most southerly and westerly extremes of DBS East and DBS West respectively.
- *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment – Found primarily in the southern extent of the DBS East array area, in isolated locations within the DBS West array area, the southern leg of the offshore export cable corridor and in two samples near landfall.
- *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand – Located primarily towards the western edge of the DBS West array area, and comprised the majority of samples recorded along the offshore export cable corridor, up to 43km from the landfall.
- *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel – Found primarily towards the western edge of the DBS West array area and isolated locations within DBS East.
- Circalittoral coarse sediment – Found in isolated samples primarily in the DBS West array area, two locations in the southern extent of the DBS East array area and in two locations along the eastern and western extremes of the offshore export cable corridor.
- *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel – Found in five locations within a stretch of the offshore export cable corridor from approximately 18km – 40km offshore from the landfall.
- Piddocks with sparse associated fauna in sublittoral very soft chalk or clay – Found in association with the biotope *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment at two locations at the southerly extent of the DBS East array area.

Table 9-12 Biotope Classifications

EUNIS (EEA, 2022) Habitat Classification		Equivalent JNCC Classification (JNCC, 2023)
Biotope Complex **Level 4**	**Biotope** **Level 5**	
MB523 Faunal communities of full salinity Atlantic infralittoral sand	MB5233 *Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand	SS.SSa.IFiSa.NcirBat *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand
MC125 Communities on Atlantic circalittoral soft rock	MC1251 Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay	CR.MCR.SfR.Pid Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay
MC321 Faunal communities of Atlantic circalittoral coarse sediment	MC3215 *Branchiostoma lanceolatum* in Atlantic circalittoral coarse sand with shell gravel	SS.SCS.CCS.Blan *Branchiostoma lanceolatum* in circalittoral coarse sand with shell gravel
	MC3212 *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	SS.SCS.CCS.MedLumVen *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel
MC521 Faunal communities of Atlantic circalittoral sand	MC5212 *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand	SS.SSa.CFiSa.ApriBatPo *Abra prismatica*, *Bathyporeia elegans* and polychaetes in circalittoral fine sand
	MC5214 *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	SS.SSa.CMuSa.AalbNuc *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment

9.5.1.1.2.1 *Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic Infralittoral Sand (MB5233)

65. The most prevalent biotope across the array areas area, this biotope is described as well sorted medium and fine sands characterised by polychaetes such as *Nephtys cirrosa* and amphipods of the genus *Bathyporeia*, which occur in the shallow sublittoral. Sandeels of the genus *Ammodytes* may be present (EEA, 2022).

66. This biotope is characterised by moderately well sorted sand. Fauna comprised amphipods such as *B. guilliamsoniana* and *B. elegans* and polychaetes such as *Spiophanes bombyx* agg., *N. cirrosa*, and species of *Owenia*, and, to a lesser extent, bivalves such as *Chamela striatula, Fabulina fabula*, and *Mactra stultorum*.

67. Colonial epifauna from the grab samples was represented mainly by hydroids such as *Phialella quadrata, Clytia hemisphaerica*, and species of Tubulariidae, as well as bryozoans, such as *Electra pilosa* and Ciliophora of the family Folliculinidae.

68. The seabed video and photographic analysis of sample stations associated with this biotope indicated a seabed comprising rippled sand and/or muddy sands with shell fragments and pebbles. Epibiota included starfish, such as *Luidia sarsi*, *Astropecten irregularis*, and *Asterias rubens*, hermit crabs including *Pagarus bernhardus* and associated hydroids of the genus Hydractinia, the bryozoan *Flustra foliacea*, sandeels of the genus *Ammodytes*, the soft coral *Alcyonium digitatum*, and the urchin *Echinocardium cordatum*. Faunal burrows were recorded at stations ST069, ST070, ST071, ST101, ST103 to ST105, ST112, ST122, and ST123, while anthropogenic debris was recorded at station ST030.

69. An impoverished version of this biotope was assigned to station ST113, characterised by moderately sorted sand. This station had low species richness and abundance, represented mainly by the polychaetes *S. bombyx* agg., *N. cirrosa* and *Paraonis fulgens*, and the bivalves *Spisula elliptica* and *Macomangulus tenuis*.

70. The prevalence of this biotope within the offshore development area falls in line with the findings of site-specific surveys conducted for the Dogger Bank Creyke Beck A and B offshore wind farms, which determined that the biotope was dominant across the survey area for those projects and the wider Dogger Bank as a whole (Forewind, 2014).

9.5.1.1.2.2 Piddocks With a Sparse Associated Fauna in Atlantic Circalittoral Very Soft Chalk or Clay (MC1251)

71. 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' (MC1251) occurs on circalittoral soft rock, which is sufficiently soft to be bored by bivalves, with the piddock *Pholas dactylus* the most widespread borer recorded. While it is typically too soft for rich epifaunal communities to establish, sessile fauna may include sponges and mobile fauna often includes crabs (*Necora puber* and *Cancer pagurus*; EEA, 2022). This habitat has most frequently been reported from tide-swept areas off the south-east of England (Tillin and Hill, 2016).

72. This habitat type was assigned to areas of firm clay, in some cases overlain by a veneer of sand, observed at six stations (stations ST001, ST003, ST048, ST061, ST124 and ST181), showing the characteristic round burrows of piddocks. These stations were found around the edges of the proposed arrays (five stations) and at the sampling station closest to shore (station ST181; **Figure 9-4** and **Figure 9-5**)).

73. As is typical of this biotope, the clay seabed itself had little or no attached epifauna with piddock burrows (Imparidentia) evident and abundances ranging from 'Frequent' to 'Abundant'. The most commonly occurring mobile epifauna recorded in this biotope were starfish (*A. rubens* and *A. irregularis*) and crabs (Brachyura, including *Necora puber*). In areas of coarser sediment, faunal turf (Hydrozoa/Bryozoa, including *Halecium* sp., *Alcyonidium diaphanum*, *F. foliacea* and *Nemertesia* sp.) and additional crustaceans, including lobster *Homarus gammarus* and shrimp (Caridea), were also observed. This biotope complex occurred in patches within mixed sediment areas classified as 'Faunal communities of Atlantic circalittoral mixed sediment' (MC421) at three stations (stations ST061, ST124 and ST181) and in areas classified as 'Faunal communities of Atlantic circalittoral sand' (MC521) at two stations (stations ST001 and ST003). Therefore, there is likely to be some overlap of epifauna with the adjacent habitats, including the presence of soft coral.

9.5.1.1.2.3 Circalittoral Coarse Sediment (MC3)

74. This habitat is described as coarse sediments in the circalittoral zone on the open coasts and in areas with strong hydrodynamics. This habitat is characterised by robust fauna including venerid bivalves (EEA, 2022).

75. This habitat was assigned to sample stations characterised by gravelly sand. Fauna comprised polychaetes such as *S. bombyx* agg., *O. borealis*, *S. armiger*, and *N. cirrosa*, bivalves, notably *Abra prismatica*, the cumacean *Diastylis rugosa*, and the echinoderms *Amphiura filiformis* and *Echinocyamus pusillus*. Colonial epifauna from the grab samples was represented mainly by Folliculinidae and *C. hemisphaerica*.

76. The seabed video and photographic analysis of the eight sample stations characterised by this habitat in the array areas indicated a seabed which ranged from rippled sand to gravelly sand and sandy gravel with shell fragments, pebbles, and occasional cobbles and boulders. Epibiota included *A. digitatum, A. rubens, C. pagurus, N. puber, A. irregularis,* and species of Actiniaria, Pleuronectiformes, Serpulidae, Gadidae, Paguridae and Callionymidae. Piddocks (Imparidentia) were recorded at station ST124.

77. This habitat was assigned also to stations ST135 and ST167, both characterised by very poorly sorted sandy gravel. The infaunal community of station ST135, in water depth of 67.7m (BSL) was typified by the polychaetes *Paramphinome jeffreysii, Scoloplos armiger, S. bombyx* agg. *Goniada maculata,* and the bivalve *Abra alba.* Station ST167, in water depth of 20.5m (BSL), had the lowest species richness and abundance of all stations classified as this biotope, with only five individuals of the most abundant species (*A. prismatica*) being recorded. Each of the remaining six taxa at this station (*S. foliosa, Chaetozone christiei, Travisia forbesii, S. spinulosa, Centraloecetes kroyeranus* and *D. rugosa*) comprised one individual.

9.5.1.1.2.4 *Branchiostoma lanceolatum* in Atlantic Circalittoral Coarse Sand With Shell Gravel (MC3215)

78. This biotope is described as gravel and coarse sand sediments with shell gravel. Faunal communities are typified by significant population of *Branchiostoma lanceolatum*. Other conspicuous infauna may include *E. pusillus*, and *Glycera lapidum*, while sessile epifauna are a minor component of this community (EEA, 2022).

79. This biotope was assigned to stations characterised by very poorly sandy gravel. Fauna comprised *B. lanceolatum* which was amongst the top ten characterising taxa, along with *G. lapidum*, *E. pusillus*, *S. bombyx* agg. and species of *Notomastus* and *Polycirrus*.

80. Colonial epifauna from the grab samples was represented mainly by hydroids such as *C. hemisphaerica* and species of Tubulariidae, the bryozoan *E. pilosa*, Ciliophora of the family Folliculinidae, and Entoprocta of the genus *Pedicellina*.

81. The seabed video and photographic analysis of the ten sample stations characterised by this biotope within the array areas indicated a seabed comprising gravelly sand or muddy sand with patches of pebbles and shell fragments. Epibiota included Paguridae, *F. foliacea* and *Securiflustra securifrons*, *A. digitatum*, *A. irregularis*, and *A. rubens*.

9.5.1.1.2.5 *Mediomastus fragilis*, *Lumbrineris* spp. and Venerid Bivalves in Atlantic Circalittoral Coarse Sand or Gravel (MC3212)

82. This biotope is described as gravels, coarse to medium sands, and shell gravels with small percentage of silt in the circalittoral zones. Faunal communities are characterised by polychaetes such as *M. fragilis*, species of *Lumbrineris*, *G. lapidum*, and *E. pusillus*. Other taxa may include Nemertea, *S. bombyx*, *Ampelisca spinipes*, and venerid bivalves, although the latter are often under-sampled in benthic grab surveys (EEA, 2022).

83. This biotope was assigned to stations characterised by very poorly sorted muddy sandy gravel. Fauna comprised polychaetes such *as Lumbrineris cf. cingulata*, *M. fragilis*, *Spiophanes kroyeri* agg., and *G. lapidum*, the amphipod *A. spinipes*, and bivalves such as *Nuculana minuta*, *Phaxas pellucidus*, *Timoclea ovata*, and species of *Abra.*

84. Colonial epifauna from the grab samples was represented by *A. limicola*, *C. hemisphaerica*, *Scrupocellaria scruposa*, and species of *Eudendrium* and *Pedicellina*.

85. Of the five stations designated for this biotope along the offshore export cable corridor, seabed video and photography were undertaken at station ST161, and the results indicated a seabed comprising muddy sandy gravel with shell fragments and pebbles. Epibiota were represented by the coral *A. digitatum*, the starfish *A. rubens,* crustaceans such as *Atelecyclus rotundatus* species of *Ebalia* and Paguridae, as well as bivalves of the family Pectinidae and fish of the families Callionymidae and Gadidae.

9.5.1.1.2.6 *Abra prismatica, Bathyporeia elegans* and Polychaetes in Circalittoral Fine Sand (MC5212)

86. This biotope is described as circalittoral and offshore medium to fine sands characterised by the bivalve *A. prismatica*, the amphipod *B. elegans* and polychaetes such as *S. armiger*, *S. bombyx* and *O. borealis*. The brittlestar *A. filiformis* may also be common at some sites (EEA, 2022).

87. This biotope was assigned to stations characterised by moderately sorted and moderately well sorted sand, respectively. Results of the SIMPER analysis indicated that differences between multivariate groups F and H were associated mainly with the abundance of taxa such as *N. cirrosa*, *Sthenelais limicola*, *A. filiformis*, *Bathyporeia guilliamsoniana*, *O. borealis*, *F. fabula*, and *E. pusillus*. Differences in taxa composition were associated with taxa such as *Diastylis rugosa* and *Hermania scabra/indistincta*.

88. Colonial epifauna from the grab samples included *P. quadrata*, *C. hemisphaerica*, *E. pilosa*, *F. foliacea*, *Leuckartiara octona*, *Alcyonidium parasiticum*, and species of *Barentsia*, Folliculinidae, Tubulariidae, and Sertulariidae.

89. The seabed video and photographic analysis of stations associated with this biotope indicated a seabed comprising rippled sand or muddy sand with fragments. Epibiota were sparse and included *A. irregularis*, *A. rubens*, *F. foliacea*, *Luidia ciliaris*, *A. digitatum*, and species of Paguridae, Ammodytidae, and Pleuronectiformes. Anemones potentially of the genus *Metridium* were recorded at station ST125. Anthropogenic debris was recorded at station ST128.

9.5.1.1.2.7 *Abra alba* and *Nucula nitidosa* in Circalittoral Muddy Sand or Slightly Mixed Sediment' (MC5214)

90. This biotope is described as non-cohesive muddy sands or slightly shelly/gravelly muddy sand characterised by the bivalves *A. alba* and *N. nitidosa*. Other important taxa include *S. bombyx* and *F. fabula*, whereas the echinoderm *A. rubens* may be present (EEA, 2022).

91. This biotope was assigned to stations characterised by poorly sorted muddy sand. Analysis of the survey data indicated that differences between the stations associated with this biotope were mainly due to the abundance of taxa such *Galathowenia oculata*, *Lanice conchilega*, *S. bombyx* agg., *Harpinia antennaria*, and *Spisula subtruncata*. Differences in taxa composition were associated with taxa such as *A. filiformis* and polychaetes of the genus *Leiochone*.

92. Colonial epifauna from the grab samples included *P. quadrata*, *C. hemisphaerica*, *E. Pilosa*, and species of Tubulariidae and Anthoathecata.

93. The seabed video and photographic analysis of stations associated with this biotope indicated a seabed comprising rippled sand and muddy sand with shell fragments and pebbles. Epibiota included *A. digitatum*, *A. rubens*, *A. irregularis*, and crabs of the family Paguridae with associated hydroids of the genus *Hydractinia*, anemones of the order Actiniaria, and fish of the infraorder Pleuronectiformes and the families Triglidae and Gadidae. Faunal burrows and mounds were recorded at stations ST009 and ST010, whereas piddocks (Imparidentia) were recorded at stations ST001 and ST003.

94. **Figures 9-3** and **9-4** illustrate the EUNIS habitats and biotopes distribution in the array areas and along offshore export cable corridor, respectively.

9.5.1.2 Contaminants

95. Sediment samples collected during the survey campaign were analysed for their hydrocarbon, heavy metal, polychlorinated biphenyls (PCB) and organotin content.

96. Total Hydrocarbon Content (THC) values were below marine sediment quality guidelines (SQGs) for all stations except for station ST161 where the THC was above the Cefas Action Level 1 (AL1). The THC content in the array areas were generally lower than the THC content along the offshore export cable corridor.

97. Concentrations of all poly-aromatic hydrocarbons (PAHs) analysed were below the marine SQGs at all stations, except from naphthalene at station ST168 which exceeded the Canadian thresholds effect level (TEL).

98. Arsenic concentrations were above the Canadian SQG TEL at 11 stations, with station ST164 also above the Canadian SQG probable effects level (PEL). Three stations (ST125, ST161, and ST164) were above the Cefas AL1 concentration with station ST164 also above the National Oceanic and Atmospheric Administration (NOAA) effects range median (ERM). However, the arsenic concentrations in the current survey were within the range reported previously from the region.

99. The lead concentration at station ST164 was above the Canadian SQG TEL. All other metal concentrations were lower than all environmental quality standards. The concentrations of the sum of the 25 PCB congeners analysed and the organotins (dibutyltin (DBT) and tributyltin (TBT)) were below the Cefas ALs at all stations.

100. Comparing the contaminants analysis results between the Projects and those detailed in previous reports, a similar spike in contaminants in the vicinity of ST161 and ST164 was recorded for the Dogger Bank A and B projects (Forewind, 2014). Contaminant concentrations were higher in the nearshore in the Dogger Bank A and B samples when compared with the samples for the Projects, with six stations in the nearshore exceeding the Canadian SQG TEL for arsenic, cadmium, chromium, copper and lead. For the Projects, there were exceedances at three stations only, with arsenic exceeding the Canadian SQG TEL.

101. Further analysis on sediment chemistry within the offshore development area is detailed in **Appendix 9-2**.

9.5.1.3 Potential Sensitive Habitats and Species

9.5.1.3.1 Sandbanks

102. The array areas fall within the Dogger Bank SAC, a site designated for the Annex I habitat '*Sandbanks which are slightly covered by sea water all the time*'. All of the seabed within the array areas and offshore export cable corridor which overlaps the SAC is therefore considered to comprise this Annex I habitat. Species that act as indicators of sandbanks recorded during the survey included the lesser weever *Echiichthys vipera*, the shrimp *Philocheras trispinosus*, common hermit crab *P. bernhardus* and the lesser sandeel *A. marinus*.

9.5.1.3.2 Peat and Clay Exposures with Piddocks

103. Under the Natural Environment and Rural Communities Act 2006 (NERC), Section 41, Peat and clay exposures with piddocks are classified as a priority habitat ('Peat and clay exposures with piddocks'). The habitat is also classified as a Habitat Feature of Conservation Interest (FOCI) ('Peat and clay exposures') for Marine Conservation Zones (MCZ). Piddocks are elongated burrowing bivalves and include *P. dactylus*, *Barnea candida* and *Barnea parva*. These are capable of boring into substrates, such as peat and soft rock or clay (JNCC, 2008a).

104. Peat and clay exposures with either existing or historical evidence of piddock activity have been reported intertidally on coasts arounds the UK, from the north-west coast to the south and east coasts of England, around the north and south coasts of Wales. Although the distribution of the subtidal element of this habitat is relatively unknown, due to the common nature of *P. dactylus* around the coastlines of England and Wales the priority habitat is likely to form where sufficient areas of peat or clay exposures allow (Tillin & Hill, 2016).

105. Clay exposures, potentially representing the UK BAP listed habitat 'Peat and clay exposures', were observed from the seabed photographic data at six stations (stations ST001, ST003, ST048, ST061, ST124 and ST181). No peat was observed from the seabed photographic data or samples.

9.5.1.3.3 Subtidal Sands and Gravels

106. Subtidal sands and gravels are classified as a priority habitat and a MCZ Habitat FOCI. However, although identified as a priority habitat it is recognised that this habitat is the most common habitat present subtidally around the coast of the UK (JNCC, 2008b) and is well represented within the Marine Protected Area (MPA) network (JNCC, 2023).

107. 'Sublittoral sand and gravel' habitats occur in a wide variety of environments and range from mainly sand, through various combinations of sand and gravel, to mainly gravel. Therefore, the majority of the biotopes identified within the current survey area may be considered to fall within this habitat type.

9.5.1.3.4 Stony Reef

108. Due to the presence of cobbles, and occasional boulders in the photographic data, a stony reef assessment was required at 16 stations. The habitat type 'Faunal communities of Atlantic circalittoral mixed sediment' (MC421), which includes mosaics of shell, cobbles and pebbles, was identified from five stations within the survey area and aggregations of cobble and/or boulder sized material were seen at a further 11 stations which surveyed other habitat types. Two stations (ST167 and ST181) were classified as 'low' potential as a stony reef.

9.5.1.3.5 Other Potentially Sensitive Habitats and Species

109. Sandeels were observed at 26 stations comprising sandy sediments. In this instance, it was not possible to identify sandeels to species level. It should be noted that of the five sandeel species found in the North Sea (NatureScot, 2023), only the lesser sandeel *Ammodytes marinus* is a UK Biodiversity Action Plan (BAP) Priority Species (UK Post-2010 Biodiversity Framework). Potential impacts on sandeels are assessed separately in **Chapter 10 Fish and Shellfish Ecology**.

110. No other Annex I habitats or Annex II species, OSPAR threatened and/or declining species and habitats or UK BAP priority habitats and species were observed within the survey area.

9.5.2 Intertidal Zone

111. A Phase I qualitative intertidal ecology survey was undertaken on 28 September 2022 at the possible two landfall locations for the Projects.

112. Five transects across the two landfalls were surveyed to determine the habitat present within each landfall area and the presence/absence of any fauna. Three distinct habitats were identified within Landfall 8 and four within Landfall 9. Instances of *Arenicola marina* worm casts and *Lanice conchilega* tubes were found along the lower shore. While distinct differences in habitat and species composition were identified across the tidal range, such differences were not significant enough to constitute a change in biotope present. As such, the entirety of the survey area has been classified as the biotope barren littoral coarse sand (EUNIS biotope MA5231).

113. See **Appendix 9-1** for further details on the methodology and results of this survey.

9.5.3 Designated Sites

114. The offshore development area lies within/in the vicinity of sites designated for the protection of benthic habitats and species. These sites are detailed in the following section and summarised in **Table 9-13**, which includes their distance from the Projects.

9.5.3.1 Dogger Bank SAC

115. The Dogger Bank SAC is designated for the Annex I habitat 'Sandbanks which are slightly covered by sea water all the time'. The Dogger Bank is an extensive sublittoral sandbank in the southern North Sea formed by glacial processes and submergence through sea-level rise. A large part of the southern area of the bank is covered by water typically no deeper than 20m below chart datum. The bank is non-vegetated and comprises moderately mobile, clean sandy sediments (JNCC, 2019).

9.5.3.2 Holderness Inshore MCZ

116. The Holderness Inshore MCZ is located north of the Humber estuary mouth (DEFRA, 2016). The seabed in this site is made up of rock, sand, mud and sediment. The mosaic of habitats within the site supports a diverse range of organisms including red algae, sponges and other encrusting fauna. The site also supports fish species such as European eel, dab and wrasse, as well as commercially significant crustaceans such as edible and velvet swimming crabs and lobster.

117. Partly above the water, the sandy beaches of intertidal sand and muddy sand are uncovered at low tide. These beaches are home to many species, buried in the damp sand.

9.5.3.3 Holderness Offshore MCZ

118. The Holderness Offshore MCZ is located approximately 11km offshore from the Holderness coast (JNCC, 2021). The seabed is dominated by subtidal coarse sediment and hosts subtidal sand, subtidal mixed sediments and part of a glacial tunnel valley. The diverse seabed allows for a wide variety of species which live both in and on the sediment such as, crustaceans (crabs and shrimp), starfish and sponges. This site is also a spawning and nursing ground for a range of fish species for example lemon sole *Microstomus kitt*, plaice *Pleuronectes platessa* and European sprat *Sprattus*. Therefore, the species living both in and on the sediment may benefit from the protection afforded to the habitat features within this site.

119. The slow-growing (but widely occurring) bivalve, Ocean quahog *Arctica islandica* has been found in the site. Ocean quahog is a threatened/declining species of bivalve mollusc that can take up to 6 years to reach maturity and can live for over 500 years.

9.5.3.4 Flamborough Head SAC

120. The Flamborough Head SAC is designated for the Annex I habitats 'Reefs', 'Vegetated sea cliffs of the Atlantic and Baltic Coasts and 'Submerged or partially submerged sea caves'. Of the designated habitats for the site, those of interest in relation to potential indirect effects from the Projects activities are the areas of reef within the site. The clarity of the relatively unpolluted sea water and the hard nature of the extensive sublittoral chalk habitat have enabled kelp *Laminaria hyperborea* forests to become established in the shallow sublittoral zone. The reefs to the north of the site support a different range of species from those on the slightly softer and more sheltered south side of the headland. The site supports an unusual range of marine species and includes rich animal communities and some species that are at the southern limit of their North Sea distribution, e.g. the northern alga *Ptilota plumosa* (JNCC, 2022a).

9.5.3.5 Humber Estuary SAC

121. The Humber is the second-largest coastal plain estuary in the UK, and the largest coastal plain estuary on the east coast of Britain. At the time of writing there exists the potential for cable protection to be installed in the nearshore zone. This could potentially cause changes to nearshore sediment transport processes and result in impacts to the Humber Estuary SAC, designated for the following Annex I habitats:

- Estuaries;
- Mudflats and sandflats not covered by seawater at low tide;
- Sandbanks which are slightly covered by seawater all the time;
- Coastal lagoons; and
- *Salicornia* and other annuals colonising mud and sand Atlantic salt meadows (*Glauco Puccinellietalia maritima*)

9.5.3.6 Summary of Designated Sites

Table 9-13 Designated Sites for Benthic Features Within/In the Vicinity of the Offshore Development Area

Site	Distance from Projects	Designated Features
Dogger Bank SAC	0km (array areas and part of offshore export cable corridor within SAC)	Annex I Sandbanks which are slightly covered by sea water all the time
Holderness Inshore MCZ	0km (offshore export cable corridor overlaps MCZ near the landfall area)	EUNIS Habitat Features • Intertidal sand and muddy sand (A2.2) • High energy circalittoral rock (A4.1) • Moderate energy circalittoral rock (A4.2) • Subtidal coarse sediment (A5.1) • Subtidal sand (A5.2) • Subtidal mud (A5.3) • Subtidal mixed sediments (A5.4) • Spurn head (subtidal) **Geological feature*
Holderness Offshore MCZ	Approximately 0.7km south-east of the offshore export cable corridor	Broad scale habitat: • Subtidal coarse sediment • Subtidal sand • Subtidal mixed sediments

Site	Distance from Projects	Designated Features
		Species feature of conservation importance: Ocean quahog (*Arctica islandica*)
Flamborough Head SAC	Approximately 3km north-west of the offshore export cable corridor	Annex I Reefs Vegetated sea cliffs of the Atlantic and Baltic Coasts Submerged or partially submerged sea caves
Humber Estuary SAC	44.6km south of the proposed landfall location	Estuaries Mudflats and sandflats not covered by seawater at low tide Sandbanks which are slightly covered by seawater all the time Coastal lagoons *Salicornia* and other annuals colonising mud and sand Atlantic salt meadows (*Glauco Puccinellietalia maritima*).

9.5.4 Invasive/Non-Native Species

122. Invasive/non-native species (INNS) are those that have reached the UK by accidental human transport, deliberate human introduction, or which have arrived by natural dispersion from a non-native population in Europe (Government Digital Service [GDS], 2021). Once introduced, some INNS can become established and their subsequent dispersal from the point of introduction can result in environmental and economic impact (Cottier-Cook *et al*., 2017). The INNS that have a negative impact on biodiversity, through the spread of disease, competition for resources, or by direct consumption, parasitism, or hybridisation, are termed 'invasive' (GDS, 2021).

123. The INNS recorded in the grab samples included the polychaete *Goniadella gracilis*. This species was first recorded in 1970 in Liverpool Bay and had been previously reported from South Africa and North America, from where it was originally described. Although the method of introductions is unknown, this species is likely to have been introduced from the United States east coast through trans-Atlantic shipping. In the British Isles, this species is common in Liverpool Bay in sandy gravel at depths greater than 15m and widespread in the southern Irish Sea (Eno *et al*., 1997) and in Europe it has been recorded in bay of Douarnenez in France (Ifremer, 2004). In this study, 15 individuals of *G. gracilis* were recorded, including six individuals at station ST131, three individuals at station ST012, 2 individuals at station ST063 and one individual at stations ST015, ST080, ST107, and ST133.

124. In addition, cryptogenic species (species of unknown origin) were recorded in the grab samples. These included the polychaetes *Polydora cornuta* and ascidians of the genus *Molgula*, the latter potentially including the cryptogenic species *Molgula manhattensis*.

125. The polychaete *P. cornuta* is reported to be widely distributed from the Atlantic to the Pacific and reported for the first time in the Mediterranean in 2008 in organically enriched and polluted environments (Simboura *et al*., 2008). In this study, one individual of *P. cornuta* was recorded in the grab sample from station ST001. Two individuals of the genus *Molgula* were recorded, including one from station ST106 and one from station ST164.

126. The INNS recorded are not included in the invasive species England Biodiversity Indicator for 2021 (Harrower *et al*., 2021).

9.5.5 Future Trends

127. In the event that the Projects are not developed, an assessment of future conditions for benthic and intertidal ecology has been carried out and is described within this section.

128. The baseline conditions for benthic ecology are considered to be relatively stable within the Dogger Bank. Datasets from the last three decades in the area, including surveys for the Dogger Bank A and B offshore wind farm (Forewind, 2014), the original Dogger Bank SAC selection assessment (JNCC, 2011) and a 1995 review of the Dogger Bank by Kröncke and Knust, detailing a similar habitat and species composition to that identified by the site-specific surveys for the Projects.

129. The existing environment within the Dogger Bank is influenced by the physical processes which exist within the southern North Sea, including waves and tidal currents driving changes in sediment transport and then seabed morphology (see **Chapter 8 Marine Physical Environment**). Long

term established patterns may be affected by climate change driven sea-level rise, however this will have a reduced impact offshore compared to along the coastline. Warming sea temperatures and ocean acidification are leading to changes in the composition and geographical distribution of benthic communities, with a general north westerly shift (Hiddink, Burrows and García Molinos, 2015) in the latitudinal ranges of many species.

130. Long term analyses of the current communities of North Sea benthos have led to the conclusions that they are under severe threat from climate change. Sea bottom temperature has increased by 1.6°C between 1980 and 2004 (Dulvy *et al*., 2008) and sea surface temperature (SST) has increased by ~0.06°C yr^{-1} when the average global SST rise is 0.017±0.005 (Good *et al*., 2007). Using predictions for increasing ocean temperature, the populations of key benthic species will change over time, with key indicator species such as *A. filiformis* being replaced completely by species more suited to the warming of bottom water temperature predicted to occur (Weinert *et al*., 2021).

131. As a result of The Dogger Bank SAC (Specified Area) Bottom Towed Fishing Gear Byelaw 2022, enacted to protect the entirety of the Dogger Bank SAC from the impacts of bottom-towed fishing gear (MMO, 2022), impacts from fishing will be significantly reduced as long as the byelaw remains in place. It is expected that the prohibition of fishing with bottom-towed gear will result in changes to the benthic and fish communities within the SAC through their recovery from the effect of bottom-towed fishing gear. The assessment underpinning the enactment of the byelaw is scheduled to be reviewed every five years, or if significant new information supports its review at an earlier date.

132. As such, it can be reasonable expected that populations of benthic species that have been negatively impacted by bottom-towed gear, such as the long-lived, slow growing mollusc *A. islandica*, will recover in the absence of this pressure.

9.6 Assessment of Significance

133. The likely significant effects to benthic and intertidal ecology that may occur during construction, operation, maintenance and decommissioning of the Projects are assessed in this section. The worst-case scenarios listed in **Table 9-2** for each impact are assessed.

134. As described in section 9.4 , the sensitivities of benthic receptors have been assessed using the MarESA method.. The MarESA method assesses sensitivity of biotopes identified in the survey area. Where habitats or biotope complexes have been identified at high-level EUNIS classifications based on physical parameters only, biotopes commonly found within these habitats have been used to assess the sensitivities as a proxy.

9.6.1 Potential Effects During Construction

9.6.1.1 Impact 1 - Temporary Physical Disturbance (Including Sediment Deposition and Smothering)

9.6.1.2 Array Areas and Offshore Export Cable Corridor

135. During construction there will be disturbance within the offshore development area due to cable laying operations, jack-up operations, construction works for foundations and UXO clearance. This will cause temporary habitat loss and physical disturbance to the seabed.

136. Where disturbed sediments (e.g. preparation areas for foundations) are subsequently covered with infrastructure, habitat loss will be for the 30 year duration of the Projects. As such, habitat loss has been assessed as an operational impact in section 9.6.2.2, and is not considered further here.

9.6.1.2.1 Sensitivity of Receptor

137. The sensitivity of the biotopes identified within the array areas and offshore export cable corridor have been assessed in relation to MarESA pressures relevant to the construction phase and temporary habitat loss / physical disturbance:

- Habitat structure changes – removal of substratum (extraction);
- Abrasion/disturbance of the surface of the substratum or seabed; and
- Penetration or disturbance of the substratum subsurface.

138. The sensitivity of identified habitats and biotopes to temporary physical disturbance (including sediment deposition and smothering) pressures are summarised in **Table 9-14** below. Note that the sensitivity definitions presented in **Table 9-14** (and following tables referring to the sensitivity of biotopes to potential impacts) have been taken directly from the assessments presented on the MarLIN website. It should also be noted that MarESA sensitivity information was not available for the habitat 'circalittoral coarse sediment' due to its high level classification. As such, the nearest available proxy biotope, '*Pomatoceros triqueter* with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles', was selected by expert judgement (detailed in **Table 9-14** below) to represent the sensitivity of this habitat.

Table 9-14 The Sensitivity of Biotopes to Temporary Physical Disturbance

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	None	High	Medium	High
Circalittoral coarse sediment (MC3) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles* (MC3211)	None	High	Medium	Low
Branchiostoma lanceolatum in Atlantic circalittoral coarse sand with shell gravel (MC3215)	None	Medium	Medium	Medium
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)	None	Medium	Medium	Medium
Abra prismatica, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (MC5212)	None	Medium	Medium	High

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Abra alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (MC5214)	None	Medium	Medium	High
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	None	Very Low	High	High
Impact pressure pathway: Abrasion/disturbance of the surface of the substratum or seabed				
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	Low	High	Low	High
Circalittoral coarse sediment (MC3) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (MC3211)*	Low	High	Low	High
Branchiostoma lanceolatum in Atlantic circalittoral coarse sand with shell gravel (MC3215)	Medium	High	Low	Low
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)	Medium	High	Low	Low
Abra prismatica, Bathyporeia elegans and polychaetes in circalittoral fine sand (MC5212)	Medium	High	Low	Low
Abra alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (MC5214)	Medium	High	Low	Low

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	Medium	Very Low	Medium	Low
Impact pressure pathway: Penetration or disturbance of the substratum subsurface				
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	Medium	High	Low	High
Circalittoral coarse sediment (MC3) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (MC3211)*	Low	High	Low	High
Branchiostoma lanceolatum in Atlantic circalittoral coarse sand with shell gravel (MC3215)	Low	Medium	Medium	Low
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)	Medium	High	Low	Medium
Abra prismatica, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (MC5212)	Medium	High	Low	Medium
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	Medium	High	Low	Medium
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	Low	Very Low	High	Low

139. The most prevalent biotopes within the offshore development area are characteristic of highly disturbed environments, and typically have medium to high recoverability and will therefore recover rapidly from disturbance as a result of construction impacts. However, the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' is more sensitive to physical disturbance, being classed as highly sensitive to removal of substratum and penetration or disturbance of the substratum subsurface. As such, this biotope has the potential to be impacted in the long-term by construction activities. This biotope can be considered as being of medium value given its association with the UK BAP Priority Habitat 'Peat and clay exposures with piddocks'.

140. The remaining identified biotopes are considered as being of low value as they are not specifically designated as requiring protection under national or international law. It should be noted that the determination of value for these biotopes remains the same for the entirety of this assessment.

9.6.1.2.2 Magnitude of Impact – DBS East or DBS West in Isolation

141. Together, installation of the array cabling and inter-platform cabling, turbine and OSP foundations, and vessel jack-up and anchoring will result in a worst-case temporary disturbance of 6.85km² within DBS East and 7.59km² within DBS West (**Table 9-2**). It is worth noting that this disturbance would be episodic, associated with particular locations across the array areas at any one time and occur over the five-year duration of construction, not as a single event. As detailed previously in section 9.5.1.1.2, the biotopes present within the array areas are typical to those found within the wider Dogger Bank and wider North Sea. Given the Dogger Bank SAC itself measures 12,331km² in extent and does not cover the entirety of the Dogger Bank itself, the extent of disturbance within either array area is negligible in the context of the wider available habitat (designated and undesignated), representing only 0.1% of the area of the Dogger Bank SAC.

142. Installation of the offshore export cable corridor will result in a worst case temporary disturbance of 11.6km² for the DBS East, and 19.3km² for DBS West. As with the array areas, disturbance would be localised and episodic and occur over the 5 year duration of construction, not as a single event.

143. Dredged material from sandwave levelling during the construction process will be disposed at a site yet to be determined at the time of writing. This will be equivalent to a worst-case of 100,413,040m³ from across the offshore development area. Such redeposition of dredged material will occur over the course of the entire offshore construction period (between 5-7 years). In addition, disposal will occur over a large area, for example Dogger Bank C and Sofia were granted a disposal licence across the entirety of their respective array areas. As such, it can be expected that redeposition of dredged material for the Projects will be spread out over a large area and thus will settle at a minimal depth over the existing seabed.

144. Previous studies on the potential size of craters left behind after UXO clearance found that, in similar predominantly sandy conditions and water depths to that of the Dogger Bank, in the worst-case the detonation of a German LMB (GC) Ground Mine (Hexanite) would lead to a crater 21.1m in diameter and 3.3m deep (Ordtek, 2018). While such a detonation would lead to a temporary loss of habitat, due to the dynamic nature of the underlying sediment and strong tidal currents within the offshore development area (see section 8.5.7 **Chapter 8 Marine Physical Environment**) craters would be expected to re-fill with sediment over the course of days (see section 8.7.4.10 in **Chapter 8 Marine Physical Environment** for further information on seabed recoverability regarding indentations). In addition, the overall spatial extent of any craters resulting from UXO clearance will be negligible in the context of the habitat present in the Dogger Bank and wider North Sea.

145. Due to the temporary, episodic and relatively localised nature of the impact, recoverability of the receptors and extent of the receptors across the wider region, temporary physical disturbance is considered to be of negligible magnitude.

9.6.1.2.3 Magnitude of Impact – DBS East and DBS West Together

146. Together, installation of the array cabling (and inter-platform cabling in the case of DBS West), turbine and OSP foundations, and vessel jack-up and anchoring will create a worst-case scenario total disturbance of 20.6km² within DBS East and DBS West together. Installation of the offshore export cable corridor will result in a worst case temporary disturbance of 30.9km² for DBS East and DBS West combined.

147. As with the Projects in isolation, this represents a very small portion of the Dogger Bank and wider North Sea, and combined with the temporary nature of the disturbance, is considered to be of negligible magnitude.

9.6.1.2.4 Significance of Effect – DBS East or DBS West in Isolation

148. Due to the negligible magnitude and low to medium sensitivity for the widespread biotopes to each impact pathway for physical disturbance, the effect is considered to be of negligible to minor adverse significance for the majority of biotopes from temporary physical disturbance.

149. However, the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' was identified at five stations within the array areas (two stations in DBS East and three in DBS West). This is a biotope with high sensitivity to temporary physical disturbance. While this biotope was rarely encountered within the survey, and that these stations were all found on the periphery of the array areas, there still exists the potential for temporary physical disturbance to this biotope.

150. As such, the overall significance of effect is assessed to be minor adverse, due to the high sensitivity of 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' and negligible magnitude of the impact. No additional mitigation is proposed due to the negligible to minor adverse significance of effect. The overall confidence in this assessment is medium, based on a balance of confidence levels provided by MarESA (see **Table 9-14**).

9.6.1.2.5 Significance of Effect – DBS East and DBS West Together

151. Due to the negligible magnitude and low to medium sensitivity for the widespread biotopes to each impact pathway for physical disturbance, the effect is considered to be of negligible to minor adverse significance from temporary physical disturbance. No additional mitigation is proposed due to the negligible to minor adverse significance of effect. The overall confidence in this assessment is medium as detailed in section 9.6.1.2.4 above.

9.6.1.3 Intertidal Zone

152. HDD will be used at the landfall so most potential impacts upon the shore will be avoided. However, while the exit pit may be located offshore, there is potential for the HDD exit pit to be within the intertidal zone. As such, there is potential for temporary physical disturbance to occur. As the location of the HDD exit pit will remain the same regardless of the Projects being built in isolation or concurrently, this assessment will cover both build scenarios as one.

9.6.1.3.1 Sensitivity of Receptor

153. As detailed in section 9.5.2, the intertidal survey conducted at the proposed landfall areas for the Projects determined that the intertidal zone was characterised by the biotope '*Barren littoral coarse sand*'.

154. The sensitivity of the biotope identified within the intertidal zone has been assessed in relation to the following MarESA pressures relevant to the construction phase and temporary habitat loss / physical disturbance:

- Habitat structure changes – removal of substratum (extraction)
- Abrasion/disturbance of the surface of the substratum or seabed
- Penetration or disturbance of the substratum subsurface

155. The sensitivity of 'Barren littoral coarse sand' to temporary habitat loss / disturbance pressures is summarised in **Table 9-15** below.

Table 9-15 The Sensitivity of Barren Littoral Coarse Sand to Temporary Physical Disturbance

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Impact pressure pathway: Habitat structure changes – removal of substratum (extraction)				
Barren littoral coarse sand (MA5231)	None	High	Medium	Low
Impact pressure pathway: Abrasion/disturbance of the surface of the substratum or seabed				
Barren littoral coarse sand (MA5231)	High	High	Not Sensitive	Low
Impact pressure pathway: Penetration or disturbance of the substratum subsurface				
Barren littoral coarse sand (MA5231)	High	High	Not Sensitive	Low

156. As shown in **Table 9-15** above, the only pressure for which 'Barren littoral coarse sand' is sensitive to is habitat structure changes – removal of substratum (extraction), for which it has a sensitivity of medium. The biotope is considered to be of negligible value, as it is not specifically designated as habitats requiring protection under national or international law and not considered to be particularly important or rare.

157. From previous evidence of beaches with a similar composition, recoverability is high for this biotope, with recovery from sediment extraction expected to occur within a year (Tillin and Budd, 2016).

9.6.1.3.2 Magnitude of Impact

158. The exact parameters of the HDD exit pit are not yet available. However, given the wide extent of the existing biotope across the north-east coast of England, with the beach stretching for approximately 58km from Bridlington to the mouth of the Humber estuary, any disturbance will be negligible in magnitude in the context of the wider available habitat.

9.6.1.3.3 Significance of Effect

159. With the existing biotope in the intertidal zone having a medium sensitivity in the worst-case and negligible magnitude of the impact, the significance of effect has been assessed as minor adverse. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is low as per Tillin and Budd, 2016.

9.6.1.4 Impact 2 - Increased Suspended Sediment Concentrations

160. Increases in suspended sediment concentrations (SSC) may occur as a result of seabed preparation for the installation of infrastructure in the array areas and offshore export cable corridor. Activities such as seabed disturbances from jack-up vessels and placement of cable protection are not expected to increase suspended sediment concentrations to the extent which there could potentially be a significant effect to benthic ecology receptors. **Chapter 8 Marine Physical Environment** provides details of changes to SSC and subsequent sediment deposition.

161. Increased suspended sediment loads have the potential to affect benthic ecology receptors by causing physical damage or injury, blocking feeding apparatus and by smothering sessile species upon redeposition.

9.6.1.4.1 Sensitivity of Receptor

162. The sensitivity of the biotopes identified in the offshore development area have been assessed in relation to MarESA pressures relevant to construction phase increased SSC and deposition. The relevant pressures are:

- Changes in suspended solids (water clarity); and
- Smothering and siltation rate changes (light).

163. The pressure 'smothering and siltation rate changes (light)' has been used to assess the significance of effect as the MarESA justification for light smothering and siltation is 'up to 5cm' and in **Chapter 8 Marine Physical Environment** the worst-case level sediment smothering and deposition is approximately 10-50mm in localised areas adjacent to foundation installation.

164. The sensitivity of identified biotopes to increased suspended sediment pressures are summarised in **Table 9-16** below.

Table 9-16 The Sensitivity of Biotopes to Increased Suspended Sediments

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Impact pressure pathway: Changes in suspended solids (water clarity)				
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	Medium	High	Low	Low
Circalittoral coarse sediment (MC3) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (MC3211)*	High	High	Not Sensitive	High
Branchiostoma lanceolatum in Atlantic circalittoral coarse sand with shell gravel (MC3215)	High	High	Not Sensitive	Low
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)	Medium	High	Low	Low
Abra prismatica, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (MC5212)	Medium	High	Low	Low
Abra alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (MC5214)	Medium	High	Low	Low
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	High	High	Not Sensitive	Low

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Impact pressure pathway: Smothering and siltation rate changes (light)				
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	High	High	Not Sensitive	High
Circalittoral coarse sediment (MC3) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (MC3211)*	High	High	Not Sensitive	Medium
Branchiostoma lanceolatum in Atlantic circalittoral coarse sand with shell gravel (MC3215)	Low	High	Low	Low
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)	Medium	High	Low	Medium
Abra prismatica, *Bathyporeia elegans* and polychaetes in circalittoral fine sand (MC5212)	Medium	High	Low	Medium
Abra alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (MC5214)	Medium	High	Low	Medium
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	Medium	Medium	Medium	Low

165. The majority of the identified biotopes have a none-to-low sensitivity to the pressures described above. Therefore, these biotopes will not be affected by or recover rapidly from an increase in SSC and subsequent deposition.

166. The exception to this is the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay', which has a medium sensitivity to light smothering and siltation rate changes. This is due to the short length of the siphons (utilised by the characteristic piddock species to maintain contact with the surface of the seabed) being susceptible to smothering (Tillin and Hill, 2016). The piddock species *Pholas dactylus* has been found to be tolerant of deposition depths of 1-5cm (Knight, 1984).

167. As detailed in section 9.6.1.1, the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' is considered to be of medium value, while the remaining biotopes are considered to be of low value.

9.6.1.4.2 Magnitude of Impact – DBS East or DBS West in Isolation

168. As detailed in **Chapter 8 Marine Physical Environment**, regional mapping of seabed sediments indicates the array areas are dominated by sandy sediments and mixed sediment. The seabed sediments of the offshore export cable corridor transition from coarser mixed sediments (sandy gravel and gravelly sand) in the nearshore area to sand-dominated sediments as the offshore export cable corridor approaches the array areas.

169. It is expected that the coarser sediment found along the offshore export cable corridor will settle rapidly to the seabed following disturbance, in close proximity of the disturbance event. The finer sand that comprises the majority of the array areas and easterly extremes of the offshore export cable corridor may stay in suspension within the water column for a longer period of time.

170. Any released fine material will form a plume which would become advected by tidal currents. It is expected that the maximum predicted deposition resulting from a sediment plume will be 10-50mm in localised areas immediately adjacent to the foundation installation area. Outside the area of installation within the array areas or the offshore export cable corridor, deposition reduces to an average of 1-5mm within 10km of the disturbance and is less than 0.5mm within 35km. Over an installation period of 30 days, changes in seabed level induced by deposition of suspended sediment are persistent for a maximum period of seven days within the foundation installation area and reduce within hours to days with distance from the location of disturbance. This conceptual evidence-based assessment is supported by the findings of a review of the evidence base into the physical impacts of marine aggregate dredging on sediment plumes and seabed deposits (Whiteside *et al.* 1995; John *et al.* 2000; Hiscock and Bell, 2004; Newell *et al.* 2004; Tillin *et al.* 2011; Cooper and Brew, 2013).

171. Overall, increases in SSC are expected to be localised and short-term. Fine suspended sediment may be transported a further distance than coarse sediments, however this is likely to be widely and rapidly dispersed and within the range of natural variability within the region.

172. Given the localised and short-term increases in SSC around the point of discharge, and negligible changes in seabed level expected due to deposition, the magnitude of effect is considered to be negligible.

9.6.1.4.3 Magnitude of Impact – DBS East and DBS West Together

173. If both projects are constructed together, the same volume of sediment will be disturbed over the construction phase over a shorter period of time (five-years compared to seven). This may result in higher concentrations of suspended sediment at a single point in time during construction. However, as outlined in **Chapter 8 Marine Physical Environment** and summarised above, suspended sediment concentrations arising from one foundation installation are unlikely to persist for a sufficiently long period of time for them to interact with subsequent operations, and therefore no cumulative effect is anticipated from multiple installations. There does exist the potential for two cable lay operations to be undertaken simultaneously. However, increases in SSC will remain localised and short-term around the point of discharge, and as such the magnitude of effect is still considered to be negligible.

9.6.1.4.4 Significance of Effect – DBS East or DBS West in Isolation

174. The significance of effect for the majority of biotopes is assessed as negligible, due to the negligible magnitude and not sensitive to low sensitivity assessed for these biotopes. The worst-case effect for the biotope 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay' is considered to be of minor adverse significance from increased suspended sediment concentrations, should there be sediment deposition of >50mm (which could only occur in locations immediately adjacent to foundation installation).

175. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is medium (as per MarESA), due to the mix of high, medium and low confidence in assessments for the described biotopes.

9.6.1.4.5 Significance of Effect – DBS East and DBS West Together

176. The same minor adverse significance of effect will apply for both Projects being built together, due to the high recoverability of the biotopes in the array areas and export cable corridors and the short-term and localised nature of sediment disturbance.

177. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is medium (as per MarESA) for the reasons set out for DBS East and DBS West in Isolation .

9.6.1.5 Impact 3 - Remobilisation of Contaminated Sediments

178. Sediment disturbance during construction (e.g. through drilling for foundation installation) could lead to the mobilisation of contaminants within sediment and which could be harmful to the benthos.

9.6.1.5.1 Sensitivity of Receptor

179. The sensitivity of the identified biotopes within the offshore development area to chemical pressures have not been assessed by MarESA . However, the majority of instances of elevated contaminants were located in the vicinity of ST164, where lead and arsenic levels were identified as being above the Canadian SQG TEL. ST164 was characterised by the biotope '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel'.

180. Overall, the evidence for species typical of this biotope indicates a tolerance of low-levels of heavy metal contamination. *Mediomastus fragilis*, a key indicator species for the biotope present at ST164, is considered to be tolerant of contaminated sediments (Dean, 2008). Other species typical of the biotope, such as *O. fusiformis* and *G. lapidum*, are noted as being tolerant of heavy metal contamination (Gibbs *et al.*, 2000, Hiscock *et al*,, 2004).

181. Given the tolerance of species characteristic of the biotope to low levels of heavy metal contamination, the sensitivity has been assessed as negligible.

9.6.1.5.2 Magnitude of Impact – DBS East or DBS West In Isolation

182. As detailed in section 9.5.1.2, overall levels of contaminants were very low across the majority of the offshore development area. This is likely due to the fact that sediment contaminants are typically associated with mud and silt particles, which as detailed in 9.5.1.1.1 have limited distribution within the offshore development area. As they are associated with mud and silt particles, any contaminants will not remain in the water column for a significant length of time, and will not travel a great distance from their point of origin. Any contaminant dispersal will occur at very low levels, given the minimal contaminants identified across the offshore development area, with any dispersal remaining under the significant contaminant level thresholds. Therefore, the magnitude of effect is considered to be negligible.

9.6.1.5.3 Magnitude of Impact – DBS East and DBS West Together

183. The magnitude of effect will remain the same for both Projects built together, due to the minimal findings of elevated sediments identified during the benthic survey campaign. As such, the magnitude of effect is considered to be negligible

9.6.1.5.4 Significance of Effect – DBS East or DBS West in Isolation

184. Due to the negligible magnitude and low sensitivity to the presence of existing contamination, the overall worst-case effect is considered to be of negligible significance from the remobilisation and redeposition of contaminated sediments. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is high due to the evidence of species characteristic of the biotope at ST164 being tolerant of contaminated sediments.

9.6.1.5.5 Significance of Effect – DBS East and DBS West Together

185. The same negligible significance of effect will apply for both Projects being built together. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is low for the reasons detailed in section 9.6.1.5.4.

9.6.1.6 Impact 4 - Underwater Noise and Vibration

186. Underwater noise and vibration from UXO clearance, pile driving for the installation of some foundation types, cable installation and other construction activities including seabed preparation, rock placement and vessel activity (as described in **Chapter 5 Project Description**) have the potential to impact on benthic ecology receptors.

9.6.1.6.1 Sensitivity of Receptor

187. The sensitivity of benthic species to noise and vibration is poorly understood and studies have tended to focus on crustaceans. Studies have shown that some species, such as the common lobster *Homarus gammarus*, are able to detect sound by utilising their hair-fan organ to act as an underwater vibration receptor (Horridge, 1966). Lovell *et al*. (2005) showed that the common prawn *Palaemon serratus* is capable of hearing sounds within a range of 100 to 3,000Hz, and the brown shrimp *Crangon crangon*, has shown behavioural changes at frequencies around 170Hz (Heinisch and Wiese, 1987).

188. Further research into the effects of vibration on common benthic species, such as common hermit crab *Pagurus bernhardus*, found that they exhibited behaviours associated with shell rapping (when a hermit crab rapidly and repeatedly makes contact with the shell of another individual in a series of bouts (Briffa and Elwood, 2000)) as a consequence of vibrations within the sediment (Roberts *et al*., 2016). At high amplitudes, individuals lifted their shells, and some left their shell completely. High amplitudes in the study matched levels within those produced by construction works such as pile-driving, therefore further understanding of the effects of vibration is needed. .

189. Dannheim *et al*. (2020) acknowledge that even though there is evidence to suggest a change in behaviour for some benthic species, the effects of noise and vibration is a priority area for future research as we do not know if changes to population structure and distribution may be affected long term.

190. The sensitivity of biotopes identified in the offshore development area have been assessed in relation to the following MarESA pressures relevant to underwater noise and vibration as a result of construction activities:

- Underwater noise changes

191. There is evidence to suggest that some benthic species perceive and react to noise, however the MarESA sensitivity assessment for all of the biotopes recorded in the offshore development area is that noise impacts are 'Not Relevant'. 'Not Relevant' is recorded where the evidence suggests that there is no direct interaction between the pressure and biotope or characteristic species within. Therefore, the sensitivity of biotopes and species to underwater noise and vibration is considered to be negligible.

9.6.1.6.2 Magnitude of Impact – DBS East or DBS West in Isolation

192. The spatial extent of underwater noise and vibration impacts on benthic receptors is unknown. However, it is likely to be localised to areas in the immediate vicinity of monopile or jacket foundation installation. These installation activities would be intermittent. Therefore, the magnitude of effect from noise and vibration is considered to be low.

9.6.1.6.3 Magnitude of Impact – DBS East and DBS West Together

193. The magnitude of impact for both Projects together will be identical to that of the Projects in isolation, and is therefore considered to be low.

9.6.1.6.4 Significance of Effect – DBS East or DBS West in Isolation

194. Based on the worst-case negligible sensitivity of biotopes and the low magnitude of effects of underwater noise on benthic ecology receptors during the construction phase, the significance of effect is assessed as negligible.

195. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is low, due to the lack of information available on this effect in regard to the species present within the offshore development area.

9.6.1.6.5 Significance of Effect – DBS East and DBS West Together

196. As with the Projects in isolation, the significance of effect is assessed as negligible, and the confidence in assessment is low. No additional mitigation is proposed due to the negligible significance of effect.

9.6.2 Potential Effects During Operation

197. Impacts on the intertidal zone have been scoped out of further assessment in regard it the operational phase of the Projects. This is because HDD will be used to install the cable, ensuring that the cable is buried to a sufficient depth and will not lead to any operation phase impacts. While there exists the potential for the HDD exit pit to be located within the intertidal zone, and therefore some cable trenching may be required in the lower intertidal zone, this will also be buried to a sufficient depth to avoid any impacts during the operational phase. As such no impacts on the intertidal zone will occur.

198. Remobilisation of contaminated sediments has also been scoped out of assessment for the operational stage, due to the minimal presence of elevated contaminants present in the offshore development area, minimal potential for disturbance events during this phase to occur resulting in re-suspension, and negligible sensitivity assessed during the construction phase.

199. In addition, as impacts from underwater noise during the operational phase of the Projects will be of a lesser magnitude than that during the construction phase due to the lack of noisy activities like pile-driving and a reduction in vessel traffic, the significance of effect for underwater noise and vibration during the construction phase will remain negligible.

9.6.2.1 Impact 1 - Temporary Physical Disturbance (Including Sediment Deposition and Smothering)

200. Temporary physical disturbance will occur during the operational phase of the Projects through activities such as cable repairs and reburial, turbine repairs, and potentially the deployment of jack up vessels or vessel anchors. The areas disturbed would be extremely small in comparison to during construction. For this impact, it is considered that there is no difference in the worst case scenario between DBS East and DBS West. As such a single assessment is provided that applies to the entire offshore development area.

9.6.2.1.1 Sensitivity of Receptor

201. The sensitivity of the biotopes identified in the offshore development area have been assessed in relation to MarESA pressures relevant to construction phase temporary physical disturbance, set out in **Table 9-14**.

202. Whilst there is potential for recurring disturbance during maintenance, these impacts would be at discrete locations and times, and it is highly unlikely that the same stretch of cable or turbine would repeatedly fail. Therefore recurring disturbance in the same location is considered highly unlikely. The worst case would be temporary disturbance to the biotopes *'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay'*, which as detailed previously is highly sensitive to penetration or disturbance of the substratum subsurface.

9.6.2.1.2 Magnitude of Impact – DBS East or DBS West in Isolation

203. The impacts from planned maintenance and changes in physical processes would be temporary, localised and small scale and overall there would be less impact than during construction.

204. The area of disturbance will be even smaller than that already detailed in section 9.6.2.1.2 above. A indiscernible, temporary change, over a small area of the receptors is anticipated and therefore the magnitude of this effect is considered to be negligible.

9.6.2.1.3 Magnitude of Impact – DBS East and DBS West Together

205. While the area of disturbance will be larger with both Projects together as opposed to the Projects in isolation, the area of disturbance will still be very small in the context of the extent of the biotopes present across the Dogger Bank and wider North Sea. The magnitude of this effect is considered to be negligible.

9.6.2.1.4 Significance of Effect – DBS East or DBS West in Isolation

206. Based on the worst-case medium sensitivity of biotopes and the negligible magnitude of temporary physical disturbance during the operation phase, the effect is assessed as minor adverse for the offshore development area. This has been reached on the basis that each disturbance activity would occur relatively infrequently, would be localised and temporary and that benthic ecology receptors would recover rapidly.

207. No additional mitigation is proposed due to the minor adverse significance of effect. The overall confidence in this assessment is medium based on a balance of confidence provided by MarESA.

9.6.2.1.5 *Significance of Effect – DBS East and DBS West Together*

208. The same minor adverse significance as detailed for the Projects built in isolation remains applicable for both Projects built together, given the infrequent disturbance activities and localised and temporary nature of any impacts. No additional mitigation is proposed due to the minor adverse significance of effect. The overall confidence in this assessment remains medium.

9.6.2.2 Impact 2 - Long-term Habitat Loss

209. Habitat loss will occur during the lifetime of the projects a result of the presence of foundations, scour and scour protection and external cable protection installed on the seabed.

9.6.2.2.1 *Sensitivity of Receptor*

210. The sensitivity of biotopes identified in the array areas have been assessed in relation to the following MarESA pressure relevant to habitat loss:

- Physical change to another seabed type

211. Installed infrastructure / protection added will be colonised by the some species of the existing epibenthic community (such as more mobile species, hydroids and bryozoans). Though the new hard substrate will differ in character from the existing hard substrate of shell fragments, pebbles and occasional cobbles/boulders, so that replacement of natural surfaces with artificial hard substratum may lead to changes in the biotope through changes in species composition, richness and diversity.

212. The sensitivity of the identified biotopes to habitat loss is summarised in **Table 9-17**.

Table 9-17 The Sensitivity of Biotopes to Physical Change to Another Seabed Type

Receptor	Tolerance	Recoverability	Sensitivity	Confidence Assessment
Impact Pressure Pathway: Physical Change to Another Seabed Type				
Faunal communities of full salinity Atlantic infralittoral sand (MB523) *Proxy used - Infralittoral mobile clean sand with sparse fauna (MC5231)*	None	Very Low	High	High

Receptor	Tolerance	Recoverability	Sensitivity	Confidence Assessment
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	None	Very Low	High	High
Faunal communities of Atlantic circalittoral coarse sediment (MC321) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (MC3211)*	None	Very Low	High	High
Faunal communities of Atlantic circalittoral mixed sediment (MC421) *Proxy used - Mysella bidentata and Thyasira* spp. *in circalittoral muddy mixed sediment (MC4213)*	None	Very Low	High	High
Faunal communities of Atlantic circalittoral sand (MC521) and offshore circalittoral sand (MD521) *Proxy used - Echinocyamus pusillus, Ophelia borealis and Abra prismatica in circalittoral fine sand (MC5211)*	None	Very Low	High	High
Faunal communities of Atlantic circalittoral mud (MC621) *Proxy used - Seapens and burrowing megafauna in circalittoral fine mud (MC6126)*	None	Very Low	High	High

213. As shown in **Table 9-17,** the sensitivity of all benthic ecology biotopes identified within the array areas and offshore export cable corridor to habitat loss is high.

9.6.2.2.2 Magnitude of Impact – DBS East or DBS West in Isolation

214. The estimated area of worst-case habitat loss within the DBS East and DBS West array areas is 3.7km² and 3.9km² respectively, representing 0.75% and 0.79% of each array area and combined only 0.06% of the area of the Dogger Bank SAC. The estimated loss of habitat within the offshore export cable corridor is 1.2km² and 1.9km² for DBS East and DBS West respectively, representing 0.06% and 0.09% of the offshore export cable corridor respectively.

215. Although the effect is long term, with the lifespan of the Projects estimated to be 30 years, as shown above this represents a very small portion of the Dogger Bank and wider North Sea with these biotopes being commonly encountered, with the exception of 'Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay'. Therefore, loss of habitat is considered to be of negligible magnitude in relation to the site and the wider region.

9.6.2.2.3 Magnitude of Impact – DBS East and DBS West Together

216. The estimated area of worst-case habitat loss within both DBS East and DBS West together is 8.3km², representing 0.8% of the combined total array area for the Projects and 0.07% of the overall area of the Dogger Bank SAC. The estimated loss of habitat within the offshore export cable corridor is 3.1km² for both DBS East and DBS West combined, representing 0.15% of the offshore export cable corridor.

217. As with the Projects in isolation, although the effect is long term it is over a negligible percentage of the comparable biotopes within the Dogger Bank and wider North Sea. Therefore, the impact of loss of habitat is considered to be of negligible magnitude in relation to the site and the wider region.

9.6.2.2.4 Significance of Effect – DBS East or DBS West in Isolation

218. While the biotopes identified within the array areas and offshore export cable corridor are considered sensitive to the MarESA pressure 'physical change to another seabed type', given the negligible magnitude of the impact of habitat loss, the significance of effect is assessed as minor adverse.

219. No additional mitigation is proposed due to the negligible significance of effect. The confidence in this assessment is high, in line with MarESA .

9.6.2.2.5 Significance of Effect – DBS East and DBS West Together

220. The significance of effect for both Projects together in regard to long-term habitat loss remains minor adverse, with confidence in the assessment being high. No additional mitigation is proposed due to the negligible significance of effect.

9.6.2.3 Impact 3 - Interactions of EMF (Including Potential Cumulative EMF Effects)

221. There is potential for array cables, inter-platform cables and offshore export cables to produce electromagnetic fields (EMFs) that interfere with the behaviour of benthic species.

222. The effect of EMFs on benthic species has received increasing interest through a variety of studies conducted both in the field and under controlled environments. Boles and Lohmann (2003) found the Spiny lobster *Panulirus argus* use geomagnetic fields to return to known locations after displacement. Similar responses have been found in subsequent studies. Hutchison, Secor and Gill (2020) found the American lobster *Homarus americanus* showed an increase in exploratory response when exposed to EMF from a HVDC cable compared to their natural geomagnetic response. Similarly, Scott, Harsanyi and Lyndon (2018) found *Cancer pagarus* individuals to have a strong attraction to EMF sources.

223. In contrast, Love *et al*. (2015) found that yellow rock crabs *Metacarcinus anthonyu* and red rock crabs *Cancer productus* have shown no preferences for EMF sources. Further support for the findings from Love *et al*. (2017) found no significant differences among fish and invertebrate communities between energised cables, pipe and natural habitat.

9.6.2.3.1 Sensitivity of Receptor

224. The sensitivity of biotopes identified in the offshore export cable corridor and the array areas have been assessed in relation to the MarESA pressure relevant to the impact of EMF:

- Electromagnetic changes

225. There is a lack of evidence as to the impacts of EMF on benthic species. There is a need for further research so understanding can be complete for how EMF impacts the behavioural, physiological and biological aspects of the benthos.

226. The biotopes identified over the entire offshore development area have a MarESA sensitivity of 'Not Relevant' in relation to the impact of EMF. 'Not Relevant' is recorded where the evidence suggests that there is no direct interaction between the pressure and biotope or characteristic species within. Therefore, the sensitivity of biotopes and species to EMF is considered to be negligible.

9.6.2.3.2 Magnitude of impact – DBS East or DBS West in Isolation

227. The presence of increased EMF will last over the entirety of the operational phase for either Project in isolation, however indiscernible alteration to baseline EMF levels is predicted. This is due to the cables being planned to be buried in the seabed (where conditions allow) to a depth of 0.5-1m, a depth at which Love *et al.* (2017) found that EMF levels for submarine power cables declined to background levels. Therefore, the magnitude of the interactions of EMF is considered negligible.

9.6.2.3.3 Magnitude of Impact – DBS East and DBS West Together

228. The presence of increased EMF will last over the entirety of the operational phase of the Projects, however indiscernible alteration to baseline EMF levels is predicted, given attenuation of effects due to cable burial. Therefore, the magnitude of the interactions of EMF is considered negligible.

9.6.2.3.4 Significance of Effect – DBS East or DBS West in Isolation

229. Due to the negligible sensitivity of biotopes present in the offshore cable corridor and interconnector cable, and the negligible magnitude of effect, the overall significance of effect from interactions of EMF is negligible.

230. No additional mitigation is proposed due to the negligible significance of effect. The overall confidence in this assessment is low, due to the lack of information available on the effects of EMF upon the species present within the offshore development area.

9.6.2.3.5 Significance of Effect – DBS East and DBS West Together

231. As for the Projects in isolation, due to the negligible sensitivity of biotopes present in the offshore cable corridor and interconnector cable, and the negligible magnitude of effect, the overall significance of effect from interactions of EMF is negligible, with the confidence in assessment being low. No additional mitigation is proposed due to the negligible significance of effect.

9.6.2.4 Impact 4 - Colonisation of Introduced Substrate, Including Invasive / Non-native Species

232. Artificial hard substrates introduced via infrastructure such as foundations, scour and cable protection could act as potential 'stepping stones' or vectors for invasive/non-native species (INNS).

233. The colonisation of marine fauna on introduced hard substrate has been widely recognised across the southern North Sea. Schrieken *et al*. (2013) found that new species were colonising wrecks around the Dogger Bank and Cleaver Bank regions. Twenty nine species were identified on the wrecks that had not been previously known to reside in the entire Dogger Bank area.

234. The introduction of hard substrate into an open, sandy marine environment such as that of the southern North Sea, could provide a potentially detrimental transition for benthic communities of hard-bottom or intertidal communities (Kerckhof *et al*., 2011).

235. The primary pathway for the potential introduction of INNS is from the use of vessels and infrastructure that has originated from an ecologically different location than the southern North Sea. Though the initial introduction of INNS will most likely be in the construction phase, it has been assessed in the operation phase as all the hard substrate would be installed and establishment of INNS could take place. Therefore, the significance of effect would be greater in this phase.

236. It should be noted that in line with the embedded mitigation measures outlined in section 9.3.3, the risk of spreading INNS during the operation phase will be reduced by employing a range of industry standard biosecurity measures. As such, the risk of introduction of INNS from operational activities for the Projects is limited, with any potential spread of INNS arising from existing species within the Dogger Bank and wider North Sea, such as those found in the site-specific surveys for the Projects (see section 9.5.4).

237. Due to a natural lack of hard substrate in the southern North Sea, many species found in such habitats do not naturally occur across the study area (Cameron and Askew, 2011). However, increasing numbers of wreck, oil and gas rigs, and now offshore wind turbines, may make it possible for more species to successfully colonise and establish communities in sheltered, productive zones.

9.6.2.4.1 Sensitivity of Receptor

238. The sensitivity of biotopes identified in the offshore export cable corridor and the array areas have been assessed in relation to the MarESA pressure :

- Introduction or spread of invasive non-indigenous species.

239. The sensitivity of identified biotopes to increased suspended sediment pressures are summarised in **Table 9-18** below.

Table 9-18 The Sensitivity of Biotopes to Introduction or Spread of Invasive Non-Indigenous Species

Receptor	Tolerance	Recoverability	Sensitivity	Confidence assessment
Impact pressure pathway: Introduction or Spread of Invasive Non-Indigenous Species				
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand (MB523)	High	High	Not Sensitive	High
Circalittoral coarse sediment (MC3) *Proxy used - Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles (MC3211)*	High	High	Not Sensitive	High
Branchiostoma lanceolatum in Atlantic circalittoral coarse sand with shell gravel (MC3215)	High	High	Not Sensitive	High
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel (MC3212)	None	Very Low	High	High
Abra prismatica, Bathyporeia elegans and polychaetes in circalittoral fine sand (MC5212)	None	Very Low	High	High
Abra alba and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment (MC5214)	None	Very Low	High	High
Piddocks with a sparse associated fauna in Atlantic circalittoral very soft chalk or clay (MC1251)	High	High	Not Sensitive	High

240. Of the identified biotopes, four are considered not sensitive to the introduction of INNS, primarily due to the mobile nature of the sediments upon which the biotopes are based preventing INNS from establishing themselves.

241. The three remaining biotopes are considered to be highly sensitive to INNS, in particular the slipper limpet *Crepidula fornicata*, colonial ascidian *Didemnum vexillum* and the whelk *Rapana venosa*, all species which may be able to establish themselves within these biotopes and lead to a reduction in the characteristic bivalve populations or, in the case of *D. vexillum*, smother the existing habitat (Tillin, 2022a, Tillin, 2022b and Tillin and Budd, 2023).

242. It should be noted that there is no existing evidence for the spread of these species being facilitated by offshore wind developments, with *D. vexillum*, for example, typically being spread via shipping and aquaculture activities (Marine Scotland, 2023).

9.6.2.4.2 Magnitude of Impact – DBS East or DBS West in Isolation

243. The risk of spreading INNS will be reduced by employing biosecurity measures in accordance the regulations detailed in **Table 9-3**. As such, the magnitude of effect is negligible.

9.6.2.4.3 Magnitude of Impact – DBS East and DBS West Together

244. As the same regulations will be followed for the construction of both Projects together, the magnitude of effect is still considered to be negligible.

9.6.2.4.4 Significance of Effect – DBS East or DBS West in Isolation

245. As the sensitivity of present biotopes across the offshore development area is high and the magnitude of effect is negligible, the overall significance of effect from the colonisation and introduction of INNS is minor adverse. No additional mitigation is proposed due to the negligible significance of effect. The confidence in this assessment is high.

9.6.2.4.5 Significance of Effect – DBS East and DBS West Together

246. As with the Projects in isolation, the overall significance of effect from the colonisation and introduction of INNS is minor adverse effect, and the confidence in this assessment is high. No additional mitigation is proposed due to the negligible significance of effect.

9.6.3 Potential Effects During Decommissioning

247. A decision regarding the final decommissioning policy is yet to be decided as it is recognised that rules and legislation change over time in line with best industry practice. The decommissioning methodology and programme would need to be finalised nearer to the end of the lifetime of the proposed Projects to ensure it is in line with the most recent guidance, policy and legislation.

248. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in **Chapter 5 Project Description** and the detail would be agreed with the relevant authorities at the time of decommissioning. Offshore, this is likely to include removal of all of the wind turbine components and part of the foundations (those above seabed level), removal of some or all of the array and export cables. Scour and cable protection would likely be left in situ.

249. During the decommissioning phase, there is potential for wind turbine foundation and cable removal activities to cause effects that would be comparable to those identified for the construction phase and the operational phase, specifically:

- Temporary physical disturbance (including sediment deposition and smothering);
- Temporary increase of SSC;
- Remobilisation of contaminated sediments; and
- Underwater noise and vibration.

250. Permanent habitat loss as a result of infrastructure decommissioned in situ is assessed as an operational impact because the impact begins when the operation phase starts when the wind farm infrastructure is in place. The same is true for colonisation of foundations and cable protection.

251. The magnitude of decommissioning effects will be comparable to or less than the construction phase. Accordingly, given that impacts were assessed to be of no greater than minor adverse significance for the identified benthic ecology receptors during the construction phase, it is anticipated that the same would be true for the decommissioning phase.

9.7 Preliminary Assessment of Cumulative Effects

252. As detailed in section 9.4.4 this section presents a preliminary assessment of cumulative effects in relation to benthic and intertidal ecology. The final CEA will be undertaken within the ES chapter.

9.7.1 Initial Screening for Cumulative Effects

253. **Table 9-19** below details the potential cumulative effects that may occur between the Projects and other plans, projects and activities. Only potential impacts assessed in section 9.6 where the potential for cumulative effects has been identified (minor, moderate or major) will be taken forward to the final CEA (i.e. those assessed as 'no impact' are not taken forward as there is no potential for them to contribute to a cumulative impact

Table 9-19 Potential Cumulative Effects

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Construction			
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Yes	High	Temporary physical disturbance from construction activities for nearby projects could result in a cumulative effect on benthic receptors.
Impact 2: Increased suspended sediment concentrations	Yes	High	Increased suspended sediment concentrations from nearby projects could result in a cumulative effect on benthic receptors.
Impact 3: Remobilisation of contaminated sediments	No	High	Due to the very low levels of contaminants identified during surveys for the Projects, no cumulative effects are predicted for the remobilisation of contaminated sediments.
Impact 4: Underwater noise and vibration	Yes	High	Underwater noise generated construction activities for nearby projects could result in a cumulative effect on benthic receptors.

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Operation & Maintenance			
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Yes	High	Temporary physical disturbance from construction activities for nearby projects could result in a cumulative effect on benthic receptors.
Impact 2: Long-term habitat loss	Yes	High	Habitat loss in the Dogger Bank SAC and wider area from nearby plans/projects may result in a cumulative effect on benthic receptors
Impact 3: Interactions of EMF (including potential cumulative EMF effects)	No	High	As the impact from EMF is negligible for the Projects, there will be no cumulative effect.
Impact 4: Colonisation of introduced substrate, including non-native species	Yes	High	Presence of hard substrate from nearby projects could provide a surface for INNS to colonise, resulting in a cumulative effect on benthic receptors.
Decommissioning			
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Yes	High	Plans and projects currently in planning have potential to have cumulative effects due to temporary disturbance from construction activities.
Impact 2: Increased suspended sediment concentrations	Yes	High	Increased suspended sediment concentrations from nearby projects could result in a cumulative effect on benthic receptors.

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Impact 3: Remobilisation of contaminated sediments	No	High	Due to the very low levels of contaminants identified during surveys for the Projects, no cumulative effects are predicted for the remobilisation of contaminated sediments.
Impact 4: Underwater noise and vibration	Yes	High	Underwater noise generated construction activities for nearby projects could result in a cumulative effect on benthic receptors.

9.7.2 Plans/Projects Considered for Cumulative Impacts

254. A high-level list of plans/projects that may result in cumulative effects with the Projects is detailed in **Table 9-20**. For benthic and intertidal ecology, a search distance of 15km from the offshore development area has been used to determine the initial list of projects considered for the CEA.

255. Plans / projects have been assigned a tier level between 1 and 7, based on the most recent guidance (see **Chapter 6 EIA Methodology**). For the full CEA at ES, this high-level list will be reviewed and screened to ensure all relevant plans / projects are considered in the final assessment. All listed plans / projects will be re-examined at ES to ensure each assigned tier remains accurate at the time of writing.

256. Classes of projects that are considered to be part of the baseline conditions for the surrounding area, and therefore these have been have not been the subject of further assessment, include:

- Marine aggregate extraction;
- Oil and gas exploration and extraction;
- Sub-sea cables and pipelines; and
- Commercial shipping.

Table 9-20 High-Level List of Plans/Projects Screened For Further Assessment in the Full CEA

Tier	Plan / Project	Distance to Offshore Development Area (km)
Strategic Plans		
7	East Inshore, North East Inshore, East Offshore and North East Offshore Marine Plans	Within offshore development area
Offshore Wind Farms		
2	Dogger Bank A	7
2	Dogger Bank B	17
3	Dogger Bank C	56
6	Dogger Bank D	68 (estimated)
2	Sofia	34
Carbon Capture and Storage		
3	Northern Endurance CCS	2
7	CCS North Sea Leasing Round – SNS Areas 1 & 3	Within array areas
Subsea Cables		
6	Eastern Link 2 (SEGL2)	2
7	Third Eastern Link HVDC cable (TGDC)*	Crosses offshore export cable corridor
7	Fourth Eastern Link HVDC cable (E4L5)*	Crosses offshore export cable corridor
7	National Grid HND Bootstrap*	Potentially within the array areas

**Cable route not yet finalised*

9.8 Potential Monitoring Requirements

257. Monitoring requirements will be described in the In-Principal Monitoring Plan (IPMP) submitted alongside the DCO application and further developed and agreed with stakeholders prior to construction based on the IPMP and taking account of the final detailed design of the Projects.

258. Due to the use of the Dogger Bank by multiple industries, such as offshore wind, oil and gas extraction and commercial fishing, there exists a large amount of existing data on the habitat and species composition of the Dogger Bank, and by association, the offshore development area.

259. Any monitoring requirements are intended to be focused on any habitats/species where there exists substantial uncertainty regarding their presence and/or the predicted effects on them.

9.9 Transboundary Effects

260. There are no transboundary effects with regard to benthic and intertidal ecology as the offshore development area is located 40km from the economic exclusive zone boundary, which is greater than the 15km ZoI of the Projects. Transboundary effects are therefore scoped out of this assessment and not considered further.

9.10 Interactions

261. The effects identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between effects are presented in **Table 9-21**. This provides a screening tool for which effects have the potential to interact. **Table 9-22** provides an assessment for each receptor (or receptor group) as related to these impacts.

262. Within **Table 9-22** the effects are assessed relative to each development phase to see if multiple effects could increase the significance of the effect upon a receptor. Following this a lifetime assessment is undertaken which considers the potential for effect to affect receptors across all development phases.

Table 9-21 Interactions Between Impacts - Screening

Potential Interactions between Impacts				
Construction				
	Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Impact 2: Increased suspended sediment concentrations	Impact 3: Remobilisation of contaminated sediments	Impact 4: Underwater noise and vibration
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)		Yes	Yes	Yes
Impact 2: Increased suspended sediment concentrations	Yes		Yes	No
Impact 3: Remobilisation of contaminated sediments	Yes	Yes		No
Impact 4: Underwater noise and vibration	Yes	No	No	

Potential Interactions between Impacts				
Operation				
	Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Impact 2: Long-term habitat loss	Impact 3: Interactions of EMF (including potential cumulative EMF effects)	Impact 4: Colonisation of introduced substrate, including non-native species
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)		No	No	No
Impact 2: Long-term habitat loss	No		No	Yes
Impact 3: Interactions of EMF (including potential cumulative EMF effects)	No	No		No
Impact 4: Colonisation of introduced substrate, including non-native species	No	Yes	No	

Potential Interactions between Impacts				
Decommissioning				
	Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Impact 2: Increased suspended sediment concentrations	Impact 3: Remobilisation of contaminated sediments	Impact 4: Underwater noise and vibration
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)		Yes	Yes	Yes
Impact 2: Increased suspended sediment concentrations	Yes		Yes	No
Impact 3: Remobilisation of contaminated sediments	Yes	Yes		No
Impact 4: Underwater noise and vibration	Yes	No	No	

Table 9-22 Interaction Between Impacts - Phase and Lifetime Assessment

Receptor	Highest Significance Level				
	Construction	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Benthic habitats and biotopes	Minor adverse	Minor adverse	Minor adverse	No greater than individually assessed impacts: • Long term habitat loss during operation increases the potential for interactions with other impacts assessed for that phase. • However, all potential effects are non-significant (minor adverse or less) and localised in nature, being restricted to the project ZoI. The majority of effects are also temporary in nature. Together, these factors limit the potential for different impacts to interact within each phase.	No greater than individually assessed impacts: • As with the phase assessment, all potential effects are non-significant and localised in nature, limiting the potential for different impacts to interact across the different phases. • Effects from decommissioning are temporary in nature, limiting their potential to result in a synergistic or greater impact with those considered in other phases

Receptor	Highest Significance Level				
	Construction	Operation	Decommissioning	Phase Assessment	Lifetime Assessment
				• As a result, none of the potential interactions identified with respect to benthic ecology are expected to result in a synergistic or greater significance of effect than those already assessed	

9.11 Inter-relationships

263. For benthic and intertidal ecology, potential inter-relationships between other topics assessed within this PEIR including **Chapter 8 Marine Physical Environment** and **Chapter 10 Fish and Shellfish Ecology**. A summary of the potential inter-relationships between benthic and intertidal ecology and these topics is provided in **Table 9-23**.

Table 9-23 Benthic and Intertidal Ecology Inter-Relationships

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Construction			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	**Chapter 10 Fish and Shellfish Ecology**	This chapter informs **Chapter 10**.	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to indirect impacts on fish and shellfish.
Suspended sediments and deposition	**Chapter 8 Marine Physical Environment**	Impacts as a result of suspended sediment and deposition are assessed in section 9.6.1.4.	Changes in suspended sediment concentrations are assessed in **Chapter 8 Marine Physical Environment**. Changes in suspended sediment concentrations and associated sediment deposition could have potential impacts on benthic habitats and species.

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Re-mobilisation of contaminated sediments	**Chapter 8 Marine Physical Environment**	Re-mobilisation of contaminated sediments during construction is assessed in section 9.6.1.5.	**Chapter 9 Marine Physical Environment** provides an assessment of the potential for contaminants to be present in the study area. Re-mobilisation of contaminated sediments and associated deposition could have potential impacts on benthic habitats and species.
Operation			
Fish and Shellfish – edible crabs, prey resources, nursery and spawning ground	**Chapter 10 Fish and Shellfish Ecology**	This chapter informs **Chapter 10**.	The benthic environment represents a habitat for many fish and shellfish species. Additionally, a number of benthic species are prey for fish and shellfish. Therefore, impacts on benthic ecology can lead to indirect impacts on fish and shellfish.
Suspended sediments and deposition	**Chapter 8 Marine Physical Environment**	Impacts as a result of suspended sediment and deposition are assessed in section 9.6.1.4.	Changes in suspended sediment concentrations are assessed in **Chapter 8 Marine Physical Environment**. Changes in suspended sediment concentrations and associated sediment deposition could have potential impacts on benthic habitats and species.
Decommissioning			
Inter-relationships for impacts during the decommissioning phase will be the same as those outlined above for the construction phase.			

9.12 Summary

264. This chapter has provided a characterisation of the existing environment for benthic and intertidal ecology based on both existing and site specific survey data.

265. Seabed composition across the survey area was predominantly characterised by sand, with gravel comprising the highest proportion of sediment up to 24km from the proposed landfall locations. Minor instances of elevated contaminants were detected primarily around one sample station (ST164), approximately 24km offshore.

266. Of non-native species, 15 individuals of *Goniadella gracilis* were recorded across seven sample stations, with the cryptogenic species *Polydora cornuta* (polychaete) and ascidians of the genus *Molgula* spp. (potentially including *Molgula manhattensis*) were recorded across three sample stations. The INNS recorded are not included in the invasive species England Biodiversity Indicator for 2021.

267. Six biotopes and one habitat were identified across the survey area, with the biotope *Nephtys cirrosa and Bathyporeia spp. in Atlantic infralittoral sand* (MB5233) typifying the majority of survey area. Some of the habitats and biotopes recorded are, or are representative of, UK BAP priority habitats and include '*Subtidal sands and gravel*' and '*Piddocks with Sparse Associated Fauna in Sublittoral Very Soft Chalk or Clay*'. Aggregations of cobbles at 16 stations were evaluated for the potential of Annex I habitat 'Reef' (geogenic). The overall assessment for the aggregations of cobbles was of 'no resemblance' or 'low resemblance' to a stony reef and as such, unlikely to represent Annex I habitat under the current marine nature conservation legislation.

268. The entirety of the intertidal zone for each potential landfall has been classified as the biotope '*Barren littoral coarse sand*' (MA5231).

269. The assessment has established that there will be some minor adverse residual effects during the construction, operation and decommissioning phases of DBS East and DBS West, both in isolation and together. Effects are generally localised in nature, being restricted to the project boundaries and immediate surrounding area.

270. A summary of the significance of effect assessment for benthic and intertidal ecology is provided in **Table 9-24** below.

Table 9-24 Summary of Potential Likely Significant Effects on Benthic and Intertidal Ecology

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Construction						
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Benthic habitats and species within the offshore development area.	Low-High	Negligible	Negligible – Minor Adverse	N/A	Negligible
Impact 2: Increased suspended sediment concentrations		Not Sensitive – Medium	Negligible	Negligible	N/A	Negligible
Impact 3: Remobilisation of contaminated sediments		Low	Negligible	Negligible	N/A	Negligible
Impact 4: Underwater noise and vibration		Negligible	Negligible	Negligible	N/A	Negligible
Operation						

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Benthic habitats and species within the offshore development area.	Low – High	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Impact 2: Long-term habitat loss		High	Negligible	Minor Adverse	N/A	Minor Adverse
Impact 3: Interactions of EMF (including potential cumulative EMF effects)		Negligible	Negligible	Negligible	N/A	Negligible
Impact 4: Colonisation of introduced substrate, including non-native species		Medium	Low	Minor Adverse	N/A	Minor Adverse
Decommissioning						

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 1: Temporary physical disturbance (including sediment deposition and smothering)	Benthic habitats and species within the offshore development area.	Low-High	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse
Impact 2: Increased suspended sediment concentrations		Not Sensitive – Medium	Negligible	Negligible	N/A	Negligible
Impact 3: Remobilisation of contaminated sediments		Low	Negligible	Negligible	N/A	Negligible
Impact 4: Underwater noise and vibration		Negligible	Negligible	Negligible	N/A	Negligible

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