RWE Renewables UK Dogger Bank South (West) Limited

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Dogger Bank South Offshore Wind Farms

Environmental Statement

Volume 7

Chapter 10 – Fish and Shellfish Ecology

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Glossary

Term	Definition
Accommodation Platform	An offshore platform (situated within either the DBS East or DBS West Array Area) that would 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, offshore platforms and array cables would be located. The Array Areas do not include the Offshore Export Cable Corridor or the Inter-Platform Cable Corridor within which no wind turbines are proposed. Each area is referred to separately as an Array Area.
Array cables	Offshore cables which link the wind turbines to the Offshore Converter Platform(s).
Astronomical tide	The predicted tide levels and character that would result from the gravitational effects of the earth, sun, and moon without any atmospheric influences.
Autecology	The interactions of a given species with the surrounding environment that may influence their distribution and abundance.
Baseline	The existing conditions as represented by the latest available survey and other data which is used as a benchmark for making comparisons to assess the impact of the Projects.
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
Construction Buffer Zone	1km zone around the Array Areas and Offshore Export Cable Corridor, and 500m zone around the Inter-Platform Cabling Corridor. Construction vessels may occupy this zone but no permanent infrastructure would be installed within these areas.

Term	Definition
Cumulative effects	The combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor / resource.
Cumulative Effects Assessment (CEA)	The assessment of the combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor/resource.
Cumulative impact	The combined impact of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor / resource.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
Development Scenario	Description of how the DBS East and / or DBS West Projects would be constructed either in isolation, sequentially or concurrently.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the value, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
Electrical Switching Platform (ESP)	The Electrical Switching Platform (ESP), if required would be located either within one of the Array Areas (alongside an Offshore Converter Platform (OCP)) or the Export Cable Platform Search Area.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the

Term	Definition
	EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Fish and Shellfish Ecology Study Area	The Fish and Shellfish Ecology Study Area for the Projects is defined as ICES Rectangles 36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. It covers a total of 26,858km^2, and includes the Offshore Development Area with a minimum buffer distance of 7km.
Habitats Regulations Assessment (HRA)	The process that determines whether or not a plan or project may have an adverse effect on the integrity of a European Site or European Offshore Marine Site.
Impact	Used to describe a change resulting from an activity via the Projects, i.e. increased suspended sediments / increased noise.
In Isolation Scenario	A potential construction scenario for one Project which includes either the DBS East or DBS West array, associated offshore and onshore cabling and only the eastern Onshore Converter Station within the Onshore Substation Zone and only the northern route of the onward cable route to the proposed Birkhill Wood National Grid Substation.
Inter-Platform Cable Corridor	The area where Inter-Platform Cables would route between the DBS East and DBS West Array Areas, should both Projects be constructed.
Inter-Platform Cables	Buried offshore cables which link offshore platforms.
Intertidal	Area on a shore that lies between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS).

Term	Definition
Landfall	The point on the coastline at which the Offshore Export Cables are brought onshore, connecting to the onshore cables at the Transition Joint Bay (TJB) above mean high water.
Landings	Quantitative description of amount of fish returned to port for sale – can be defined in terms of value or weight.
Mean High Water Springs (MHWS)	MHWS is the average of the heights of two successive high waters during a 24 hour period.
Mean Low Water Springs (MLWS)	MLWS is the average of the heights of two successive low waters during a 24 hour period.
National Policy Statement (NPS)	A document setting out national policy against which proposals for NSIPs will be assessed and decided upon.
Nationally Significant Infrastructure Project (NSIP)	Large scale development including power generating stations which requires development consent under the Planning Act 2008. An offshore wind farm project with a capacity of more than 100 MW constitutes an NSIP.
Nearshore	The zone which extends from the swash zone to the position marking the start of the offshore zone (~20 m).
Offshore Converter Platforms (OCPs)	The OCPs are fixed structures located within the Array Areas 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.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, the Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Offshore Export Cable Corridor	This is the area which will contain the Offshore Export Cables (and potentially the ESP) between the Offshore Converter Platforms and Transition Joint Bays at the landfall.

Term	Definition
Projects Design (or Rochdale) Envelope	A concept that ensures the EIA is based on assessing the realistic worst-case scenario where flexibility or a range of options is sought as part of the consent application.
Safety zones	Legislated under the Energy Act 2004, safety zones are rolling buffer areas which protect construction activities by preventing unauthorised vessels from entering their boundary.
Scoping opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.
Scoping report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Sea level	Generally, refers to 'still water level' (excluding wave influences) averaged over a period of time such that periodic changes in level (e.g. due to the tides) are averaged out.
Sequential Scenario	A potential construction scenario for the Projects where DBS East and DBS West are constructed with a lag between the two. Either Project could be built first.
Suspended sediment	The sediment moving in suspension in a fluid kept up by the upward components of the turbulent currents or by the colloidal suspension.
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South offshore wind farms).
Wind turbine	Power generating device that is driven by the kinetic energy of the wind.

Acronyms

Term	Definition
AL1	Action Level 1
BAC	Background Assessment Concentrations
BERR	Department for Business, Enterprise and Regulatory Reform
BGS	British Geological Survey
CEA	Cumulative Effect Assessment
CPUE	Catch per Unit Effort
DBS	Dogger Bank South
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
Defra	Department for Environment Food and Rural Affairs
DESNZ	Department for Energy Security and Net Zero
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EPP	Evidence Plan Process
ES	Environmental Statement
ESP	Electrical Switching Platform
GBS	Gravity Based Structures
HDD	Horizontal Directional Drill

Term	Definition
HFIG	Holderness Fishing Industry Group
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IBTS	International Bottom Trawl Survey
ICES	International Council for the Exploration of the Sea
IFCA	Inshore Fisheries and Conservation Authorities
IHLS	International Herring Larvae Survey
IPMP	In-Principle Monitoring Plan
JNCC	Joint Nature Conservation Committee
LAT	Lowest Astronomical Tide
LW	Landing Weight
MARPOL	International Convention for the Prevention of Pollution from Ships
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MPCP	Marine Pollution Contingency Plan
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OCP	Offshore Converter Platform
PAH	Polycyclic aromatic hydrocarbons
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan

Term	Definition
PLGR	Pre-Lay Grapnel Run
PTS	Permanent Threshold Shift
RMS	Route Mean Squared
SAC	Special Area of Conservation
SEL	Sound Exposure Level
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentration
THC	Total hydrocardons
TTS	Temporary Threshold Shift
UXO	Unexploded Ordnance
VMS	Vessel Monitoring System

10 Fish and Shellfish Ecology

10.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the likely significant effects of the Projects on fish and shellfish 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 in **Volume 7**:

- **Chapter 8 Marine Physical Environment (application ref: 7.8)**;
- **Chapter 9 Benthic Habitats (application ref: 7.9)**; and
- **Chapter 13 Commercial Fisheries (application ref: 7.13)**.

3. Additional information to support the fish and shellfish ecology assessment is included in **Volume 7**:

- **Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**; and
- **Appendix 11-2: Underwater Noise Modelling Report (application ref: 7.11.11.2)**.

10.2 Consultation

4. Consultation with regard to fish and shellfish ecology has been undertaken in line with the general process described in **Volume 7, Chapter 7 Consultation (application ref: 7.7)** and the **Consultation Report (application ref: 5.1)**. The key elements to date include Environmental Impact Assessment (EIA) Scoping, formal consultation on the Preliminary Environmental Information Report (PEIR) under section 42 of the Planning Act 2008 and the ongoing Evidence Plan Process (EPP) via the Fish and Shellfish Expert Topic Group (ETG).

5. The feedback received throughout this process has been considered in preparing the ES. This chapter has been updated following consultation in order to produce the final assessment submitted within the Development Consent Order (DCO) application. **Volume 7, Appendix 10-1 (application ref: 7.10.10.1)**. Provides a summary of the consultation responses received to date relevant to this topic, and details how the comments have been addressed within this chapter.

10.3 Scope

10.3.1 Study Area

6. The Fish and Shellfish Ecology Study Area for Dogger Bank South (DBS) East and DBS West Array Areas is defined as the International Council for the Exploration of the Sea (ICES) rectangles 37F1, 37F2, 38F1 and 38F2 and the Offshore Export Cable Corridor would be located within 36E9, 37E9, 37F0, 37F1, 38F0 and 38F1. ICES Rectangle 36F0 is also included within the Fish and Shellfish Ecology Study Area due to its proximity to the Offshore Export Cable Corridor. The Fish and Shellfish Ecology Study Area covers a total of 26,858km². This Fish and Shellfish Ecology Study Area provides wider regional context to the local fish and shellfish assemblage, whilst also ensuring consideration of any effects that may occur both within and outside of the Offshore Development Area. This includes fish and shellfish spawning and nursery grounds, feeding habitats, and migratory pathways within the region. The Fish and Shellfish Ecology Study Area is presented within **Volume 7, Figure 10-1 (application ref: 7.10.1)**.

10.3.2 Realistic Worst Case Scenario

10.3.2.1 General Approach

7. The realistic worst case design parameters for likely significant effects scoped into the ES for the fish and shellfish ecology assessment are summarised in **Table 10-1**. These are based on the Project parameters described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, which provides further details regarding specific activities and their durations.

8. In addition to the design parameters set out in **Table 10-1**, consideration is also given to the different Development Scenarios still under consideration, and the possible phasing of the construction as set out in sections 10.3.2.2 to 10.3.2.4.

Table 10-1 Realistic Worst Case Design Parameters

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**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 for a total construction period of 7 years. Final overall footprint would be identical to the concurrent design scenario.				
Temporary habitat disturbance and direct damage	**Array Areas** **Total Array Area assessed for ES – 427km²** (349km² for Array Area + 78km² Construction Buffer Zone) **Total area of disturbance within Array Areas – 11,207,499m²** Array and Inter-platform Cables **Maximum area disturbed (trenching + sandwave levelling) – 9,900,000m²** Array cable trench area (325,000m x 20m boulder plough width) – 6,500,000m² Inter-platform cable trench area (115,000m x 20m disturbance width) – 2,300,000m² Maximum seabed area disturbed by sandwave levelling – 1,100,000m² Foundations and Vessel Impacts **Maximum area disturbed (foundations, platforms, vessel jack-up locations and anchoring) – 1,307,499m²** Seabed preparation area for 100 small turbine monopile foundations (including scour protection) – 358,498m² Seabed preparation area for four offshore platforms (monopile foundations), including scour protection – 24,889m²	**Array Areas** **Total Array Area assessed for ES – 434km²** (355km² for Array Area + 79km² Construction Buffer Zone) **Total area of disturbance within Array Areas – 11,517,499m²** Array and Inter-platform Cables **Maximum area disturbed (trenching + sandwave levelling) – 10,210,500m²** Array cable trench area (325,000m x 20m boulder plough width) – 6,500,000m² Inter-platform cable trench area (129,000m x 20m disturbance width) – 2,576,000m² Maximum seabed area disturbed by sandwave levelling – 1,134,500m² Foundations and Vessel Impacts **Maximum area disturbed (foundations, platforms, vessel jack-up locations and anchoring) – 1,307,499m²** Seabed preparation area for 100 small turbine monopile foundations (including scour protection) – 358,498m² Seabed preparation area for four offshore platforms (monopile foundations), including scour protection – 24,889m²	**Array Areas** **Total Array Area assessed for ES – 1,008km²** (874km² for Array Areas and Inter Platform Cabling Area + 134km² Construction Buffer Zone) **Total area of disturbance within Array Areas – 24,924,843m²** Array and Inter-platform Cables **Maximum area disturbed (trenching + sandwave levelling) – 22,309,875m²** Array cable trench area (650,000m x 20m boulder plough width) – 13,000,000m² Inter-platform cable trench area (342,000m x 20m disturbance width) – 6,831,000m² Maximum seabed area disturbed by sandwave levelling – 2,478,875m² Foundations and Vessel Impacts **Maximum area disturbed (foundations, platforms, vessel jack-up locations and anchoring) – 2,614,968m²** Seabed preparation area for 200 small turbine monopile foundations (including scour protection) – 716,966m² Seabed preparation area for eight offshore platforms (monopile foundations), including scour protection – 49,778m²	Construction Buffer Zone measures 1km surrounding each Array Area, and 500m surrounding the Inter Platform Cable Corridor. Construction vessels may occupy this zone but no permanent infrastructure would be installed within these areas. Total area disturbance includes array and inter-platform cable trenching, sandwave levelling, foundation installation and vessel impacts. Figure totals include a mix of large and small turbine parameters to represent an absolute worst case situation. As such covers for a scenario where a mix of small and large turbines are utilised in the build-out of the Projects. Pre-lay grapnel run (PLGR) activities would fall within the area of the cable trench disturbance width of 20m. In situations where a number does not divide equally between DBS East and DBS West (e.g. 113 large turbines), rounded up to higher number (e.g. 57 large turbines as opposed to 56.5). Anchoring events assumes four activities per turbine foundation

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
	Area of seabed contact for vessel jack-up assuming six jack-up locations per turbine (275m² per jack up leg x four legs x six operations per Area of seabed contact for vessel jack-up for all platforms in Array Areas (1,100m² combined leg area x five operations per platform x four offshore platforms) – 22,000m² Anchoring area (116m² area x four anchors per activity x five activities requiring the deployment of anchors x 100 small turbines + four offshore platforms – 242,112m²	Area of seabed contact for 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 Area of seabed contact for vessel jack-up for all platforms in Array Areas (1,100m² combined leg area x five operations per platform x four offshore platforms) – 22,000m² Anchoring area (116m² area x four anchors per activity x five activities requiring the deployment of anchors x 100 small turbines + four offshore platforms) – 242,112m²	Area of seabed contact for vessel jack-up 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 Area of seabed contact for vessel jack-up for all platforms in Array Areas (1,100m² combined leg area x five operations per platform x eight offshore platforms) – 44,000m² Anchoring area (116m² area x four anchors per activity x five activities requiring the deployment of anchors x 200 small turbines + eight offshore platforms) – 484,224m²	installation + one activity for topside installation per turbine. In some instances, the Projects in sequence / concurrently are not double those of the Projects in isolation – for example there is only ever one Accommodation Platform under any design scenario. Final totals are based on the unrounded figures of the above parameters. As such there is a small variation in the total figures stated in the table compared to the figure reached when adding the rounded figures of each parameter.
	Offshore Export Cable Corridor **Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 19,885,242m²** Total offshore cable length per cable – 188km Maximum number of cables required – Two Max. offshore cable length for all cables – 376km *Note – Assumes a worst-case of a separate cable trench for each cable, spaced 50m apart.* Maximum temporary disturbance area for cable installation – 7,510,800m² (based on 376,000m distance x 20m width of temporary disturbance)	**Offshore Export Cable Corridor** **Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 16,985,644m²** Total offshore cable length per cable – 153km Maximum number of cables required – Two Max. offshore cable length for all cables – 306km *Note – Assumes a worst-case of a separate cable trench for each cable, spaced 50m apart.* Maximum temporary disturbance area for cable installation – 6,120,400m² (based on 306,000m distance x 20m width of temporary disturbance)	**Offshore Export Cable Corridor** **Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 36,861,507m²** Total offshore cable length per cable – 188km for DBS East, 153km for DBS West. Maximum number of cables required – Four Max. offshore cable length for all cables – 682km *Note – Assumes a worst-case of a separate cable trench for each cable, spaced 50m apart.* Maximum temporary disturbance area for cable installation – 13,631,200m² (based on 682,000m distance x 20m width of temporary disturbance)	Maximum export cable length assumes worst case that cable circuits are laid and buried in separate trenches rather than bundled. Sandwaves were divided into three categories: small bedforms (maximum height <0.4 m); medium bedforms (maximum height <0.4 m to 0.75 m); and large or very large bedforms (maximum height 5 m), as per the Ashley (1990) bedform classification. The total sandwave levelling volumes were calculated by estimating the profile area of a trenched sandwave (separately for small, medium and large or very large) and multiplying this figure by the estimated worst-case length of each export cable route where bedforms of each classification may be encountered. The separate

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
	Maximum seabed area disturbed by sandwave levelling – 12,282,010m² Maximum total area impacted by anchoring – 22,061m² *Note - 10km stretch along the Offshore Export Cable Corridor <10m Lowest Astronomical Tide (LAT), may require use of anchoring.* Foundation disturbance area for up to one ESP within the Offshore Export Cable Corridor (Gravity Based Structures (GBS) foundations) – 64,871m² Vessel jack-up area for all platforms in Offshore Export Cable Corridor (1,100m² combined leg area x five operations per platform x one offshore platform) – 5,500m²	Maximum seabed area disturbed by sandwave levelling – 10,833,835m² Maximum total area impacted by anchoring – 22,061m² *Note – 10km stretch along the Offshore Export Cable Corridor where water depth is <10m LAT, may require use of anchoring.* Foundation disturbance area for up to one ESP within the Offshore Export Cable Corridor (GBS foundations) – 64,871m² Vessel jack-up area for all platforms in Offshore Export Cable Corridor (1,100m² combined leg area x five operations per platform x one offshore platform) – 5,500m²	Maximum seabed area disturbed by sandwave levelling – 23,115,845m² Maximum total area impacted by anchoring – 44,091m² *Note – 10km stretch along the Offshore Export Cable Corridor <10m LAT, may require use of anchoring.* Foundation disturbance area for up to one ESP within the Offshore Export Cable Corridor (GBS foundations) – 64,871m² Vessel jack-up footprint for all platforms in Offshore Export Cable Corridor (1,100m² combined leg area x five operations per platform x one offshore platform) – 5,500m²	figures for small, medium and large or very large bedforms were then added together and multiplied by the maximum number of offshore export
	Landfall **Total volume of sediment disturbed by exit pits – 1,800m³** No. of exit pits – 3 Size of each exit pit – 20m length x 10m width x 3m depth Volume of displaced sediment per cofferdam – 600m³ **Total volume of sediment disturbed by trenching in the intertidal - 990m³** Maximum temporary disturbance area for cable installation (based on 110m distance x 6m width) – 660m² Depth of cable – 1.5m	**Landfall** **Total volume of sediment disturbed by exit pits – 1,800m³** No. of exit pits – 3 Size of each cofferdam – 20m length x 10m width x 3m depth Volume of displaced sediment per cofferdam – 600m³ **Total volume of sediment disturbed by trenching in the intertidal - 990m³** Maximum temporary disturbance area for cable installation (based on 110m distance x 6m width) – 660m² Depth of cable – 1.5m	**Landfall** **Total volume of sediment disturbed by exit pits – 3,600m³** No. of exit pits – 6 Size of each cofferdam – 20m length x 10m width x 3m depth Volume of displaced sediment per cofferdam – 600m³ **Total volume of sediment disturbed by trenching in the intertidal - 990m³** Maximum temporary disturbance area for cable installation (based on 110m distance x 6m width) – 660m² Depth of cable – 1.5m	Technique for trenchless cable installation is not yet decided, however Horizontal Directional Drilling (HDD) is preferred. Number of exit pits assumes ducts for two power cables, one communications cable for each Project In Isolation Exit pits may be located within the intertidal area or subtidal. Length of trench assumes 160m based on the distance between MHWS and MLWS minus mitigation to place exit pits at least 50m from the toe of the cliff.

	Maximum Parameter			
	DBS East in isolation	DBS West in isolation	DBS West and DBS East concurrently and / or in sequence	Notes and rationale
Increase in local suspended sediment concentrations and sediment settlement; and **Release of sequestered contaminants following sediment disturbance**	**Total displaced sediment across the Offshore Development Area - 39,973,497m³** **Total Displaced sediment during sandwave levelling (Array Cables, Inter-Platform Cables and Export Cables) - 33,567,300m³** Maximum volume of sandwave material to be dredged / relocated for Array Cables and Inter-Platform Cables – 445,500m³ Maximum volume of sandwave material to be dredged / relocated for Export Cables – 33,121,800m³ **Maximum volume of displaced sediment during cable trenching – 6,369,000m³** Array cable – 1,950,000m³ (325,000m length x 6m width x 1m depth) Inter-platform cables – 1,035,000m³ (115,000m length x 6m width x 1.5m depth) Export cables – 3,384,000m³ (376,000m length x 6m width x 1.5m depth) **Maximum volume of drill arisings – 37,197m³** Drill arisings from 57 large wind turbines = 34,382m³ Drill arisings from four offshore platform monopile foundations = 2,815m³	**Total displaced sediment across the Offshore Development Area - 35,664,569m³** **Total Displaced sediment during sandwave levelling (Array Area, Inter-Platform Cabling Corridor and Offshore Export Cable Corridor) - 29,762,372m³** Maximum volume of sandwave material to be dredged / relocated for Array Cables and Inter-Platform Cables – 459,473m³ Maximum volume of sandwave material to be dredged / relocated for Export Cables – 29,302,899m³ **Maximum volume of displaced sediment during cable trenching – 5,865,000m³** Array cable – 1,950,000m³ (325,000m length x 6m width x 1m depth) Inter-platform cables – 1,161,000m³ (129,000m length x 6m width x 1.5m depth) Export cable – 2,754,000m³ (306,000m length x 6m width x 1.5m depth) **Maximum volume of drill arisings – 37,197m³** Drill arisings from 57 large wind turbines = 34,382m³ Drill arisings from four offshore platform monopile foundations = 2,815m³	**Total displaced sediment across the Offshore Development Area - 76,618,434m³** **Total Displaced sediment during sandwave levelling (Array Cables, Inter-Platform Cables and Offshore Export Cable Corridor) – 63,428,644m³** Maximum volume of sandwave material to be dredged / relocated for Array Cables and Inter-Platform Cables – 1,003,944m³ Maximum volume of sandwave material to be dredged / relocated for Export Cables – 62,424,700m³ **Maximum volume of displaced sediment during cable trenching – 13,116,000m³** Array cable – 3,900,000m³ (650,000m length x 6m width x 1m depth) Inter-platform cables – 3,078,000m³ (342,000m length x 6m width x 1.5m depth) Export cable – 6,138,000m³ (682,000m length x 6m width x 1.5m depth) **Maximum volume of drill arisings – 73,790m³** Drill arisings from 113 large wind turbines = 68,160m³ Drill arisings from eight monopile foundations = 5,630m³	Maximum burial depth for Offshore Export Cable and inter-platform cable burial is 1.5m and 1m for array cables. These depths have been assumed across the entire length of the each cable type to determine the worst-case volume of sediment disturbed. 6m trenching width based on worst-case pre-lay ploughing width.
Impacts on fish and shellfish species as a result of noise and	**Array Area** Piling (monopile)	**Array Area** Piling (monopile)	**Array Area** Piling (pin piling)	Various types and sizes of UXO may require clearance over the course of the construction phase.

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
vibration (from piling and UXO clearance only)	Maximum piles per day – 4 Maximum concurrent monopile piling events – 2 Hammer energy – 6,000kJ hammer Duration per monopile – Indicative 320 minutes, up to 8 hours Number of wind turbine monopiles – 100 Monopiles for offshore platforms – 4 UXO Maximum UXO to be cleared in one day – 2 **Offshore Export Cable Corridor** Piling (monopile) Monopile for offshore platforms - 1 Maximum concurrent monopile piling events – 1 UXO Maximum UXO to be cleared in one day – 2	Maximum piles per day – 4 Maximum concurrent monopile piling events – 2 Hammer energy – 6,000kJ hammer Duration per monopile – Indicative 320 minutes, up to 8 hours Number of wind turbine monopiles – 100 Monopiles for offshore platforms – 4 UXO Maximum UXO to be cleared in one day – 2 **Offshore Export Cable Corridor** Piling (monopile) Monopile for offshore platforms - 1 Maximum concurrent monopile piling events – 1 UXO Maximum UXO to be cleared in one day – 2	Maximum pin piles per day – 12 Maximum concurrent pin piling events – 3 Hammer energy – 3,000kJ hammer Maximum pin piles per turbine foundation – 4 Duration per pin pile – Indicative 190 minutes, up to 8 hours Number of wind turbine pin piles – 800 Pin piles for offshore platforms – 56 UXO Maximum UXO to be cleared in one day – 2 **Offshore Export Cable Corridor** Piling (pin piling) Pin piles for offshore platforms - 8 Maximum concurrent piling events – 3 UXO Maximum UXO to be cleared in one day – 2	For In Isolation Scenarios the use of monopiles represents the worst case scenario for noise and vibration as only a maximum of two piling events will occur simultaneously – both within the respective Array Area under construction. The geographical extent of potential underwater noise impacts to fish and shellfish receptors is therefore greater when monopiling when compared to pin piling in this scenario. Monopiling associated with any offshore platforms along the export cable corridor would be undertaken in isolation of other monopiling activities. The concurrent / sequential worst case scenario is represented by pin piling. A maximum of three pin piling events may occur simultaneously in this scenario, with a worst case being represented by one pin pile being installed within each array area and one along the export cable corridor route associated with the offshore platform. This therefore represents the greatest spatial extent of potential underwater noise impact to fish and shellfish receptors.
Reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Areas	**Total Developable Array Area - 349km²** **Total Offshore Export Cable Development Area -376km²**	**Total Developable Array Area - 355km²** **Total Offshore Export Cable Development Area -306km²**	**Total Developable Array Area - 874km²** **Total Offshore Export Cable Development Area - 682km²**	

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
Operation Operating life is currently expected to be 30 years, with a range for consenting purposes of 24-40 years.				
Temporary habitat disturbance and direct damage	**Array Area** Area of 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)* Area of seabed disturbance from array cable repairs over Projects lifetime – **54,000m²** (Nine events x 6,000m² per event) Area of seabed disturbance from inter-platform cable repairs over Projects lifetime – **12,000m²** (Two events x 6,000m² per event) **Offshore Export Cable Corridor** Area of seabed disturbance from export cable repairs 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)* Area of seabed disturbance from array cable repairs over Projects lifetime – **54,000m²** Nine events x 6,000m² per event) Area of seabed disturbance from inter-platform cable repairs over Projects lifetime – **12,000m²** (Two events x 6,000m² per event) **Offshore Export Cable Corridor** Area of seabed disturbance from export cable repairs over Projects lifetime – **30,000m²** (Five events x 6,000m² per event)	**Array Areas** Seabed disturbance from jacking-up activities over Projects lifetime – **613,800m²** (20,460m² per year x 30 year lifespan) Area of seabed disturbance from array cable repairs over Projects lifetime – **102,000m²** (17 events x 6,000m² per event) Area of seabed disturbance from inter-platform cable repairs over Projects lifetime – **36,000m²** (Six events x 6,000m² per event) **Offshore Export Cable Corridor** Area of seabed disturbance from export cable repairs over Projects lifetime – **72,000m²** (12 events x 6,000m² per event)	N/A
Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition	**Array Area** **Total area of habitat loss within the Array Area (foundations, scour protection, cable protection and cable crossings) – 890,879m²** Total worst case turbine foundation area, including scour protection – 311,725m² (100 small turbines x 3,117m² total protection per turbine)	**Array Area** **Total area of habitat loss within the Array Area (foundations, scour protection, cable protection and cable crossings) – 922,971m²** Total worst case turbine foundation area, including scour protection – 311,725 m² (100 small turbines x 3,117m² total protection per turbine)	**Array Areas** **Total area of habitat loss within the Array Areas (foundations, scour protection, cable protection and cable crossings) – 2,053,218m²** Total worst case turbine foundation area, including scour protection – 623,449m² (200 small turbines x 3,117m² total protection per turbine)	N/A

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
	Total worst case offshore platforms foundation area, including scour protection– 21,642m² Total area of array and inter-platform cable protection – 496,212m² (312,900m² array cable protection + 183,312m² inter-platform cable protection) Estimated number of array / inter-platform cable pipeline / cable crossings - 19 Total area of pipeline / cable crossing material (array + inter-platform cables) – 61,300m² **Offshore Export Cable Corridor** **Total area of habitat loss within the Offshore Export Cable Corridor – 1,203,825m²** Total area of export cable protection – 1,000,282m² Total worst case area of scour protection for ESP in Offshore Export Cable Corridor – 56,410m² Estimated number Offshore Export Cable Corridor pipeline / cable crossings – 24 Total area of pipeline / cable crossing material – 147,133m²	Total worst case offshore platforms foundation area, including scour protection – 21,642 m² Total area of array and inter-platform cable protection – 516,004m² (310,500m² array cable protection + 205,504m² inter-platform cable protection) Estimated number of array / inter-platform cable pipeline / cable crossings – 27 Total area of pipeline / cable crossing material (array + inter-platform cables) – 73,600m² **Offshore Export Cable Corridor** **Total area of habitat loss within the Offshore Export Cable Corridor – 992,484m²** Total area of export cable protection – 788,941m² Total worst case area of scour protection for ESP in Offshore Export Cable Corridor – 56,410m² Estimated number Offshore Export Cable Corridor pipeline / cable crossings – 24 Total area of pipeline / cable crossing material – 147,133m²	Total worst case offshore platforms foundation area, including scour protection – 43,285m² Total area of array and inter-platform cable protection – 1,159,884m² (623,400m² array cable protection + 536,484m² inter-platform cable protection) Estimated number of array / inter-platform cable pipeline / cable crossings – 61 Total area of pipeline / cable crossing material (array + inter-platform cables) – 226,600m² **Offshore Export Cable Corridor** **Total area of habitat loss within the Offshore Export Cable Corridor – 2,139,889m²** Total area of export cable protection – 1,789,222m² Total worst case area of scour protection for ESP in Offshore Export Cable Corridor – 56,410m² Estimated number Offshore Export Cable Corridor pipeline / cable crossings – 48 Total area of pipeline / cable crossing material – 294,267m²	
Increase in local suspended sediment concentrations and sediment settlement; and	**Maximum estimated volume of displaced sediment during maintenance activities in the Array Areas – 1,666,500m³** Volume of displaced sediment from array cable repairs over Projects lifetime	**Maximum estimated volume of displaced sediment during maintenance activities in the Array Areas – 1,666,500m³** Volume of displaced sediment from array cable repairs Projects lifetime –	**Maximum estimated volume of displaced sediment during maintenance activities in the Array Areas – 3,345,000m³** Volume of displaced sediment from array cable repairs over Projects lifetime	Jack-up vessel footprint assumes a maximum penetration depth of 5m Cable repairs assume a maximum depth of 2m. The cable is buried 0.5-1.5 but repairs also account for

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
Release of sequestered contaminants following sediment disturbance	– 108,000m³ (Nine events x 12,000m³ per event) Volume of displaced sediment from inter-platform cable repairs - over Projects lifetime – 24,000m³ (Two events x 12,000m³ per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 1,534,500m³ (51,150m³ per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 84,000m³** Volume of displaced sediment from export cable repairs over Projects lifetime – 84,000m³ (seven events x 12,000m² per event)	108,000m³ (Nine events x 12,000m³ per event) Volume of displaced sediment from inter-platform cable repairs - over Projects lifetime – 24,000m³ (Two events x 12,000m³ per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 1,534,500m³ (51,150m³ per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 60,000m³** Volume of displaced sediment from export cable repairs over Projects lifetime – 60,000m³ (Five events x 12,000m² per event)	– 204,000m³ (17 events x 12,000m³ per event) Volume of displaced sediment from inter-platform cable repairs - over Projects lifetime – 72,000m³ (Six events x 12,000m³ per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 3,069,000m³ (102,300m³ per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 144,000m³** Volume of displaced sediment from export cable repairs - over Projects lifetime – 144,000m³ (12 events x 12,000m² per event)	potential additional mobile sand coverage.
Electromagnetic field effects arising from cables.	**Maximum Offshore Export Cable length** 2 x cables of 188km = 376km **Maximum array cable length** 325km **Offshore Export Cable Voltage** Up to 525kV DC **Array Cable Voltage** Up to 132kV **Minimum Burial Depth** 0.5m	**Maximum Offshore Export Cable length** 2 x cables of 153km = 306km **Maximum array cable length** 325km **Offshore Export Cable Voltage** Up to 525kV DC **Array Cable Voltage** Up to 132kV **Minimum Burial Depth** 0.5m	**Maximum Offshore Export Cable length** 682km **Maximum array cable length** 650km **Offshore Export Cable Voltage** Up to 52kV DC **Array Cable Voltage** Up to 132kV **Minimum Burial Depth** 0.5m	Burial would be attempted across the full length of the array and Offshore Export Cables. However, regions without cable burial are possible at transition points for cable crossings, or at regions of hard substrate. At these points cable protection would be utilised.
Reduced fishing pressure within the Array Areas and increased fishing	**Total footprint of infrastructure within the Array Area - 3.72km²** **Total footprint within the Offshore Export Cable Corridor - 1.21km²**	**Total footprint of infrastructure within the Array Area - 3.87km²** **Total footprint within the Offshore Export Cable Corridor -1.93km²**	**Total footprint of infrastructure within the Array Areas - 8.28km²** **Total footprint within the Offshore Export Cable Corridor - 3.14km²**	

	Maximum Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently and / or in sequence**	**Notes and rationale**
pressure outside of the Array Area				
Decommissioning				
No final decision regarding the final decommissioning policy for the offshore project infrastructure including landfall, has yet been made. It is also recognised that legislation and industry best practice change over time. 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. A decommissioning plan for the offshore works would be submitted prior to any decommissioning commencing.				

10.3.2.2 Development Scenarios

9. Following Statutory Consultation high voltage alternating current (HVAC) technology (previously assessed in PEIR) was removed from the Projects' Design Envelope (see **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4)** for further information). As a result, only high voltage direct current (HVDC) technology has been taken forward for assessment purposes. The ES considers:

- Either DBS East or DBS West is built In Isolation (the In Isolation Scenario); or
- DBS East and DBS West are both built either Sequentially or Concurrently.

10. An In Isolation Scenario has been assessed within the ES on the basis that theoretically one Project could be taken forward without the other being built out. If an In Isolation project is taken forward, either DBS East or DBS West may be constructed. As such the offshore assessment considers both DBS East and DBS West In Isolation.

11. In order to ensure that a robust assessment has been undertaken, all Development Scenarios have been considered to ensure the realistic worst case scenario for each topic has been assessed. A summary is provided here, and further details are provided in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

12. The three Development Scenarios to be considered for assessment purposes are outlined in **Table 10-2**:

Table 10-2 Development Scenarios and Construction Durations

Development Scenario	Description	Total Maximum Construction Duration (Years)	Maximum construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
In Isolation	Either DBS East or DBS West is built In Isolation	Five	Five	Four
Sequential	DBS East and DBS West are both built Sequentially,	Seven	A five year period of construction for each project	Construction works (i.e. onshore cable civil works, including duct

Development Scenario	Description	Total Maximum Construction Duration (Years)	Maximum construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
	either Project could commence construction first with staggered / overlapping construction		with a lag of up to two years in the start of construction of the second project (excluding landfall duct installation) – reflecting the maximum duration of effects of seven years.	installation) to be completed for both Projects simultaneously in the first four years, with additional works at the landfall, substation zone and cable joint bays in the following two years. Maximum duration of effects of six years.
Concurrent	DBS East and DBS West are both built Concurrent reflecting the maximum peak effects	Five	Five	Four

13. The In Isolation, Concurrent and Sequential Development Scenarios all allow for flexibility to build out either or both Projects using a phased approach offshore. Under a phased approach the maximum timescales for individual elements of the construction are assessed.

14. 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 lag) are identified and discussed where relevant in section 10.6. For each potential impact, the worst case construction scenario for the In Isolation Scenario and the Concurrent or Sequential Scenario is presented. The worst case scenario presented for the concurrent or Sequential Scenario would depend on which of these is the worst case for the potential impact being considered. The justification for what constitutes the worst case is provided, where necessary, in section 10.6

10.3.2.3 Operation Scenarios

15. Operation scenarios are described in detail in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. The assessment considers the following scenarios:

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

16. 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 **Volume 7, Chapter 5 Project Description (application ref: 7.5)** for further information on phasing scenarios for the Projects.

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

10.3.2.4 Decommissioning Scenarios

18. Decommissioning scenarios are described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. Decommissioning arrangements would 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.

10.3.3 Embedded Mitigation

19. This section outlines the embedded mitigation relevant to the fish and shellfish ecology assessment, which has been incorporated into the design of the Projects (**Table 10-3**) or constitutes standard mitigation measures for this topic. Mitigation is also detailed within the **Volume 8, Commitments Register (application ref: 8.6)** and cross-referenced within **Table 10-3**. Where additional mitigation measures are proposed, these are detailed in the impact assessment (section 10.4).

Table 10-3 Embedded Mitigation Measures

Parameter	Embedded Mitigation Measures	Where commitment is secured
Offshore Export Cable Corridor	The Offshore Export Cable Corridor was selected in consultation with key stakeholders to select a route which minimised impacts on designated sites and ecologically important	DCO Schedule 1

Parameter	Embedded Mitigation Measures	Where commitment is secured
	habitats for fish and shellfish species. See **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4)**.	
Minimise use of scour and external cable protection	Following industry best-practice The Applicants will seek to minimise the use of scour protection and external cable protection for any stretches of unburied cables and cable crossings. This is presented in two Cable Burial Risk Assessments and secured in Cable Protection Plans, produced in line with the detail outlined in the **Volume 8, Cable Statement (application ref: 8.20)** that has been submitted with the DCO application, and in accordance with conditions attached to the Deemed Marine Licences (DMLs) in the **Volume 3, Draft DCO (application ref: 3.1)**. In addition, The Applicants will seek to minimise the use of foundation scour protection. This is presented in the **Volume 8, Outline Scour Protection Plan (application ref: 8.27)** that has been submitted with the DCO application, and in accordance with conditions attached to the DMLs in the **Volume 3, Draft DCO (application ref: 3.1)**.	Scour Protection Plan Cable Statement DML 1 & 2 - Condition 15 DML 3 & 4 - Condition 13 DML 5 - Condition 11
Underwater Noise	No piling activity within the Offshore Export Cable Corridor between the months of August and October to mitigate for disturbance to the Banks population of Atlantic herring via impulsive underwater noise impacts unless otherwise agreed with the relevant stakeholders. The requirement for **Volume 8, Outline Project Environmental Management Plan (PEMP) (application ref: 8.21)** is secured within the **Volume 3, Draft DCO (application ref: 3.1)**. In addition, the relevant DMLs in the Draft DCO include conditions securing this restriction on piling activity.	DML 3 & 4 - Condition 24

Parameter	Embedded Mitigation Measures	Where commitment is secured
Concurrent piling	There will be no concurrent monopile installation for the ESP in the Offshore Export Cable Corridor with the Project Array Areas concurrently.	DML 3 & 4 - Condition 24
Electromagnetic Fields (EMF)	The Applicants are committed to burying offshore export cables to 0.5-1.5m (depending on cable location) where practicable (subject to a cable burial risk assessment (**see Cable Statement (application ref: 8.20)**). 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 (see **Volume 8, Cable Statement (application ref: 8.20)**).	Cable Statement DML 1 & 2 - Conditon 15 DML 3 & 4 - Conditions 13 DML 5 - Condition 11
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. The production of one or more Project Environmental Management Plans (PEMPs) is a Condition of the five Deemed Marine Licences (DMLs). The final PEMP(s) would be in accordance with **Volume 8, Outline PEMP (application ref: 8.21)** and would detail all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed during the different phases of the Projects to minimise the risk of, and effects in, the event of an accidental spill. The final PEMP will identify all potential sources and types of accidental pollution for the relevant project phase and set out the proposed mitigation measures and will be developed in consultation with key stakeholders for approval by the MMO. The individual Projects and phases may	PEMP MPCP DML 1 & 2 - Condition 15 DML 3 & 4 - Condition 13 DML 5 - Condition 11

Parameter	Embedded Mitigation Measures	Where commitment is secured
	require separate final PEMP(s). In addition, separate PEMPs may also be produced for individual packages.	
Safety Zones	One or more applications would be made to DESNZ for Safety Zones post consent including up to 500m around ongoing activities during construction, major maintenance, and decommissioning and up to 50m for installed structures pre commissioning. The application will be made in compliance with MGN654. This would to ensure navigational safety and minimise risk of snagging.	Safety Zone Statement DML 1 & 2 - Condition 18 DML 3 & 4 - Condition 16 DML 5 - Condition 12

10.4 Assessment Methodology

10.4.1 Policy, Legislation and Guidance

10.4.1.1 National Policy Statements

20. The assessment of potential impacts upon fish and shellfish ecology has been made with specific reference to the relevant National Policy Statements (NPS)) including the Overarching NPS for Energy (EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5) (DESNZ, 2023a-c). These were published in November 2023 and were designated in January 2024. The specific assessment requirements for fish and shellfish ecology, as detailed in the NPS, are summarised in **Table 10-4**, together with an indication of the section of this chapter where each is addressed.

Table 10-4 NPS Assessment Requirements

NPS Requirement	NPS Reference	ES section Reference
EN-1 NPS Overarching National Policy Statement for Energy		
The design of Energy NSIP proposals would need to consider the movement of mobile / migratory species such as birds, fish and marine and terrestrial mammals and their	EN-1, section 5.4.22	Migratory fish have been included as a receptor group and assessed for

NPS Requirement	NPS Reference	ES section Reference
potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, DESNZ both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development.		each impact throughout this chapter.
EN-3 NPS for Renewable Energy Infrastructure		
There is the potential for the construction and decommissioning phases, including activities occurring both above and below the seabed, to impact fish communities, migration routes, spawning activities and nursery areas of particular species.	EN-3, section 2.8.138	Construction Phase: sections 10.6.1.1, 10.6.1.2 and 10.6.1.4. Operational Phase: sections 10.6.2.1, 10.6.2.1, 10.6.2.2 and 10.6.2.4. Decommissioning Phase: section 10.6.3.
There are potential impacts associated with energy emissions into the environment (e.g. noise or electromagnetic fields (EMF)), as well as potential interaction with seabed sediments.	EN-3, section 3.8.139	Sections 10.6.1.1; 10.6.1.2; 10.6.1.3; 10.6.2.1; 10.6.2.1; 10.6.2.2; 10.6.2.3; 10.6.1.4; 10.6.2.4; and 10.6.2.4.
The Applicants should identify fish species that are the most likely receptors of impacts with respect to spawning grounds; nursery grounds; feeding grounds; over-wintering areas for crustaceans; migration routes; and protected sites	EN-3, section 3.8.140	Sections 10.6.1.1 and 10.6.2.1.
The Applicants' assessments should identify the potential implications of underwater noise from construction and unexploded ordnance including, where possible, implications of predicted construction and	EN-3, section 3.8.141	Sections 10.6.1.4, 10.6.2.4, and 10.6.2.4

NPS Requirement	NPS Reference	ES section Reference
soft start noise levels in relation to mortality, permanent threshold shift (PTS), temporary threshold shift (TTS) and disturbance and addressing both sound pressure and particle motion and EMF on sensitive fish species.		
The use of external cable protection has been suggested as a mitigation for EMF (by increasing the distance between fish species and individual cables). However, the Secretary of State should also consider any negative impacts from external cable protection on benthic habitats, and a balance between protection of various receptors must be made, with all mitigation and alternatives reviewed.	EN-3, section 3.8.300	Section 10.6.2.4.

10.4.1.2 Other

21. In addition to the NPS, there are a number of pieces of policy and guidance applicable to the assessment of fish and shellfish ecology. These include:

- The Marine Policy Statement (2011) provides high level guidance to ensure that all Marine Plans allow for sustainable usage of marine resources. Included within this guidance is the high level objective stating that marine resources are used in such a way as to ensure their sustainability and health, and the functioning of marine ecosystems and protection of marine habitats and species.
- The East Inshore and East Offshore Marine Plans comprises a number of policies and objectives, some of which are relevant to fish and shellfish ecology.
  - BIO1 states: "*Appropriate weight should be attached to biodiversity, reflecting the need to protect biodiversity as a whole, taking account of the best available evidence including on habitats and species that are protected or of conservation concern in the East marine plans and adjacent areas*". Areas of ecological importance, for example foraging grounds and migration are considered within section 10.5. The conservation status of relevant species are listed within **Volume**

7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2).

  - ECO1 states: "*Cumulative impacts affecting the ecosystem of the East marine plans and adjacent areas (marine, terrestrial) should be addressed in decision-making and plan implementation.*" Cumulative impacts are assessed within section 10.7.
- The North East Inshore and North East Offshore Marine Plan comprise a number of policies, some of which are relevant to fish and shellfish ecology:
  - NE-UWN-1 states: "*Proposals that result in the generation of impulsive sound must contribute data to the UK Marine Noise Registry as per any currently agreed requirements. Public authorities must take account of any currently agreed targets under the Marine Strategy Part One Descriptor 11*".
  - NE-CBC-1 states: "*Proposals must consider cross-border impacts throughout the lifetime of the proposed activity. Proposals that impact upon one or more marine plan areas or terrestrial environments must show evidence of the relevant public authorities (including other countries) being consulted and responses considered*".

22. Further detail is provided in **Volume 7, Chapter 3 Policy and Legislative Context (application ref: 7.3).**

10.4.2 Data and Information Sources

23. Data sources that have been used to inform the assessment are listed in **Table 10-5** as discussed and agreed with stakeholders through the scoping and EPP processes.

Table 10-5 Available Data and Information Sources

Data Set	Spatial Coverage	Year	Notes
MMO (2023)	British Isles	2018-2022	Landings data for species by value and landed weight available for the whole Fish and Shellfish Ecology Study Area: ICES Rectangles 36E9; 36F0; 37E9;

Data Set	Spatial Coverage	Year	Notes
			37F0; 37F1; 37F2; 38F0; 38F1; and 38F2.
North Sea International Bottom Trawl Survey (IBTS) (ICES, 2023a)	North Sea	2012-2022	Data available for ICES Rectangles 36F0, 37E9, 37F0, 37F1, 38F0, and 38F1.
Dogger Bank South Site Investigation **(Volume 7, Appendix 9-3 Benthic Ecology Monitoring Report (application ref: 7.9.9.3)** and **Appendix 9-4 Environmental Features Report (application ref: 7.9.9.4))**	Dogger Bank South Array Areas and export cable routes	2022	Site specific benthic ecology survey utilising grab and drop-down video sampling.
ICES International Herring Larvae Survey (IHLS) data (ICES 2023b)	North Sea	2010-2022	Used to inform potential Atlantic herring habitat within assessment.
Coull *et al.* (1998)	British Isles	1998	Fish spawning and nursery grounds.
Ellis *et al.* (2012)	British Isles	2012	Fish spawning and nursery grounds.
Volume 7, Chapter 13 – Commercial Fisheries (consultation) (application ref: 7.13)	Fish and Shellfish Ecology Study Area and Commercial Fisheries Study Area	2022-2023	Important scallop grounds have been identified within the export cable route and Dogger Bank SAC that have been highlighted within the Fish and Shellfish Ecology Chapter as a key point of note.

10.4.3 Impact Assessment Methodology

24. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** provides a summary of the general impact assessment methodology applied. The following sections describe the methods used to assess the likely significant effects on fish and shellfish ecology.

10.4.3.1 Definitions

25. 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 fish and shellfish ecology assessment are provided in **Table 10-6** and **Table 10-7**.

Table 10-6 Definition of Sensitivity for a Fish and Shellfish Ecology Receptor

Sensitivity	Definition
High	A stock or species of national importance with an inability to adapt to, and limited to no tolerance of, a given effect. The receptor would not be able to make a permanent recovery.
Medium	A stock or species of importance within the North Sea with a limited ability to adapt to, and a limited tolerance of, a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 10 - 25 years. OR A stock or species of national importance with a level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 2 - 10 years.
Low	A stock or species of local importance with a limited ability to adapt to, and a limited tolerance of, a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 10 - 25 years. OR A stock of species of importance within the North Sea with a level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 2 - 10 years. OR A stock or species of national importance with a high level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 2 year.

Sensitivity	Definition
Negligible	A stock or species of national importance, or importance within the North Sea that is entirely tolerant and / or adaptable to a given effect. Following exposure, no change in the receptor population is anticipated. OR A stock or species of local importance with a high level of adaptability and tolerance to a given effect. Following exposure, the receptor population is anticipated to recover to baseline levels within 2 years.

Table 10-7 Definition of Magnitude of Impacts

Magnitude	Definition
High	An irreversible effect that is certain to occur. The effect would result in a change that is outside of the natural variation in background conditions for the given effect.
Medium	A long term (10 - 25 years) effect that is likely to occur. The effect would result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect.
Low	A medium term (2 - 10 years) effect that is likely to occur. The effect would result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect.
Negligible	A short term (0 - 2 years) effect that may occur. The effect would result in a change that is unnoticeable from the natural variation in background conditions for the given effect.

10.4.3.2 Significance of Effect

26. 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 (**Table 10-8**) presented in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)**. Definitions of each level of significance are provided in **Table 10-9**.

27. 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 10-8 Fish and Shellfish Ecology Significance of Effect Matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 10-9 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. This because the receptor contributes 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.

10.4.4 Cumulative Effects Assessment Methodology

28. The Cumulative Effect Assessment (CEA) considers other schemes, plans, projects and activities that may result in significant effects in cumulation with the Projects. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** (and accompanying **Volume 7, Appendix 6-2 Offshore Cumulative Effects Assessment (application ref: 7.6.6.2)**) provides further details of the general framework and approach to the CEA.

29. For fish and shellfish ecology, cumulative effects may occur where receptors also have the potential to be impacted by other consented and / or proposed schemes or activities. This includes consideration of the extent of influence of changes to fish and shellfish populations arising from the Projects alone and those arising from the Projects cumulatively with other schemes.

10.4.5 Transboundary Effect Assessment Methodology

30. The transboundary effect assessment considers the potential for transboundary effects to occur on fish and shellfish ecology receptors as a result of the Projects; either those that might arise within the Exclusive Economic Zone (EEZ) of the European Economic Area (EEA) member states, or arising on the interests of EEA member states e.g. a non UK fishing vessel. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** provides further details of the general framework and approach to the assessment of the transboundary effects.

31. For Fish and Shellfish Ecology, the potential for transboundary effects has been identified in relation to underwater noise and vibration, and is assessed within section 10.9.

10.4.6 Assumptions and Limitations

32. No overarching assumptions or limitations have been identified that apply to the assessment for fish and shellfish ecology. Where routine assumptions have been made in the course of undertaking the assessment, these are noted throughout.

33. No site-specific surveys have been performed specifically for the assessment for fish and shellfish ecology. However, site specific drop-down video data collected primarily for the assessment of benthic ecology baseline assessment has been used to identify fish species present within the region that were not identified within landings data or IBTS data. The assessment has been performed based on desk-based data, including peer-reviewed literature sources and governmental reports.

10.5 Existing Environment

34. This section outlines aspects of the existing environment that influence fish and shellfish ecology within the Fish and Shellfish Ecology Study Area. The existing environment has been informed using the data and information sources outlined in section 10.4.2 and also data presented in other relevant ES chapters.

10.5.1 Offshore Physical Environment

35. The Fish and Shellfish Ecology Study Area is located in the southern North Sea and covers a total area of 26,858km². Water depth within the Study Area decreases from a maximum of 98m offshore, to 0m at the coast (EMODnet, 2023). The minimum and maximum water depths within the Array Areas at the time of the site-specific geophysical survey ranged from 14.2 - 41.8m below the lowest astronomical tide (LAT).

36. The Dogger Bank area is influenced by cool Atlantic water masses originating from the north, and warmer water masses originating from the English Channel to the south. The resulting front where the two distinct water masses meet, named the Flamborough Front, gives rise to turbulence and eddies on both sides of the headland. Within the Fish and Shellfish Ecology Study Area, mean spring tide was highest close to shore, with a maximum of 1.63m/s, and progressively decreased offshore to a minimum of 0.12m/s (BERR, 2008).

37. The Fish and Shellfish Ecology Study Area straddles the 50m contour, which delineates a soft border between the two main fish communities which relate to the deeper northern and shallower southern waters (Harding *et al.*, 1986; Callaway *et al.*, 2002; Reis *et al.*, 2010). The 50m contour also reflects the Flamborough Front, where the thermally stratified waters to the north and the typically permanently mixed waters to the south meet (Brown *et al.*, 1999). The difference in bottom water temperature on either side of the 50m contour boundary (Flamborough Front) was determined by Reis *et al.* (2010) as the most influential environmental variable on demersal fish community structure in the North Sea. The overlap of distribution of the northern and southern fish species around the Flamborough Front may be a contributory factor causing the relatively high species diversity within the Fish and Shellfish Ecology Study Area (Reis *et al.*, 2010).

38. Due to the depth of the DBS Array Areas, and exposure of the Fish and Shellfish Ecology Study Area to nearshore ocean processes, wave energy is relatively high. The most frequent wave movement across the Offshore Development Area originates from the north to north-north-west sector. The nearshore area of the Fish and Shellfish Ecology Study Area is naturally more variable in wave condition, with waves approaching from the north east and consequent net sediment transport predominantly to the south. In general, the annual mean significant wave height within the Fish and Shellfish Ecology Study Area ranges from 0.92m close to shore, to 1.9m offshore (BERR, 2008).

39. Seabed sediments underpin the location of spawning grounds for focal fish species such as sandeel species of *Ammodytes* spp. (hereby referred to as sandeel) and Atlantic herring *Clupea harengus*. Sediments within the Offshore Development Area predominantly comprise sand, with lower components of gravels and fines. The areas of highest proportions of gravel content lie towards the south west corner of the DBS West Array Area, and between approximately KP10 and KP30 of the Offshore Export Cable Corridor as indicated within Figures 4.5 and 4.6 of **Volume 7, Appendix 9-3 Benthic Ecology Monitoring Report (application ref: 7.9.9.3).**

40. Average annual suspended sediment concentrations (SSC) within the Dogger Bank region, including the Fish and Shellfish Ecology Study Area, are characterised by values up to 5mg/l (Cefas, 2016). These may be greater during winter periods as a result of increased turbidity resulting from storm events. Further information regarding the offshore physical environment is detailed in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** of this ES.

10.5.2 Offshore Biological Environment

41. Dogger Bank supports a wide variety of fish and shellfish species, many of which have high commercial importance within the region and have supported significant fisheries for over 300 years (Plumeridge & Roberts, 2017). Recent MMO landings and information outlined in section 10.4.2 identified numerous fish and shellfish species within the Fish and Shellfish Ecology Study Area. Alongside a range of additional sources discussed below, a list of species with likely or known presence within the Fish and Shellfish Ecology Study Area was compiled, and is presented within **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**. Details pertinent to the biology, autecology, behaviour and conservation status are also presented in **Volume 7, Appendix 10-2 (application ref: 7.10.10.2)**. Where certain species have been identified as having similar or identical sensitivities to a given potential impact, they have been grouped within section 10.5.3 (receptor groups). Where individual species are identified as having significant differences in terms of their sensitivities to a given impact, these differences are highlighted, and are considered within the overall assessment of sensitivity for their respective receptor group.

42. Data relating to the spawning and nursery grounds of relevant species has in part been sourced from Coull *et al*. (1998), and Ellis *et al*. (2012). These publications represent the most comprehensive studies of their type to date, and are considered to remain relevant, whilst acknowledging time since publication. A summary of the periods of spawning for species identified as having spawning and nursery grounds near to the Fish and Shellfish Ecology Study Area is presented within **Table 10-10.** For species including sandeel and herring, additional modelling has been undertaken to further verify potential for habitat and spawning grounds.

Table 10-10 Fish species with spawning and nursery grounds (Coull et al., 1998; Ellis et al., 2012) near the Fish and Shellfish Ecology Study Area, alongside information on their spawning periods and whether their spawning and / or nursery ground lie within the study area.

Species	Spawning Period	Spawning Grounds within the Fish and Shellfish Ecology Study Area	Nursery Grounds within the Fish and Shellfish Ecology Study Area
Spurdog	Broadly occurs between January and August	×	✓

Species	Spawning Period	Spawning Grounds within the Fish and Shellfish Ecology Study Area	Nursery Grounds within the Fish and Shellfish Ecology Study Area
Thornback ray	Between February-September	×	×
Tope shark	Mating and parturition occurs during the spring	×	✓
Cod	Winter and beginning of spring	✓	✓
Anglerfish	Between January-June	×	✓
Whiting	Between January-September	✓	✓
Blue whiting	Late winter to early spring	×	✓
Plaice	Between January-March	✓	✓
Sandeel	Between December-January	✓	✓
European hake	Between April-December, with a peak in February-March	×	✓
Ling	Spring	×	✓
Sole	Between May-August, with a peak in May-August	✓	✓
Haddock	Between March-May	×	×
Mackerel	During Summer	×	✓
Herring	Between Autumn and Winter	×	✓

10.5.2.1 Commercial Landings Data

43. Regional landings data were sourced from the MMO and included the most recent five years of data available, ranging from 2018-2022, as published within the MMO landings data (MMO, 2023). This includes data from both national and international fleets, and all gear types. Further, these data are not collected whilst utilising a scientific sampling method. Further information on fishing gear and gear types within the region can be found in **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**.

44. Data were processed to only include landings data from the ICES Rectangles included in the Fish and Shellfish Ecology Study Area (36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2) (10.3.1). Species identified within these landings data are presented within **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.2.2 International Bottom Trawl Survey

45. IBTS data is available for all ICES Rectangles within the Fish and Shellfish Ecology Study Area, with the exception of 36E9. This dataset presents species alongside a catch per unit effort (CPUE) value. This metric acts as a proxy for species abundance. Between 2012 and 2022, 122 species were recorded. Many of these species are of commercial value and are therefore included within the MMO landings data (MMO, 2023) The commercial landings dataset is considered within section 10.5.2.1. The five species with highest mean CPUE value, over surveys undertaken in the 2012-2022 period as recorded within the dataset, are presented in **Table 10-11**. Further, it is likely that pelagic species are underrepresented within this dataset, as a bottom trawl sampling method is used that would naturally target demersal species.

Table 10-11 Species with the highest recorded mean catch per unit effort between 2012-2022 within ICES rectangles 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. (From: North Sea International Bottom Trawl Survey, 2022)

Species	Catch per Unit Effort
European sprat	490.52
Whiting	184.44
Atlantic herring	150.75
Common dab	96.38

Species	Catch per Unit Effort
Atlantic horse mackerel	51.23

46. In addition to commercial species, this dataset also highlights species present within the region, that whilst not commercially valuable, are likely to provide benefit to the wider ecosystem, for example as cornerstone or prey species for other species within the local environment. The top 5 in terms of CPUE species of this type are presented in **Table 10-12**.

Table 10-12 Species with limited to no commercial importance within the North Sea presenting the highest recorded mean catch per unit effort between 2012-2022 within ICES rectangles 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. (From: North Sea International Bottom Trawl Survey, 2022).

Species	Catch per Unit Effort
Lesser weever	15.77
Grey gurnard	9.27
Solenette	7.01
Montagu's seasnail	4.89
American plaice	4.21

10.5.3 Fish and Shellfish Ecology Receptor Groups

47. The fish and shellfish species identified as having a likely presence within the Fish and Shellfish Ecology Study Area can be classified within one of five receptor groups. These receptor groups have been determined based on the similar biological and behavioural traits of the comprising species, resulting in similar or identical sensitivities to impacts identified within this assessment. The following receptor groups would therefore be utilised throughout section 10.6:

- Elasmobranchs;
- Demersal fish;
- Pelagic fish;
- Migratory fish; and
- Shellfish.

48. The baseline information for each of these groups is presented in the following subsections 10.5.3.1-10.5.3.5. Species considered within each of the receptor groups, alongside information on their biology and conservation status can be found in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

49. Due to the specificity of species and impacts associated with underwater noise, this impact is assessed using alternative receptor groups, as described within Popper *et al.* (2014):

- Fish with a swim bladder used in hearing;
- Fish with a swim bladder not used in hearing;
- Fish without a swim bladder; and
- Fish eggs and larvae.

50. The above receptor groups are listed in order of decreasing sensitivity to underwater noise. Species with a swim bladder used in hearing include gadids (e.g. Atlantic cod), European eel, and the clupeids shad and herring. This receptor group is used to determine the worst case scenario assessment for underwater noise impacts. Fish with a swim bladder not used in hearing include Atlantic salmon and sea trout, and fish without a swim bladder include elasmobranchs and pleuronectiforms (Popper *et al.*, 2014). Further, all of the above receptor groups with the exception of fish eggs and larvae exhibit a degree of motility that would allow avoidance or fleeing behaviour. This response would allow for a reduction in exposure to underwater noise.

51. **Table 10-13** indicates key indicative thresholds for mortality and mortal injury, recoverable injury and temporary threshold shift (TTS), relating to underwater noise exposure for fish and shellfish receptors. This table should be considered in combination with **Volume 7, Appendix 11-2 Underwater Noise Modelling Report (application ref: 7.11.11.2)**.

Table 10-13 Key Underwater Noise Thresholds Pertaining to Fish and Shellfish Ecology (SEL_{cum} = Cumulative Sound Exposure Level (SEL) dB re 1μPa^{2}s; SPL_{peak} = Peak Sound Power Level (SPL) dB re 1μPa; RMS = Route Mean Square dB re 1μPa *(From: Popper et al., 2014)*

Underwater Noise: Fish and Shellfish Receptor Group	Noise Source	Mortality and Potential Mortal Injury	Recoverable Injury	Temporary Threshold Shift
Fish with a swim bladder used in hearing	Continuous noise sources	N/A	170dB RMS for 48 hrs	158dB RMS for 12 hrs
	Pile driving	207dB SEL_{cum} > 207dB SPL_{peak}	203dB SEL_{cum} > 207dB SPL_{peak}	186dB SEL_{cum}
	Explosions	229 – 234dB SPL_{peak}	NA	NA
Fish with a swim bladder not used in hearing	Pile driving	210dB SEL_{cum} > 207dB SPL_{peak}	203dB SEL_{cum} > 207dB peak	> 186dB SELcum
	Explosions	229 – 234dB peak	NA	NA
Fish without a swim bladder	Pile driving	> 219dB SELcum > 213 dB peak	> 216dB SELcum > 213dB peak	>> 186dB SELcum
	Explosions	229 – 234dB peak	NA	NA
Fish eggs and larvae	Pile driving	210dB SELcum > 207dB peak	Moderate impact near-field (tens of metres), low impact beyond	Moderate impact near-field (tens of metres), low impact beyond
	Explosions	> 13 mm s-1 peak velocity	NA	NA

52. Guidelines for behavioural responses in fishes are not well defined (Popper & Hawkins, 2019), and multiple strategies have been proposed. In the UK, a species-specific frequency-weighted approach (dB_{ht}) (Nedwell *et al.*, 2007) has been used to assess the effects of anthropogenic sounds on fishes despite the identification of significant flaws, and not having passed peer-review (Hawkins & Popper, 2016; Popper & Hawkins, 2019). The US National Marine Fisheries Service (NMFS), in contrast, uses a single criterion value of 150dB re 1µPa (rms) for disturbance onset (Caltrans, 2015), however the origin and scientific basis of this value is unclear (Hastings, 2008). Furthermore, the use of a single response criteria for all species is not considered to be scientifically accurate, due to the significant variation in response with species, age, motivational state, hearing sensitivity, and whether animals were captive-bred or wild (Neo *et al.*, 2014; Popper & Hawkins, 2019). This weakness in approach is additionally compounded by the fact that most studies have been performed in the laboratory rather than natural environments (Popper and Hawkins, 2019).

53. Popper *et al.* (2014) concluded that it was not possible to define sound exposure criteria for every possible sound source, type of response to the sound, or for every fish species. They therefore developed an approach that groups fish species based on morphology of auditory apparatus and lists threshold values for major potential effects from common major sound sources (see section 10.5.3 above). The resultant interim approach is not definitive but aims to provide a science-based criteria for effects of anthropogenic sound on fishes.

54. The Popper *et al.* (2014) approach is used in this ES chapter for the assessment of injury, however the MMO have additionally advised the use of a 135 dB re 1µPa^{2}s SEL_{ss} single behavioural response threshold for Atlantic herring based on a study that exposed sprat *Sprattus sprattus* to impulsive noise in an enclosed, quiet, coastal sea lough (Hawkins *et al.*, 2014).

10.5.3.1 Elasmobranchs

10.5.3.1.1 Background

55. This receptor group is inclusive of all shark and ray species, including both demersal and pelagic species. This section has been informed using the information outlined in section 10.4.2, supplemented by additional data.

56. The Fish and Shellfish Ecology Study Area is characterised by Sand, gravelly Sand, and sandy Gravel substrates (as classified by Folk (1954), which are less suitable for skates and rays than softer sand and muddy habitats (Martin *et al.*, 2012). Therefore, the areas of Sand substrates within the Fish and Shellfish Ecology Study Area are likely to be most suitable for species of skate and ray.

10.5.3.1.2 Commercial Importance

57. A number of elasmobranch species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- Thornback ray *Raja clavata*; and
- Spotted ray *Raja montagui*.

58. The total catch value of thornback ray and spotted ray within the Fish and Shellfish Ecology Study Area between 2016 and 2020 was approximately £15,533 (10.3 tonnes landing weight (LW)) and £3,345 (2.4 tonnes LW) respectively (MMO, 2023). The remaining elasmobranch species recorded in MMO (2023) landings data are listed in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)** and all valued at <£2,000 in total during the 2018 - 2022 period. Therefore, these species are not considered to be of commercial importance within the Fish and Shellfish Ecology Study Area.

10.5.3.1.3 Spawning and Nursery Grounds

59. As shown in **Volume 7, Figure 10-2 (application ref: 7.10.1)**, a number of elasmobranch species have been identified as having nursery grounds within the Fish and Shellfish Ecology Study Area, these are:

- Spurdog *Squalus acanthias*; and
- Tope shark *Galeorhinus galeus*.

60. No elasmobranch spawning grounds have been identified within the Fish and Shellfish Ecology Study Area. Thornback ray nursery grounds that align with the southern boundary of the Fish and Shellfish Ecology Study Area are present, however there is no direct overlap, and therefore these nursery grounds are not considered within the assessment.

10.5.3.1.4 Conservation Importance

61. There are no elasmobranch species listed as designated features of any MPAs within the region surrounding the Fish and Shellfish Ecology Study Area. However, some species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance. Each species and its conservation status are listed in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**. These species are:

- Common skate *Dipturus batis*;
- Spotted ray;
- Spurdog;

- Thornback ray; and
- Tope shark.

10.5.3.2 Demersal Fish

10.5.3.2.1 Background

62. This receptor group is inclusive of all fish species (excluding elasmobranchs) for which the seabed provides the majority of habitats utilised by species throughout their life history. The full demersal fish species list, including species-specific information on biology and nature conservation status, is presented in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.2.2 Commercial Importance

63. The region between Flamborough head and the Humber Estuary is identified as a hotspot for commercial fishing, with catch rates of demersal fish species higher than any other region along the east-coast of England (Reiss *et al*., 2010). A number of demersal species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- Plaice *Pleuronectes platessa*;
- Turbot *Scophthalmus maximus*;
- Whiting *Merlangius merlangus*;
- Sandeel species *Ammodytidae*;
- Red mullet *Mullus surmuletus*;
- Atlantic cod *Gadus morhua*; and
- Lemon sole *Microstomus kitt*.

64. The demersal fish species above are listed in descending order of the sum of their total catch within the Fish and Shellfish Ecology Study Area between 2018 and 2022 (MMO, 2023) (limited to species of value >£100,000). The total catch value of plaice within the Fish and Shellfish Ecology Study Area between 2018 and 2022 was significantly higher than other demersal fish species, at approximately £4,196,797 (2,502 tonnes LW) (MMO, 2023). Turbot was the second most commercially valuable demersal fish species at approximately £410,638 (70.0 tonnes LW), respectively (MMO, 2023). The remaining demersal fish species of commercial importance are listed within **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.2.3 Spawning and Nursery Grounds

65. As shown in **Volume 7, Figure 10-3** and **Figure 10-4 (application ref: 7.10.1)**, a number of demersal fish species have been identified as having known spawning and nursery grounds within the Fish and Shellfish Ecology Study Area:

- Anglerfish *Lophius piscatorius* (nursery grounds only);
- Atlantic cod;
- Blue whiting *Micromesistius poutassou* (nursery grounds only);
- Dover sole (spawning and nursery grounds);
- European hake *Merluccius merluccius* (nursery grounds only);
- Ling *Molva* (nursery grounds only),
- Plaice (spawning and nursery grounds);
- Sandeel species; and
- Whiting.

66. Additionally European sea bass *Dicentrarchus labrax* have possible nursery grounds within the Humber estuary out to Flamborough Head. Although catches of juvenile European Sea Bass have been made in the region both recreationally and during targeted surveys, not enough evidence has been produced to formally designate a Bass Nursery Area at this time (Cefas, 2018).

67. Particular attention is given to the habitat of sandeel species through this assessment. Sandeel are of high conservation importance due to both their sensitivity to seabed disturbance, and their importance as prey species for bird species present within the region. Sandeel are demersal spawners and their eggs form batches which attach to the seabed, sandeel larvae are planktonic for approximately three months, before settling down into the seabed. Sandeel display a high level of site fidelity and so importance is placed on maintaining suitable habitat, as sandeel spawn in and within the vicinity of the sediments which they inhabit.

68. Potential habitat for sandeel (considering all life stages including spawning habitat) has been assessed for the Fish and Shellfish Ecology Study Area, using the heat mapping methodology described in Latto *et al*. (2013) and utilising known spawning grounds, British Geological Society (BGS) sediment data, Vessel Monitoring System (VMS) fishing data (for vessels utilising demersal fishing gear relating to sandeel species), inshore fishing effort, and Inshore Fisheries and Conservation Authorities (IFCA) data for the east coast indicating fishing catch.

69. The resulting extent of potential habitat for sandeel within the Fish and Shellfish Ecology Study Area is shown in **Volume 7, Figure 10-5 (application ref: 7.10.1)**. It should be noted that whilst this figure has been produced using datasets suitable for the assessment of sandeel habitat, and follows the accepted methodology within Latto *et al.* (2013), limitations associated with the datasets should be acknowledged. These include data vintage, coverage, and accuracy. Should a similar assessment be undertaken using VMS data following 2022, consideration should be given to the reduction in vessel presence within the region as a result of the Dogger Bank SAC Bylaw preventing the use of bottom towed fishing gear within the SAC. Assessments on the potential impacts to sandeel species should continue to utilise the worst case methodology as described within section 10.3.2.

70. **Volume 7, Figure 10-5 (application ref: 7.10.1)** indicates that the Offshore Development Area is considered to have a medium to high habitat potential for sandeel species. The DBS West Array Area is classed as having a high potential for sandeel habitat, with a number of localised areas of medium potential. The DBS East Array Area consists of entirely medium potential for sandeel habitat. The Offshore Export Cable Corridor consists of medium to high habitat potential, with isolated areas of very high habitat potential along the UK 12nm limit boundary. The extents of low, medium, and high potential habitat for sandeel for the Fish and Shellfish Ecology Study Area and the Offshore Development Area are displayed in **Table 10-14**.

71. Additional steps have been taken to verify and confirm the accuracy of the sandeel heat mapping presented in **Volume 7, Figure 10-5 (application ref: 7.10.1)**. Data collected during site specific surveys and presented within **Volume 7, Appendix 9-3 Benthic Ecology Monitoring Report (application ref: 7.9.9.3)** indicates seabed composition within the Offshore Development Area comprises a majority sand and gravel components. This is similarly reflected within the BGS data used to inform the heat mapping methodology. Preferred habitat for sandeel, as classified by Folk (1954), includes Sand, slightly gravelly Sand, and gravelly Sand, with marginal habitat classified as sandy Gravel.

72. To further develop an assessment of current sandeel extent, the sandeel potential heatmap has been overlaid with drop-down video observations of sandeel made during the site-specific benthic surveys, with further details presented within the **Volume 7, Appendix 9-4 Environmental Features Report (application ref: 7.9.9.4)**. Whilst this survey was not undertaken specifically for the assessment of sandeel, these data have been incorporated to increase confidence in the sandeel habitat potential modelling (using the Latto *et al.* (2013) approach) currently accepted by the MMO.

73. Sandeel were observed at 26 out of 104 stations investigated, with sightings largely falling within the area of high habitat suitability potential identified within the DBS West Array Area. All stations where they were observed presented sandy sediment, and no sandeel were observed along the Offshore Export Cable Corridor before KP110 along the western route, or before KP130 along the eastern route. Observations correlated closely with regions of higher sandeel habitat potential indicated within **Volume 7, Figure 10-5 (application ref: 7.10.1)** present in DBS West when compared to DBS East.

74. It is acknowledged that the quantification of available habitat for sandeel presented within **Table 10-14** is based on modelling, and may not represent exact values. Datasets used to inform modelling have been checked for both quality and vintage with the most recently available datasets incorporated, noting that this may not provide an exact representation of current seabed conditions. Values should therefore be considered alongside the site-specific survey results provided, and form a part of a wider assessment.

Table 10-14 Total Area in km² of potential habitat for sandeel across the Offshore Development Area and the Dogger Bank South Array Areas. Percentage of total available habitat across the Offshore Development Area indicated within brackets.

Potential Habitat for Sandeel	Total Area within the Fish and Shellfish Ecology Study Area	Total Area within the Offshore Development Area	Area within DBS West Export Cable Corridor	Area within DBS East Export Cable Corridor	Area within DBS West Array Area	Area within DBS East Array Area
No Potential	373.46	9.12 (2.44%)	5.26 (1.41%)	5.26 (1.41%)	0.00 (0.00%)	0.00 (0.00%)
Low	1948.23	16.18 (0.83%)	8.24 (0.42%)	8.24 (0.42%)	0.00 (0.00%)	0.00 (0.00%)
Medium	14887.60	702.65 (4.72%)	48.11 (0.32%)	80.07 (0.54%)	3.15 (0.02%)	349.06 (2.34%)
High	9292.03	657.53 (7.08%)	98.97 (1.07%)	58.11 (0.63%)	351.58 (3.78%)	0.00 (0.00%)
Very High	356.94	6.92 (1.94%)	3.59 (1.01%)	3.59 (1.01%)	0.00 (0.00%)	0.00 (0.00%)

10.5.3.2.4 Conservation Importance

75. There are no demersal fish species listed as designated features of any MPAs within the region surrounding the Fish and Shellfish Ecology Study Area. However, some species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance, and are listed below. Each species, and its conservation status are listed in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

- Anglerfish;
- Atlantic cod;
- Atlantic halibut *Hippoglossus hippoglossus*;
- Blue whiting;

- European hake;
- Megrim *Lepidorhombus whiffiagonis*;
- Pollock *Pollachius*; and
- Witch flounder *Glyptocephalus cynoglossus*.

10.5.3.3 Pelagic Fish

10.5.3.3.1 Background

76. This receptor group is inclusive of all species in which the water column provides the majority of habitats utilised by species throughout their life history. The full pelagic fish species list, including species-specific information on biology and nature conservation status, is presented in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.3.2 Commercial Importance

77. A number of pelagic species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- Atlantic herring *Clupea harengus*;
- Atlantic mackerel *Scomber scombrus*; and
- Sprat *Sprattus sprattus*.

78. The pelagic fish species above are listed in descending order of the sum of their total catch within the Fish and Shellfish Ecology Study Area between 2018 and 2022 (limited to species of value >£50,000) (MMO, 2023). The total catch value of Atlantic herring within the Fish and Shellfish Ecology Study Area between 2018 and 2022 was significantly higher than other pelagic fish species, at approximately £17,089,880 (26,477 tonnes LW) (MMO, 2023). Mackerel was the second most commercially valuable pelagic fish species at approximately £149,953 (120 tonnes LW) respectively (MMO, 2023). The remaining pelagic fish species of commercial importance are listed within **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.3.3 Spawning and Nursery Grounds

79. As shown in **Volume 7, Figure 10-6 (application ref: 7.10.1)**, a number of pelagic fish species have been identified as having known nursery grounds within the Fish and Shellfish Ecology Study Area:

- Atlantic mackerel; and
- Atlantic herring.

80. Particular attention is given to the spawning and nursey grounds of Atlantic herring throughout this assessment. Atlantic herring are of high conservation importance due to their reliance on specific seabed substrates as spawning habitat, and the vulnerability of developing eggs to seabed disturbance. Potential spawning habitat for Atlantic herring has been assessed for the Fish and Shellfish Ecology Study Area using the heat mapping methodology described in Reach *et al*. (2013), and utilising known spawning grounds, British Geological Society sediment data, VMS fishing data, inshore fishing effort, International Herring and Larvae Survey results, and IFCA data for the east coast indicating fishing catch.

81. Preferred spawning habitat for Atlantic herring, as classified by Folk (1954), includes Gravel and sandy Gravel, with marginal habitat classified as gravelly Sand. Additional steps have been taken to verify and confirm the accuracy of the herring heat mapping presented in **Volume 7, Figure 10-7a (application ref: 7.10.1)**. Data collected during site specific surveys and presented within **Volume 7, Appendix 9-3 Benthic Ecology Monitoring Report (application ref: 7.9.9.3)** indicates seabed composition within the Offshore Development Area comprises majority sand and gravel components. This is similarly reflected within the BGS data used to inform the heat mapping methodology. Preferred habitat for sandeel, as classified by Folk (1954), includes Sand, slightly gravelly Sand, and gravelly Sand, with marginal habitat classified as sandy Gravel.

82. The resulting extent of potential spawning habitat for Atlantic herring within the Fish and Shellfish Ecology Study Area is shown in **Volume 7, Figure 10-7a (application ref: 7.10.1)**. Each of the component layers of the Atlantic herring heatmap are presented within **Volume 7, Figures 10-7b to 10-7g (application ref: 7.10.1)**. Atlantic herring vary in their spawning times between populations, with the Banks population present in the Central North Sea being understood to spawn over the autumn period (Dickey-Collas *et al*., 2010).

83. As shown in **Volume 7, Figure 10-7a (application ref: 7.10.1)**, the Offshore Development Area is considered to have a full range of no, to very high spawning potential for Atlantic herring. The DBS West Array Area is classed as having no to medium potential for Atlantic herring spawning. The DBS East Array Area is predominantly of no spawning potential for Atlantic herring, with the exception of isolated patches of low and medium potential. The Offshore Export Cable Corridor primarily consists of no to high spawning potential, with isolated areas of very high spawning potential along the UK 12nm limit boundary. The extent of low, medium, and high potential habitat for herring for the Fish and Shellfish Ecology Study Area, and the Offshore Development Area are shown in **Table 10-15**.

84. It is acknowledged that the quantification of available spawning grounds for Atlantic herring based on modelling undertaken may not represent an exact value, and values should be considered with a number of caveats in mind. Datasets used to inform modelling have been checked for both quality and vintage with the most recently available datasets incorporated, noting that this may not provide an exact representation of current seabed conditions. Whilst Atlantic herring are known to return to a broad area on an annual basis, the exact location of spawning activity varies, with spawning events not likely to occur across the full extent of the known area but rather in discrete locations within the broad area.

Table 10-15 Total Area in km² of potential spawning ground for Atlantic herring across the Offshore Development Area and the Dogger Bank South Array Areas. Percentage of total available potential spawning ground across the Offshore Development Area indicated within brackets.

Potential Spawning Habitat for Atlantic herring	Total Area within:		Area within:			
	Fish and Shellfish Ecology Study Area	Offshore Development Area	DBS West Export Cable Corridor	DBS East Export Cable Corridor	DBS West Array Area	DBS East Array Area
No Potential	8920.47	742.75 (8.33%)	35.18 (0.39%)	69.86 (0.78%)	74.30 (0.83%)	275.94 (3.09%)
Low	6714.25	361.87 (5.39%)	50.78 (0.76%)	7.71 (0.11%)	160.27 (2.39%)	72.64 (1.08%)
Medium	7209.33	204.39 (2.84%)	34.79 (0.48%)	34.28 (0.48%)	120.15 (1.67%)	0.48 (0.01%)
High	3551.5	60.99 (1.72%)	31.91 (0.90%)	31.91 (0.90%)	0.00 (0.00%)	0.00 (0.00%)
Very High	462.71	22.40 (4.84%)	11.51 (2.49%)	11.51 (2.49%)	0.00 (0.00%)	0.00 (0.00%)

10.5.3.3.4 Conservation Importance

85. There are no pelagic fish species listed as designated features of any MPAs within the region surrounding the Fish and Shellfish Ecology Study Area. However, some species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance. Each species and its conservation status are listed in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**. These species are:

- Albacore Thunnus alalunga;
- Atlantic bluefin tuna *Thunnus thynnus*[1];
- Atlantic herring;
- Atlantic horse mackerel *Trachurus trachurus*; and
- Ocean sunfish *Mola*.

10.5.3.4 Shellfish

10.5.3.4.1 Background

86. This receptor group is inclusive of all shellfish species that are commercially important and have not been assessed alongside other benthic invertebrates within **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)**. The full shellfish species list, including species-specific information on biology and nature conservation status, is presented in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.4.2 Commercial Importance

87. A number of shellfish species of commercial importance within the Humber region are considered present within the Fish and Shellfish Ecology Study Area, including, but not limited to:

- European lobster *Homarus gammarus*;
- Brown crab *Cancer pagurus*;

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[1] Atlantic bluefin tuna have been absent from historical North Sea feeding grounds during the mid-20th century, however evidence suggests this species is reappearing within the North Sea and along UK coastlines (Bennema, 2018; Horton *et al*., 2021). It has therefore been included as a species with potential presence within the Fish and Shellfish Ecology Study Area.

- King scallops *Pecten maximus* and queen scallops *Aequipecten opercularis*;
- Common whelk *Buccinum undatum*; and
- Norway lobster *Nephrops norvegicus*.

88. The shellfish species above are listed in descending order of the sum of their total catch within the Fish and Shellfish Ecology Study Area between 2018 and 2022 (limited to species of value >£1,000,000) (MMO, 2023). The total catch value of European lobster within the Fish and Shellfish Ecology Study Area between 2018 and 2022, was the most commercially valuable shellfish species (and general fish and shellfish species), at approximately £52,949,596 (3,493 tonnes LW) (MMO, 2023). Brown crab was the second most commercially valuable shellfish species, at approximately £48,735,645 (23,113 tonnes LW) respectively (MMO, 2023). The introduction of the Dogger Bank SAC Byelaw in 2022 prohibits demersal trawling activities within the vast majority of the DBS Array Areas. However, there is a notable king scallop ground located within the Offshore Export Cable Corridor that is targeted by dredging vessels (Figure 2.6-10 located in **Volume 7, Appendix 13-2 Commercial Fisheries Technical Report (application ref: 7.13.13.2)**). For more information see **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**. The remaining shellfish species of commercial importance are listed within **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

89. The shellfish receptor group is of the highest commercial importance compared to the other fish receptor groups within the Fish and Shellfish Ecology Study Area.

90. The Holderness Fishing Industry Group (HFIG) has supported a number of peer reviewed studies on shellfish interactions with offshore developments within the region. Sampling undertaken during the pre and post construction stages of the Westermost Rough OWF is described within Roach *et al.* (2022) on behalf of HFIG. Potting surveys conducted over a 6-year period indicated that differences in size and catch rates of European lobster were not observed between control sites and sites within both the array and export cable areas, noting differences in habitat type between the Westermost Rough OWF and control sites.

10.5.3.4.3 Spawning and Nursery Grounds

91. Due to the general site fidelity of shellfish species identified as present within the Fish and Shellfish Ecology Study Area, acknowledging that some shellfish (primarily cephalopod and crustacean species) undergo annual spawning migrations, all species are assumed to have spawning grounds within the Fish and Shellfish Ecology Study Area for the purposes of this assessment.

10.5.3.4.4 Conservation Importance

92. Ocean quahog *Arctica islandica* are listed as designated features of the Holderness Offshore Marine Conservation Zone (MCZ) within the region surrounding the Fish and Shellfish Ecology Study Area. European spiny lobster *Palinurus elephas* is also identified as present within the Fish and Shellfish Ecology Study Area and considered to be of conservation importance, as listed in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.5 Migratory Fish

10.5.3.5.1 Background

93. This receptor group is inclusive of all diadromous species that transition between marine and freshwater environments during their life history. Diadromous fish are subcategorised as either catadromous (spawn in marine environments, e.g. European eel *Anguilla anguilla*) or anadromous (spawn in freshwater environments, e.g. salmonid species). It is therefore important to determine the importance of river outlets within the vicinity of the Projects, and ensure that potential disruption to migration routes is considered. Catadromous fish species identified as potentially present within the Fish and Shellfish Ecology Study Area are limited to European eel, which migrate from UK freshwater environments to the Sargasso Sea. The Humber Estuary presents one of the furthest distances for individual European eel to migrate, and may be the reason why the population within the Anglian region is considered low in number (Defra, 2010). It is expected that the more common anadromous migratory fish species remain within coastal waters during life stages involving the marine environment, and therefore migratory species are considered to have greater presence within the Offshore Export Cable Corridor, than the DBS Array Areas. The full migratory fish species list, including species-specific information on biology and nature conservation status, is presented in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**.

10.5.3.5.2 Commercial Importance

94. The only migratory fish species of commercial importance within the Fish and Shellfish Ecology Study Area is sea trout *Salmo trutta*, noting that landings of Atlantic salmon, *Salmo salar* were also present within the landings data (MMO, 2023).

10.5.3.5.3 Migration, Spawning and Nursery Grounds

95. Due to the diadromous aspect of species within this receptor group, the Fish and Shellfish Ecology Study Area is unlikely to represent major spawning grounds. If anadromous species were to spawn within Fish and Shellfish Ecology Study Area, this is likely to be limited to the Offshore Export Cable Corridor, within the inshore coastal waters.

96. European eel, salmonids, river lamprey *Lampetra fluviatilis*, and sea lamprey are found within the Humber estuary, during their seasonal migrations within the marine environment (Potts & Swaby, 1993). Little is known about the direction of travel of individuals upon leaving the mouth of the Humber estuary, therefore it has been assumed that all species regularly transit through the Offshore Export Cable Corridor associated with the Projects.

10.5.3.5.4 Conservation Importance

97. Sea lamprey *Petromyzon marinus* and river lamprey are listed as a designated feature of the Humber Estuary SAC, within the region surrounding the Fish and Shellfish Ecology Study Area.

98. A total of six species identified as present within the Fish and Shellfish Ecology Study Area are considered to be of conservation importance, and are listed within the Habitats Directive. Each species and its conservation status are listed in **Volume 7, Appendix 10-2 Fish and Shellfish Ecology Technical Appendix (application ref: 7.10.10.2)**. These species include:

- Allis shad *Alosa*;
- Twaite shad *Alosa fallax*;
- Atlantic salmon;
- European eel;
- River lamprey *Lampetra fluviatilis*; and
- Sea lamprey.

10.5.4 Future Trends

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

100. All fish and shellfish species identified within the Fish and Shellfish Ecology Study Area fundamentally depend on the existing offshore physical environment. Future changing baseline parameters such as temperature, salinity, and pH, as a result of climate change have the potential to alter interactions described within the Fish and Shellfish Ecology chapter.

101. The determinations made within this assessment are unlikely to significantly differ as a result of climate change. However, it is acknowledged that a shift in baseline species towards those more commonly found along the south coast of England (e.g. Atlantic bluefin tuna), may potentially be present currently or within the foreseeable future, unless the current rate of climate change is curtailed. The full assessment of a baseline shift over the foreseeable future is not possible within the scope of this assessment.

102. 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, impacts from fishing will be significantly reduced as long as the byelaw remains in place.

103. In addition, in January 2024 Defra announced that the UK government had decided to prohibit the fishing of sandeels within English waters of ICES Area 4 (North Sea) effective from March 2024.[2]

[2] https://www.gov.uk/government/consultations/consultation-on-spatial-management-measures-for-industrial-sandeel-fishing/outcome/government-response

10.6 Assessment of Significance

104. Impacts scoped in and out of this assessment are presented within **Table 10-16**. These decisions were determined at the scoping stage, with adjustments made following the receipt of feedback from stakeholders post-scoping.

Table 10-16 Impacts scoped in and out of assessment

Potential Impact	Construction	Operation	Decommissioning
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	✓	✓	✓
Impact 2: Increase in local suspended sediment concentrations and sediment settlement.	✓	✓	✓
Impact 3: Release of sequestered contaminants following sediment disturbance.	✓	✓	✓
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.	✓	✓	✓
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area	✓	✓	×
Impact 6: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.	×	✓	×
Impact 7: EMF effects arising from cables.	×	✓	×
Pollution events resulting from the accidental release of pollutants.	Scoped Out		

105. Pollution events resulting from the accidental release of pollutant were scoped out of assessment at the scoping stage, as agreed with the MMO. The risk of pollutant release would be managed via the production of a Project Environmental Management Plan (PEMP), note **Volume 8, Outline PEMP (application ref: 8.21)** has been submitted with the DCO application and would include details on marine pollution and associated contingency plans. Chemicals to be used during offshore operations would be approved under the Offshore Chemical Regulations 2002. Should a spill occur it is likely that pollutants would disperse rapidly, and quickly undergo degradation, leading to a subsequent reduction in potential impact.

10.6.1 Potential Effects During Construction

10.6.1.1 Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds

106. Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, referred hereafter as "temporary habitat disturbance and direct damage", may occur during the construction phase due to seabed preparation works and / or installation of project infrastructure. Direct damage (e.g. crushing) and disturbance during the construction phase can be considered as the instantaneous loss of individuals though crushing, or entrainment by construction activities and tools. Seabed preparation and sandwave levelling are considered due to the potential micro-environments associated with small-scale seabed morphology that may represent preferred spawning grounds for fish species.

107. Whilst the impacts of foundation installation, and scour and cable protection would occur in the first instance during the construction phase, these impacts are considered permanent loss of habitat within this assessment. As these impacts are considered to last throughout the operation phase of the Project, they have been considered within section 10.6.2.1., however, it should be noted that these impacts would start from the moment installation occurs, which would be within the construction phase.

108. It should be noted that this impact would occur episodically and be highly localised to the individual locations of construction or installation over the full duration of the construction period, not as a single event. The worst cases presented below represent the combined footprints from all construction or installation events.

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

109. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS East is approximately 31km². This represents approximately 0.11% of the Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the array and Inter-Platform Cables, and offshore platforms and foundations, is 11.2km² for DBS East. The footprint for the construction of all transmission assets, including the Offshore Export Cable installation, is 19.8km².

110. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS West is 28.5km². This represents approximately 0.10% of the total Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the DBS West Array Area, and Inter-Platform Cables, and offshore platforms, is 11.5km². The footprint for the construction of all transmission assets, including the Offshore Export Cable installation, is 17.0km².

111. Of the two Projects, DBS East represents the worst case scenario in isolation. The assessment of temporary habitat disturbance and direct damage in isolation therefore assumes this worst case scenario for both Projects.

112. Due to the mobile nature and high fecundity of all fish and shellfish receptor groups, exposure is considered to be short-term for any given location within the DBS West Array Area The loss of individuals as a result of temporary habitat disturbance and direct damage would be a medium term (2 - 10 years) effect that is likely to occur, accounting for the worst case scenario footprint. The effect would result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.1.1.2 Magnitude of Impact – DBS East and DBS West Together

113. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of the Projects is 61.8km². This represents approximately 0.23% of the total Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the Array Areas, array and Inter-Platform Cables, and offshore platforms, is 25km². The footprint for all offshore transmission works, including the Offshore Export Cable installation, is 36.8km².

114. The magnitude of temporary habitat disturbance and direct damage may be reduced if construction of DBS East and DBS West is staggered compared to being undertaken concurrently for the full construction period. This approach would result in a construction overlap of three years, during which time the impact of fish and shellfish ecology receptors may be greatest. This is due to the potential for local populations to be displaced into the Array Area not under construction, and then recolonisation of the disturbed Array Area upon commencement of construction of the second Array Area. Spill-over effects are more successful for multiple localised disturbance areas compared to single, large areas. If concurrent, local populations would be displaced from a greater area, which would take longer to recover upon completion of the construction phase.

115. Due to the mobile nature and high fecundity of receptor groups, exposure is considered to be short-term for any given position within the DBS West Array Area. Temporary habitat disturbance and direct damage from the combined Array Areas would be higher than the worst case for an individual Array Area, but the effect would still be anticipated to not exceed a medium term (2 - 10 years), accounting for the worst case scenario footprint. The effect would result in a change that is noticeable but remains within the natural variation in background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.1.1.3 Sensitivity of Receptor Groups

116. Elasmobranch species are generally considered to have a high tolerance and adaptability to temporary habitat disturbance and direct damage due to their high mobility. Elasmobranchs may be affected by the Projects through direct effects (e.g. crushing), but may also be indirectly affected through impacts to prey species. Prey species are typically bound by the specific habitats and spatial locations in which they reside; whereas elasmobranchs have relatively large ranges that provide a degree of flexibility, should prey species become less prevalent in certain areas. Elasmobranch species have a level of tolerance to the temporary habitat disturbance and direct effects, and are anticipated to recover to baseline levels within 2 - 10 years. They are therefore considered to have a low sensitivity to temporary habitat disturbance and direct damage.

117. Both demersal and pelagic fish species have spawning grounds that overlap with the worst case scenario footprint, resulting in temporary habitat disturbance and direct damage. The likelihood of direct damage (e.g. crushing) is limited to the short-term displacement of individuals. Whilst there is likely to be an elevated stress response by individuals to direct damage, this is not likely to elicit any significant detriment to overall population health. Most species have pelagic spawning strategies that do not depend on specific substrate types, and are generally considered tolerant and adaptable to temporary habitat disturbance to spawning or nursery areas. However, species with demersal spawning strategies, particularly sandeel and Atlantic herring, have a heightened sensitivity to any disturbance of the seabed, and are therefore considered more sensitive to temporary habitat disturbance and direct damage, especially related to spawning and nursery areas.

118. Seabed morphology is considered a potentially important factor in the preferability of seabed sediments as spawning grounds for fish species, however, the loss in such features would be limited to areas in which the seabed would undergo significant disturbance (e.g. cable burial). The Offshore Development Area is variable in its provision of potential spawning habitats for sandeel and Atlantic herring, however, there are areas of significant spawning potential for both species, particularly along the Offshore Export Cable Corridor around 12nm from the landfall site and within the Array Areas for sandeel. Furthermore, sandeel are known to exhibit a high habitat fidelity when settled, which makes them more susceptible to impacts on the seabed, and to direct damage, as they are less mobile. These are species of national importance that are anticipated to recover to baseline levels within 2 - 10 years. Demersal and pelagic fish species are therefore considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

119. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and therefore no impact pathway for temporary habitat disturbance and direct damage exists for these species.

120. Once settled, and following a pelagic larval stage, shellfish species are solely reliant on the seabed for the majority of their life-history. In addition, shellfish are less mobile than the other receptor groups, and therefore have a lower tolerance and adaptability to temporary habitat disturbance and direct damage. Furthermore, the Fish and Shellfish Ecology Study Area encompasses key grounds and protected areas for commercially important shellfish species such as scallop (discussed further in **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**). Shellfish generally have a higher fecundity than fish, and therefore a greater capacity for recovery following disturbance events. This is particularly relevant to the Dogger Bank SAC scallop population(s) which would benefit from exclusion of trawling, and provide a spill-over effect for bolstering the recovery of surrounding fished populations.

121. Like sandeel and Atlantic herring, certain shellfish species have an elevated sensitivity to temporary habitat disturbance and direct damage during the breeding season. For example, berried female brown crab remain buried in the sediment whilst eggs mature, and are less mobile than males or females at other stages of their life history. The shellfish species within the Fish and Shellfish Ecology Study Area are important stocks nationally with an ability to adapt to, and a tolerance of, temporary habitat disturbance and direct damage. Following exposure, they are anticipated to recover within a period of 2 - 10 years. Shellfish are therefore considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

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

122. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

123. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

124. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.1.5 Significance of Effect – DBS East and DBS West Together

125. The low magnitude of impact for both Projects together (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

126. The low magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, pelagic fish, and shellfish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.2 Impact 2: Increase in Local Suspended Sediment Concentrations and Sediment Settlement

127. All construction works interacting with the seabed have the potential to elevate suspended sediment concentrations (SSC) within the water column. As detailed in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**, regional mapping of seabed sediments indicates the Array Areas are dominated by sandy sediments and mixed sediment. Along the Offshore Export Cable Corridor sand and gravel are the primary sediment components. The north east of the Offshore Export Cable Corridor comprises 0-15% fines, dropping to 0-7% fines further west. The gravel component increase shoreward, rising to 90% gravel in some locations close to landfall. Coarser sediments will settle rapidly when compared to fines, and so whilst plume extent may be great in certain regions, only a small proportion of total sediment disturbed will be in suspension. Baseline SSCs within the region do not generally exceed 15mg/l, reaching up to 300mg/l during storm events.

128. Modelling of sediment plumes associated with the Projects indicates average SSCs in the Array Areas will increase by 2mg/l above background in association with seabed preparation and foundation installation at the seabed surface, decreasing to 0.5mg/l above background near the seabed. 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 Offshore Export Cable Corridor approaches the Array Areas (**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**). The maximum tidal excursion ellipse is 14km, which represents the theoretical maximum for sediment distribution via tidal forces per tidal cycle. However, modelling indicates that suspended sediment concentrations will return to baseline within 5km of the disturbance area due to the settlement rates of sediments. This increase in background SSC is not anticipated to last for more than a few hours following works.

129. Modelling of seabed levelling activities along the Offshore Export Cable Corridor and in association with other cables, are modelled to reach average concentrations 5mg/l above baseline at the seabed, decreasing to 0.5mg/l above baseline at the surface. Sediment plumes are expected to return to background levels within 7km of the Offshore Export Cable Corridor, settling up to four hours following works along the export cable corridor, and up to six hours after works within the Array Areas and Inter-Platform Cable Corridor.

130. During trenching of the Offshore Export Cable Corridor suspended sediment concentrations may reach up to 1000-1500mg/l in localised hot-spots. However, the extent of the sediment plume differs due to greater variability in tidal currents along the entire length of the Offshore Export Cable Corridor. During peak tidal currents the plume extent may extend up to 18km from the cable corridor in the offshore area, dropping to 2km in the nearshore section of cable corridor. Modelling does not indicate that the sediment plume will interact with the coast. From approximately 60km offshore the modelled plume reduces from 5km from the point of disturbance, to 2km within the Array Areas. While the predicted plume can extend kilometres from the point of disturbance, the changes in SSCs over these distances are small, typically below 1mg/l, persisting for a period of hours

131. Changes in seabed level vary between construction activities. Cable installation may result in seabed level changes of up to 1.5m within the Offshore Export Cable Corridor, dropping to <0.03m beyond the corridor. Trenching activities within the Array Area may result in seabed level change of up to 0.5m where multiple cable merge, but will typically be <0.05m. Drill arisings from foundations are anticipated to result in a change <0.05m, and changes associated with seabed preparation for foundations are even more limited at <0.005m.

132. It should be noted that this impact would occur episodically and be highly localised to the individual locations of construction or installation over the full duration of the construction period, not as a single event. The worst cases presented below represent the combined volume of SSC from all construction or installation events.

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

133. The total worst case scenario volume of sediment with the potential to cause an increase in SSC and sediment settlement associated with the construction phase of DBS East is 39,973,497m^3. The worst case scenario volume of sediment with the potential to cause an increase in SSC and sediment settlement associated with the construction phase of DBS West is 35,664,569m^3.

134. Of the two Projects, DBS East represents the worst case scenario in isolation. The assessment for an increase in SSC and sediment settlement in isolation, would therefore be assumed to be this worst case scenario for either Project.

135. Changes in levels of suspended sediment are likely occur, however they are predicted to be indistinguishable from background conditions within up to seven hours. Modelling suggests that away from the immediate release location, elevations in suspended sediment would be largely limited to the immediate construction returning to background levels within 5km of the Array Area, and 7km of the export cable corridor. Sediment settlement would result in a change of seabed elevation <0.05m outside of the highly localised work area. Movement of sediments within a plume is predicted to be to the northwest or southwest, based on tidal movement.

136. The impact pathway is considered to be short-term and highly localised, with the loss of individuals as a result of an increase in SSC and sediment settlement expected to fully recover within the short term (0 - 2 years). However, the effect would be slightly noticeable compared to background conditions, but would remain within the range of natural variation. Therefore, as a precaution, the magnitude of impact is considered low.

10.6.1.2.2 Magnitude of Impact – DBS East and DBS West Together

137. The worst case scenario volume of sediment with the potential to cause an increase in SSC and sediment settlement associated with the construction phase of the Projects is 76,618,434m³.

138. An increase in SSC and sediment settlement during concurrent construction of DBS East and DBS West would result in a greater peak in concentration (i.e. a greater density and footprint) (assuming multiple installations occurring concurrently), but would be dissipated or deposited within a shorter timeframe than if the Projects' construction were staggered. A staggered approach may reduce the maximum peak in concentration, but may increase the overall period during which SSC and deposition would be elevated, therefore increasing risk of construction coinciding with spawning seasons for key spawning receptors such as sandeel and Atlantic herring.

139. Modelling suggests that away from the immediate release location, elevations in suspended sediment would be largely limited to the immediate construction returning to background levels within 5km of the Array Area, and 7km of the export cable corridor. Sediment settlement will be <0.05m outside of the highly localised work area. This deposition is not predicted to last for more than seven days within the localised area and may reduce to a few hours or days as distance from the disturbance increases.

140. Due to the short-term and highly localised nature of the impact pathway, the loss of individuals as a result of an increase in SSC and sediment settlement would be expected to fully recover within the short term (0 - 2 years), accounting for the worst case scenario volume of sediment mobilised by DBS East and DBS West together. However, the effect would be slightly noticeable compared to background condition, but would remain within the range of natural variation. Therefore, as a precaution, the magnitude of impact is considered low.

10.6.1.2.3 Sensitivity of Receptor

141. The ecologically important impacts of elevated suspended sediments include reduced visibility and visual hunting strategy success, reduced photosynthetic efficiency of phytoplankton (due to reduced light intensity and altered spectrum), and smothering of filter-feeding species and eggs and / or larvae (Cloern, 1987; Henley *et al.*, 2010).

142. Due to the mobility of fish receptors, it is highly unlikely that elevated suspended sediments, of the scale associated with the Projects, would significantly reduce hunting success. Fish have the opportunity to move away from areas of elevated suspended sediments, and would return to the same area within – one to two tidal cycles at maximum. Elasmobranch species are more heavily reliant on electromagnetic sensors (e.g. Ampullae of Lorenzini) than visual cues when hunting prey within wide-ranging hunting grounds, and are therefore considered tolerant and adaptable to an increase in SSC and sediment settlement. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and are highly mobile within the coastal environment.

143. Demersal and pelagic fish species are also often highly mobile, and likely to return to the area once suspended sediments have returned to the baseline condition (ABP Research, 1999; EMU, 2004). Some demersal species are likely to increase their energy expenditure, by migrating through additional sediment deposition and / or through increased burrow maintenance. However, the short-term and localised nature of sediment deposition associated with the Projects is unlikely to cause any population-level effects due to an increase in individual energy expenditure. Adult elasmobranch, demersal fish, pelagic fish, and migratory fish species are therefore considered to have a negligible sensitivity to an increase in suspended sediment concentration and sediment settlement.

144. For demersal and pelagic species, an increase in SSC and sediment settlement would have the greatest effects upon spawning, particularly for maturing eggs and early-stage larval development. Sediment deposition can smother demersal eggs and larvae. Whereas sediments suspended within the water column, are known to adhere to pelagic eggs and increase the egg sinking rates (Westerberg *et al.*, 1996c; Griffin *et al.*, 2009). Both demersal and pelagic eggs and larvae are at increased risk of oxygen starvation in these scenarios, which may impact recruitment of the local population if activity overlaps spawning seasons. Whilst some evidence suggests key species such as sandeel and Atlantic herring are tolerant to increases in SSCs (Messieh *et al.*, 1981; Kiørboe *et al.*, 1981; Utne-Palm, 2004), sediment settlement is likely to represent a greater risk to these species. The eggs and larvae of demersal fish and pelagic fish species are therefore considered to have a medium sensitivity to an increase in SSC and sediment settlement.

145. Similarly to fish eggs and larvae, some shellfish species are at increased risk of impact from an increase in SSC and sediment settlement during the spawning season. Berried crustaceans such as brown crab may experience lower oxygen concentrations during key stages of egg development, which may reduce the success or quality of larvae within the area of effect. However, berried crustaceans have the ability to move out of areas with high sediment deposition rates, and therefore mitigate the risk of smothering of their eggs (Neal and Wilson, 2008). Filter-feeding shellfish species may experience elevated sediment accumulation on feeding apparatus as a result of an increase in SSC and sediment settlement (Pineda *et al*., 2017). However, the majority of shellfish species present within the Fish and Shellfish Ecology Study Area would be adapted to low levels of sedimentation (Essink, 1999; Sabatini & Hill, 2008; Szostek *et al*., 2013; Gibson-Hall *et al*., 2020). Shellfish species are therefore considered to have a medium sensitivity to an increase in SSC and sediment settlement.

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

146. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **negligible** effect, and is therefore not significant in EIA terms.

147. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

148. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.2.5 Significance of Effect – DBS East and DBS West Together

149. The low magnitude of impact for both Projects together (DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **negligible** effect, and is therefore not significant in EIA terms.

150. The low magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

151. The low magnitude of impact for both Projects together (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.3 Impact 3: Release of Sequestered Contaminants following Sediment Disturbance

152. Re-mobilisation of inert sediments has the potential to release toxic substances (e.g. mercury and arsenic) into the water column, that may adversely impact fish and shellfish species.

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

153. As described within section 10.6.1.2, sediment modelling indicates plume extents of up to 5km from the Array Area, and up to 7km from the Offshore Export Cable Corridor. Excluding changes in sediment depth directly at the cable corridor, changes are not anticipated to exceed 0.03m. Sediment deposition depth associated with trenching within either of the Array Areas will typically be under 0.05m, and changes associated with seabed preparation for foundations will typically be under 0.005m. This modelling indicates the potential distances over which contaminants may be distributed as a result of construction works.

154. As discussed within **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** fine sediments are more easily mobilised but concentrations within the region are low. Therefore, they are expected to settle, with a return to baseline conditions likely within hours due to dispersion and dilution. The disturbance of sediments is therefore considered to be highly localised and short-term, with episodic rather than continuous disturbance.

155. A total of 28 samples were collected during sediment quality surveys undertaken to determine contamination of sediments across the Offshore Development Area. Concentrations of trace metals were generally typical of the region falling below sediment quality guideline thresholds, with the exception of arsenic concentrations at three stations. One of these stations was located within the DBS West Array Area, with the other two located within the Offshore Export Cable Corridor. The station within the DBS West Array Area exceeded Cefas Action Level 1(AL1), with the two located within the Offshore Export Cable Corridor exceeding both AL1 and OSPAR Background Assessment Concentrations (BAC). Hydrocarbon contamination similarly fell below guideline levels at most stations, with the exception of 3 stations along the Offshore Export Cable Corridor. One station exceeded AL1 and BAC thresholds for both polycyclic aromatic hydrocarbons (PAH) and total hydrocarbons (THC), with the remaining two stations exceeding just the PAH threshold. These contamination levels were only marginally greater than guideline thresholds.

156. The nature of sediments (sands and gravels with limited fines components) across the Offshore Development Area significantly reduces the potential for accumulation of contaminants. Therefore, the potential levels of sequestered contaminants available for release are considered to be low.

157. Due to the localised, short-term disturbance of sediments, and the low likelihood of significant contamination within the Offshore Development Area, the magnitude of impact is considered negligible.

10.6.1.3.2 Magnitude of Impact – DBS East and DBS West Together

158. Based on modelling of sediment suspension and studies of contaminant levels and sediment types across the Offshore Development Area, it is considered that both the level of suspended sediment release (expected to be localised, short-term, and episodic) and the levels of contaminants would be low. Therefore, the magnitude of impact is considered negligible.

10.6.1.3.3 Sensitivity of Receptor

159. Fish are not considered sensitive to most natural contaminants present within seabed sediments, provided the concentration of contaminants remain within environmental protection standards. There is evidence to suggest that contaminant uptake through gills is low, and that lower trophic levels are more susceptible to increased contaminant concentrations (De Gieter *et al*., 2002). Contaminants are likely to undergo biomagnification up the food chain, or bioaccumulation with age (Baeyens *et al*., 2003), however certain contaminants (e.g. arsenic) can be metabolised if present at low concentrations within the environment (Kumari *et al*., 2017).

160. Whilst it is accepted that contaminants negatively affect body condition in fish through disease, the likelihood of effect for fish and shellfish receptors within the Fish and Shellfish Ecology Study Area would be limited to short-term and localised elevation in stress responses (Henry *et al*., 2004). All fish and shellfish receptor groups are therefore considered to have a low sensitivity to the release of sequestered contaminants following sediment disturbance.

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

161. The negligible magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.3.5 Significance of Effect – DBS East and DBS West Together

162. The negligible magnitude of impact for both Projects together (DBS East and DBS West), combined with the low sensitivity for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.4 Impact 4: Impacts on Fish and Shellfish Species as a Result of Underwater Noise and Vibration

163. Underwater noise and vibration effects may be generated from a number of sources during the construction phase. Noise generating scenarios can be categorised in three groups:

- Impact piling;
- Unexploded ordinance (UXO) clearance; and
- Other activities (e.g. vessel traffic, rock placement).

164. Modelling undertaken within **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)** represents a worst case scenario through the integration of worst case piling types, hammer blow energies, ramp up times, strike rates, and duration, whilst assuming fish and shellfish as stationary receptors.

165. Soft start and ramp up periods have been incorporated within the modelling to allow for avoidance behaviour. This soft-start procedure aims to reduce nearby individuals immediately reaching thresholds for mortality, injury or TTS, and instead increases intensity gradually in expectation that receptors will migrate away from the noise source. The approaches used in modelling are presented in **Table 10-17** and **Table 10-18**. This modelling assumes each pile would require 7,500 strikes over a period of 320 minutes.

Table 10-17 Summary of the Soft Start and Ramp up Scenario Used for the Monopile Foundation Modelling for a Single Monopile

Hammer Energy	**900kJ**	**1,500kJ**	**3,000kJ**	**4,500kJ**	**6,000kJ**
Number of strikes	100	800	800	800	5,000
Duration	10mins	20mins	20mins	20mins	250mins
Strike Rate (blows per minute)	10	40	40	40	20

Table 10-18 Summary of the Soft Start and Ramp up Scenario Used for the Pin Pile Foundation Modelling for a Single Pin Pile

Hammer Energy	**450kJ**	**750kJ**	**1,500kJ**	**2,250kJ**	**3,000kJ**
Number of strikes	100	800	800	800	2,400
Duration	10mins	20mins	20mins	20mins	120mins

Hammer Energy	450kJ	750kJ	1,500kJ	2,250kJ	3,000kJ
Strike Rate (blows per minute)	10	40	40	40	20

166. The worst case scenario for construction of either project in isolation is considered to be the concurrent installation of two monopiles at different locations. The locations in the worst case scenario (greatest separation between monopiles) are represented by the Westermost limit of the DBS West Array Area concurrent with an OCP between the DBS West and DBS East Array Areas. A more conservative underwater noise modelling approach has been undertaken using the scenario of two single monopiles installed per 24 hours, at the eastern and Westermost limits of the DBS East and DBS West Array Areas concurrently (as determined within **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**). This modelled scenario results in a greater modelled exposure (i.e. spatial coverage) compared to the realistic worst case scenario described above (as this represent the minimum overlap of noise ranges from the two locations) and this therefore provides a precautionary basis for the assessment.

167. Where the Projects undergo construction together, there is the possibility for the simultaneous installation of pin piles at each Array Area and at the Offshore Export Cable Corridor Electrical Switching Platform (ESP) for a total of three concurrent piling events. In this circumstance it is possible that there would be a combined effect of piling events, leading to an increase in total area over which an exposure threshold is reached. The combined area considers the total area over which a given threshold is reached when considering the worst case scenario for DBS East and DBS West.

168. **Table 10-19** presents a summary of predicted impact ranges determined using the INSPIRE model for the installation of two monopiles per 24 hours at two separate locations (DBS West and DBS East) concurrently, alongside the combined area that might occur during three simultaneous (pin) piling events. **Table 10-20** presents the impact range for the 135 dB re 1 μPa^2s behavioural response threshold for the same modelled parameters as **Table 10-19**. Maximum and minimum ranges in the two tables are from the DBS West location, as piling from this location is consistent between both the realistic and modelled worst case scenarios. A full breakdown as to each of

these ranges is provided within **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**.

Table 10-19 Unweighted SEL_{cum} Impact Ranges for Fish With a Bladder Used in Hearing Determined for concurrent piling at the DBS West and DBS East locations (monopile), and the combined area for three simultaneous pin pile events

Popper *et al.* (2014) Unweighted SEL_{cum}	**Monopiling at two concurrent locations (DBS West and DBS East)**			**Pin piling at three locations simultaneously**
Stationary receptor	**Area**	**Maximum range**	**Minimum range**	**Combined area**
207dB re 1μPa²s (Mortality)	179.3km²	5.7km	4.8km	270km²
203dB re 1μPa²s (Injury)	460.9km²	9.0km	7.5km	730km²
186dB re 1μPa²s (TTS)	8,033.1km²	93.8km	25.0km	15,000km²

Table 10-20 Unweighted SEL_{ss} Behavioural Response Threshold for Fish With a Bladder Used in Hearing Determined for concurrent piling at the DBS West and DBS East locations (monopile), and the area for three simultaneous pin pile events

Hawkins *et al.* (2014) Unweighted SEL_{ss}	**Monopiling at two concurrent locations (DBS West and DBS East)**			**Pin piling at three locations simultaneously**
Stationary receptor	**Area**	**Maximum range**	**Minimum range**	**Combined Area**
135dB re 1μPa²s (Behavioural response)	26,493km²	136.6km	46.1km	31,724km²

169. In the case of the installation at just a single Array Area, a worst case scenario would include the installation of an ESP along the export cable corridor at the most southerly of the proposed locations, comprising a single monopile. The installation of this will be undertaken in isolation of other piling events within the Array Area. The extent of this piling is indicated within **Volume 7, Figure 10-10 (application ref: 7.10.1)**, and predicted impact ranges indicated within **Table 10-21** and **Table 10-22**. In the case of the installation of both Array Areas, the ESP along the export cable would utilise pin piles which may be installed concurrently with pin piles in the Array Areas, and has been modelled and assessed as such within the assessment of this scenario.

Table 10-21 Unweighted SEL_{cum} Impact Ranges for Fish With a Bladder Used in Hearing Determined at the worst case Export Cable ESP Location

Popper *et al.* (2014) Unweighted SEL_{cum}	**Piling at the Export Cable ESP**		
Stationary receptor	**Area**	**Maximum range**	**Minimum range**
207dB re 1μPa^{2}s (Mortality)	58km^2	4.3km	4.3km
203dB re 1μPa^{2}s (Injury)	180km^2	7.6km	7.5km
186dB re 1μPa^{2}s (TTS)	5500km^2	47.0km	38.0km

Table 10-22 Unweighted SEL_{ss} Behavioural Response Threshold for Fish with a Bladder Used in Hearing determined at the worst case Export Cable ESP Location

Hawkins *et al.* (2014) Unweighted SEL_{ss}	**Monopiling at the Export Cable ESP Location**		
Stationary receptor	**Area**	**Maximum range**	**Minimum range**
135dB re 1μPa^{2}s (Behavioural response)	24,444km^2	127.1km	38.0km

170. It is possible that there would be a requirement for UXO clearance during the construction phase of the Projects. The underwater noise output resulting from a given charge would vary depending on a number of factors including, but not limited to the charge weight (size of the explosive charge within the UXO) and the clearance method used. Three clearance methods are described in detail within **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)** and summarised below:

- High-order clearance (detonation of the charge using a donor charge);
- Low-order clearance (slow burning of the charge); and
- Low-yield clearance (use of the HYDRA UXO clearance system (or similar) to burn and disintegrate the charge).

171. Impact ranges for a number of UXO detonation scenarios in relation to the potential impact on fish and shellfish ecology receptors is provided in **Table 10-23**. As UXO clearance is a single noise event, it is assumed that receptors would not engage in fleeing behaviour.

Table 10-23 Impact Ranges Associated with Unexploded Ordnance Clearance in Relation to Fish with a Swim Bladder Used in Hearing.

Unweighted SPL_{RMS} (Popper *et al.*, 2014)	Mortality and potential mortal injury	
	234dB	229dB
Low yield	130m / 0.05km²	210m / 0.14km²
Low order (0.25kg)	40m / 0.01km²	65m / 0.01km²
25kg + donor	170m / 0.09km²	290m / 0.26km²
55kg + donor	230m / 0.17km²	380m / 0.45km²
120kg + donor	300m / 0.28km²	490m / 0.75km²
240kg + donor	370m / 0.43km²	620m / 1.21km²
525kg + donor	490m / 0.75km²	810m / 2.01km²
698kg + donor	530m / 0.88km²	890m / 2.49km²

172. A number of other activities are likely to be undertaken during the construction phase of the Projects. Impact ranges for a number of noise and vibration sources anticipated during the construction phase of the Projects are provided within **Table 10-24**.

Table 10-24 Impact Ranges Associated with Construction and Vessel Noise for Fish With a Swim Bladder Used in Hearing

Unweighted SPL_{RMS} (Popper *et al.*, 2014)	**Recoverable Injury 170dB (48 hours)**	**Temporary Threshold Shift 158dB (12 hours)**
Cable laying	< 50m / <0.01km²	< 50m / <0.01km²
Dredging (Backhoe)	< 50m / <0.01km²	< 50m / <0.01km²
Dredging (Suction)	< 50m / <0.01km²	< 50m / <0.01km²
Drilling	< 50m / <0.01km²	< 50m / <0.01km²
Rock placement	< 50m / <0.01km²	< 50m / <0.01km²
Trenching	< 50m / <0.01km²	< 50m / <0.01km²
Vessel noise (large)	< 50m / <0.01km²	< 50m / <0.01km²
Vessel noise (medium)	< 50m / <0.01km²	< 50m / <0.01km²

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

173. **Volume 7, Appendix 11-2 Underwater Noise Modelling Report (application ref: 7.11.11.2)** determined that piling at DBS West was likely to have the highest associated impact range as a result of the local conditions. A worst case scenario would call for 104 monopiles to be installed across the DBS West Array Area, with no more than four monopiles being installed on a single day. Modelling assumes each monopile would take up to 320 minutes of piling to install, with 250 minutes being at the full 6,000kJ. This totals 554.67 hours of piling spread across a period of no less than 27 days.

174. For fish with a swim bladder involved in hearing, TTS onset is likely to occur at an exposure to 186dB SEL_{cum}, across an area of 8,033km² for each pile installed. Injury is not determined as likely to occur until exposure to 203dB SEL_{cum}, and mortality until 207dB SEL_{cum}. Therefore, recoverable injury might occur across an area of up to 461km² (1.72% of the Fish and Shellfish Ecology Study Area). Mortality is likely to be limited to an area of 179km² (0.67% of the Fish and Shellfish Ecology Study Area). It should be noted that these values assume that no avoidance behaviour is exhibited by the receptor, however in a realistic scenario some degree of avoidance is likely.

175. Behavioural response based on the single threshold criteria of 135dB re $1\mu Pa^2s$ is modelled with an area of 26,493km² (99% of the Fish and Shellfish Ecology Study Area). Behavioural response contours overlap with areas of high suitability for Atlantic herring spawning. This response threshold represents the single strike sound exposure level at which a behavioural response (dispersal / change in density of fish schools) was observed in 50% of schools of European sprat in a quiet coastal lough in a single study (Hawkins *et al.*, 2014). The authors suggest that this response may have a metabolic cost in terms of increased levels of activity and energy consumption, however no detrimental effects on the populations were observed or measured as part of the study. Within this study the authors also note that responsiveness of fish was reduced at night, with no response from individual fish to impulsive noise. Consideration must be given to the differences in baseline noise levels and study species, used within Hawkins *et al.* (2014) compared to the Offshore Development Area. The Dogger Bank is likely to have higher levels of background noise when compared to a quiet coastal lough, such that exposure to high ambient noise may have a habituating effect leading to a weaker or lack of response compared to the received levels alone (e.g. in fish: Chapman and Hawkins (1969), Peña *et al.* (2013); or in marine mammals: Erbe *et al.* (2016)). Whilst it is acknowledged that impulsive noise below levels of TTS onset can result in behavioural responses, information within Hawkins *et al.* (2014) strongly indicates that impacts at a population level are not likely to occur at the 135dB re $1\mu Pa^2s$ range as a result of works within the Offshore Development Area. Therefore, although the area encompassed by the 135dB re $1\mu Pa^2s$ behavioural response threshold is extensive it is not considered to represent a realistic area of likely significant effects.

176. The worst case scenario (greatest separation between monopiles) for construction of either project in isolation is represented by monopiling at the Westermost limit of the DBS West Array Area concurrent with monopiling at an OCP between the DBS West and DBS East sites. A more conservative underwater noise modelling approach has been undertaken using the scenario of two single monopiles installed per 24 hours, at the eastern and Westermost limits of the DBS East and DBS West Array Areas. This modelled scenario results in a greater modelled exposure (i.e. spatial coverage) compared to the realistic worst case scenario described above (as this represent the minimum overlap of noise ranges from the two locations) and this therefore provides a precautionary basis for the assessment. The extent of underwater noise impacts and disturbance from piling at DBS West and DBS East concurrently, overlaid with Atlantic herring spawning potential, is presented in **Volume 7, Figure 10-8 (application ref: 7.10.1)**. This figure indicates that mortality effects would be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning. A small region of medium Atlantic herring spawning potential is present to the west of the 207dB SEL_{cum} mortality band in modelled results. Across the wider TTS area effects would also be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning. A region of medium Atlantic herring spawning potential is present to the east of the Array Areas, and within the DBS West Array Area. As piling would be undertaken across the Array Area, it is possible that the impacts of 207dB SEL_{cum} exposure or greater would be experienced across the DBS West Array Area as piling activity takes place.

177. For UXO, a worst case scenario would represent an exposure of 229dB, potentially leading to mortality and mortal injury in fish with a swim bladder used in hearing, up to a distance of 890m (**Table 10-23**). This represents an area of 2.49km^2, or <0.01% of the Fish and Shellfish Ecology Study Area. Should two UXO clearance operations be required in a single day, this value would increase to 0.019%. Further, whilst this is a worst case scenario, it is likely that low-order or low-yield methods would result in the further reduction of impact should UXO clearance operations be required during the construction phase of the Projects.

178. When considering non-impulsive noise (associated with vessels and other activities, see **Table 10-24**), the magnitude of impact on fish and shellfish is considered negligible within the context of the Fish and Shellfish Ecology Study Area. Each of the activities presenting recoverable injury thresholds of <50m from the noise source following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, and that vessel movement and construction activity would move around the site over the period, it is not considered likely that this would result in notable impacts to any receptor groups.

179. Effects associated with underwater noise and vibration via impact piling and UXO within the Array Area are likely to occur. This effect is likely to result in a change that is noticeable but within natural variation, due to the limited presence of potential Atlantic herring spawning grounds within the area. Both noise sources pertain to discrete events, with noise and vibrations emissions occurring in the medium term (2 – 10 years). Therefore, the magnitude of impact for underwater noise and vibration is considered low.

10.6.1.4.2 Magnitude of Impact – Offshore Export Cable Corridor ESP

180. Monopiling at the export cable ESP will not occur concurrently with any monopiling at DBS East or DBS West, therefore it is presented here separately. Noise impacts associated with fish with a swim bladder involved in hearing are presented within **Table 10-21**. TTS onset following exposure to 186dB SEL_{cum}, would occur across 5,500km² for each pile installed. Injury is not determined as likely to occur until exposure to 203dB SEL_{cum}, and mortality until 207dB SEL_{cum}. Therefore, recoverable injury may occur across an area of up to 180km² (0.7% of the Fish and Shellfish Ecology Study Area). Mortality is likely to be limited to an area of 58km² (0.2% of the Fish and Shellfish Ecology Study Area). It should be noted that these values assume that no avoidance behaviour is exhibited by the receptor, however in a realistic scenario some degree of avoidance is likely. Behavioural response based on the single threshold criteria of 135dB re $1\mu Pa^2s$ is limited to an area of 24,444km² (91% of the Fish and Shellfish Ecology Study Area) (**Table 10-22**). The extent of underwater noise impacts and behavioural response from piling at the export cable ESP overlaid with Atlantic herring spawning potential is presented in **Volume 7, Figure 10-9 (application ref: 7.10.1)**. This figure indicates that mortality effects would be within areas of medium, high, and very high suitability for Atlantic herring spawning. TTS impacts have the potential to occur across regions considered to be of very high spawning potential, alongside areas of high and medium spawning potential.

181. The magnitude of impact for the worst case scenario is adversely affected due to the overlap of TTS and behavioural response threshold with coastal areas of medium and high suitability for Atlantic herring spawning. This overlap has resulted in a higher assessed magnitude, however temporal mitigation for piling at the ESP has been proposed. If works do not occur within the spawning season for Atlantic herring (August-October; ICES, 2005), then this increased magnitude would no longer be relevant.

182. When considered alongside the embedded mitigation relating to seasonal restrictions on piling along the export cable corridor between August and October due to Atlantic herring spawning, this effect is likely to result in a change that is within natural variation, due to the absence of Atlantic herring undertaking spawning activities at the time. Both noise sources pertain to discrete events, with noise and vibrations emissions occurring in the medium term (2 – 10 years). Therefore, the magnitude of impact for underwater noise and vibration is considered low.

10.6.1.4.3 Magnitude of Impact – DBS East and DBS West Together

183. When considering the impact of three simultaneous pin piling events, a total of 864 pin piles would be installed across the Array Areas and ESP, with no more than 12 piles being installed on a single day. Modelling assumes each pile would take up to 190 minutes of piling to install, with 120 minutes being at the full 3,000kJ. This totals a piling time of 2,736 hours.

184. The combined area of exposure to 186dB SEL_{cum} increases to a total of 15,000km². However, injury is not determined as likely to occur until exposure to 203dB SEL_{cum}, and mortality until 207dB SEL_{cum}. Impacts that would result in recoverable injury are predicted to occur across an area of up to 730km² (2.72% of the Fish and Shellfish Ecology Study Area). Mortality is likely to be limited to an area of 270km² (1.01% of the Fish and Shellfish Ecology Study Area). It should be noted that these values assume that no avoidance behaviour is exhibited by the receptor. In reality, some degree of avoidance is likely.

185. Behavioural response, based on the single threshold criteria required by the MMO, has been calculated as the total area within the response threshold for piling at DBS West, DBS East, and the Offshore Export Cable Corridor ESP combined. This is distributed across an area of 31,724km² (**Table 10-20**). Behavioural response contours overlap with some areas of high suitability for Atlantic herring spawning, and therefore have a limited potential to interact with The Bank North Sea Autumnal Spawning population during the spawning period. However, a review of published literature has produced no documented evidence of a barrier effect to migrating Atlantic herring from impulsive noise at this sound exposure level.

186. The extent of underwater noise impacts and disturbance from piling at DBS West, DBS East, and the Offshore Export Cable Corridor ESP overlaid with Atlantic herring spawning potential is presented in **Volume 7, Figure 10-10 (application ref: 7.10.1)**. This figure indicates that within areas impacted pin piling associated with the DBS East and DBS West Array Areas, mortality, recoverable injury, and TTS would be limited to regions of seabed largely unsuitable or of low potential for Atlantic herring spawning. A small region of medium Atlantic herring spawning potential is present to the west of the 207dB SEL_{cum} mortality band associated with DBS West. Across the wider TTS area effects would also be limited to regions of seabed largely unsuitable or of low suitability for Atlantic herring spawning. A region of medium Atlantic herring spawning potential is present to east and south west of the Array Areas, and within the DBS West Array Area. As piling would be undertaken across the Array Areas, it is possible that the impacts of 207dB SEL_{cum} exposure or greater would be experienced across the Array Areas as piling activity takes place.

187. When considering areas impacted by pin piling associated with the ESP, there is a greater level of overlap with potential Atlantic herring spawning habitat as described within section 10.6.1.4.2. Therefore, the same mitigation comprising no piling at the ESP location within the spawning period of the Banks population (August-October; ICES, 2005) is embedded.

188. The determination of magnitude for UXO clearance and non-impulsive noise remains the same for both construction scenarios. Refer to section 10.6.1.4.1.

189. Effects associated with underwater noise and vibration via impact piling and UXO within the Array Area are likely to occur. This effect is likely to result in a change that is within natural variation, due to the limited presence of potential Atlantic herring spawning grounds within the area. When considered alongside seasonal restrictions at the ESP location, noise and vibrations emissions would occur in the medium term (2 – 10 years). Therefore, the magnitude of impact for underwater noise and vibration is considered low.

10.6.1.4.4 Sensitivity of Receptor

190. Information on the receptor groups used for the assessment of this impact is provided in section 10.5.3. Fish are known to have varying sensitivity to noise and vibration based on the presence or absence of a swim bladder to inner-ear connection, with fish having a swim bladder used in hearing being most intolerant to underwater noise (Popper *et al*., 2014). It is assumed that Fish and Shellfish receptors, with the exception of eggs and larvae, have a degree of motility that would allow for avoidance behaviour following initial exposure to underwater noise and vibration. However, following comments received from the MMO during scoping, fish have been treated as stationary receptors throughout the assessment of this impact. Therefore, the group used to determine a worst case scenario throughout the assessment of this impact is stationary fish with a swim bladder used in hearing.

191. When considering piling, Temporary Threshold Shift (TTS) for fish with a swim bladder used in hearing is determined as likely to occur at 186dB SEL_{cum}. Recoverable injury is expected at 203dB SEL_{cum}, and mortality and potential mortal injury at 207dB SEL_{cum}. Details pertaining to other receptor groups are presented within section 10.5.3.2.1. Following comments received from the MMO during consultation, a single behavioural response threshold value of 135dB re 1μPa^{2}s SEL_{ss} for Atlantic herring has been assessed, based on a single study on sprat *Sprattus sprattus* to impulsive noise in an enclosed, quiet, coastal sea lough (Hawkins *et al.*, 2014). Recovery following TTS or behavioural response is predicted to occur in the short term, as elsewhere pelagic and demersal fishes have been observed returning to their original locations within hours or days following seismic disturbance (Engås *et al*., 1996; Engås & Løkkeborg, 2002).

192. This receptor group also has no adaptability to underwater noise and vibration as the impact is a result of physiological traits. Many fish with a swim bladder used in hearing are of importance within the North Sea. Notably, Atlantic herring utilise large areas of the Dogger Bank as spawning grounds. Whilst herring populations spawn at different times of the year across the UK, the most local population to the Projects, the Banks population, is known to spawn between August and October (ICES, 2005). During this period numbers of herring increase significantly as populations migrate southward to spawn. Recovery of this receptor group to baseline levels following exposure is likely to occur within 2 – 10 years. Fish with a swim bladder used in hearing, are therefore determined to have a medium sensitivity to underwater noise and vibration.

193. All other fish receptor groups, including fish eggs and larvae, and shellfish species, have an increased tolerance to underwater noise and vibration. European lobster, for example, showed no significant difference in size and catch rates between control sites and those exposed to the development of Westermost Rough offshore wind farm over a six-year period (Roach *et al.*, 2022). Fish eggs and larvae are determined as having a similar level of sensitivity to noise and vibration, as fish with a swim bladder not used in hearing (Popper *et al.*, 2014). Further, there is limited data to suggest that shellfish have greater sensitivity to noise and vibration than fish species. Whilst species within these receptor groups are of importance within the North Sea, their populations are likely to recover to baseline levels within one year due to the high fecundity of the majority of fish and shellfish species, and the limited area over which these impacts would result in individual mortalities. Therefore, all other fish and shellfish receptor groups are determined to have a low sensitivity to underwater noise and vibration.

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

194. The low magnitude of impact for DBS West (or DBS East), and the low magnitude of impact for the ESP, combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a **minor adverse** effect, and is therefore not significant in EIA terms.

195. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with low magnitude of impact, results in the assessment that impacts associated with noise and vibration have a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.4.6 Significance of Effect – DBS East and DBS West Together

196. The low magnitude of impact for both Projects together (DBS East and DBS West), and the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a **minor adverse** effect, and is therefore not significant in EIA terms.

197. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with low magnitude of impact, results in the assessment that impacts associated with noise and vibration have a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.5 Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area.

198. Commercial fishing within operational wind farms is not restricted under UK legislation. During the construction phase there would be temporary loss (up to five years per Project in isolation, or seven years maximum should the Projects be constructed partially sequentially) of fishing grounds through restriction of fishing within the Offshore Export Cable Corridor and Array Areas. It has been assumed that all cables would be buried or have external cable protection. Therefore, there would be no material loss of fishing grounds along the Offshore Export Cable Corridor after the construction phase is complete, except around the ESP if it is required.

199. The Dogger Bank SAC Byelaw restricts the use of bottom towed fishing gear within the SAC to provide protection to sensitive shallow water sandbank habitats, and has been active since 13th June 2022. In order to present a worst case scenario within this assessment, impacts have been determined in the event that the Dogger Bank SAC Byelaw is revoked, and bottom trawling can continue. More details are provided within **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**.

200. During construction of the DBS East and DBS West Array Areas, it is proposed that temporary 500m safety zones would be present around foundations, wind turbines and OCPs where works are underway. Additionally, temporary 500m safety zones would also be present around pre-commissioned infrastructure, and around vessels installing array cables, Offshore Export Cables and Inter-Platform Cables.

201. Construction would also involve seabed preparation activities (e.g. sandwave and boulder clearance for foundations, array cables, inter platform cables and the Offshore Export Cables). As with installation of the foundations, wind turbines, OCPs, and cables, temporary safety and / or voluntary safety zones would also be applied for around these preparatory activities.

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

202. The impact would be of a regional spatial extent, reversible, and occur over a short- to medium-term period (maximum offshore construction period for DBS East and DBS West in isolation of up to five years; and maximum 21 months for the Offshore Export Cable installation). Fishing activity could be excluded from the entire Offshore Development Area (inclusive of both the Array Area and Offshore Export Cable Corridor) for the duration of works. This equates to an area excluded to fishing activity of 349km^2 for the DBS East Array Area and 355km^2 for the DBS West Array Area; and 376km^2 from the DBS East Offshore Export Cable Corridor and 306km^2 from the DBS West Offshore Export Cable Corridor.

203. Voluntary safety zones of 1.5nm (2.8km) would also be present around vessels conducting seabed preparatory activities (such as sandwave and boulder clearance) and during installation of foundations, wind turbines, OCPs, Inter-Platform Cables, inter-array cables, export cables and interconnector cables. Temporary 500m safety zones would be applied around installation of infrastructure such as foundations.

204. Of the two Projects, DBS East represents the worst case scenario in isolation, with a total safety area of 725km^2. The assessment of effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area would therefore assume this worst case scenario for both Projects.

205. The effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area would be a medium term (2 – 10 years) effect that is likely to occur, accounting for the worst case scenario footprint. The effect is predicted to result in a change that is noticeable, but remains within the natural variation in background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.1.5.2 Magnitude of Impact – DBS East and DBS West Together

206. The construction period for the DBS East and DBS West Concurrent Scenario is assumed as up to five years (identical construction period to that of the DBS East and DBS West In Isolation Scenario). However, in the instance of sequential development of the two Projects, the worst case construction period increases to seven years, as up to a two year lag between the start of construction activities is possible (final overall footprint would be identical to the concurrent design scenario). As per the in isolation case, as a worst case, it is assumed that fishing could be excluded from the entire Offshore Development Area during the construction period. This comprises a total area of 874km^2 for the Array Areas, and 682km^2 for the Offshore Export Cables.

207. While construction of DBS East and DBS West together covers a larger spatial footprint and a longer temporal footprint than either in isolation, construction activities would remain localised to specific construction events, and would be short- to medium-term in nature in the context of any one spatial area. Therefore, the magnitude of impact on each receptor group remains consistent with the assessment of DBS East and DBS West in isolation.

208. The effect on fish stocks of reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area during the construction period would be a medium term (2 – 10 years) effect that is likely to occur, accounting for the worst case scenario footprint. The effect is predicted to result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.1.5.3 Sensitivity of Receptor

209. A number of fish species utilise the Offshore Development Area as nursery or spawning grounds that may increase in productivity due to the reduction in fishing disturbance. However, disturbance via construction activities may cause temporary displacement and disturbance to these populations as well as their spawning or nursery grounds that would not be present otherwise.

210. Whilst it is therefore possible that the exclusion of fishing activity from the Offshore Development Area throughout the construction period would increase the fish population within the surrounding area via spill over, this effect is likely to be greatly minimised due to other sources of disturbance associated with construction (see section 10.6.1.1.3 for sensitivities to temporary habitat disturbance). Further, in the adult life stage, many of the species comprising the fish and shellfish ecology receptor groups exhibit a

high degree of motility when compared to the overall size of the Offshore Development Area. Should spill over occur it is likely that this effect will be diffuse, and the increase in fishing activity within the immediate vicinity would be unlikely to provide meaningful benefit.

211. Due to their high level of mobility, fish and shellfish receptor groups are therefore considered to have a high level of tolerance and / or adaptability to the effect. Any change in fish stocks is anticipated to recover to baseline levels within two years following construction, noting that known spawning and nursery grounds of species of national importance are present within the Offshore Development Area. All fish and shellfish receptor groups are therefore considered to have a low sensitivity to reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area.

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

212. The low magnitude of impact for DBS East or DBS West in isolation, combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.1.5.5 Significance of Effect – DBS East and DBS West Together

213. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2 Potential Effects During Operation

10.6.2.1 Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds

214. Temporary habitat disturbance to fish and shellfish species and spawning and / or nursery grounds, including direct damage from repair and maintenance, referred hereafter as “temporary habitat disturbance and direct damage”, may occur during repair and maintenance operations. Operations can include the replacement of sections of array or Offshore Export Cables, when works interact with the seabed. This also includes the disturbance from vessels jacking up.

215. It should be noted that this impact would occur episodically and would be highly localised to the individual locations of operation and maintenance events over the full duration of the operational period, not as a single event. The worst cases presented below represent the combined footprints from all operation and maintenance events.

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

216. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase of either DBS East or DBS West over the life of the Projects is 414,900m², and 392,000m², respectively. This represents the total seabed area with the potential to be affected through repairs of either the array, inter-platform or Offshore Export Cables, and is approximately 0.001% of the total Fish and Shellfish Ecology Study Area. At each of the two Projects, the worst case assessment is based on the potential for 306,900m² of seabed disturbance from jack-up activities, nine array cable repair events (9 x 6,000m²), two inter-platform cable repairs (2 x 6,000), seven Offshore Export Cable repair events (7 x 6,000m²) for DBS East and five Offshore Export Cable repair events (5 x 6,000m²) for DBS West. DBS West is only predicted to have five export cable repairs due to the shorter Offshore Export Cable, therefore DBS East is assessed as the worst case.

217. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase is less that assessed for the construction phase. It is expected that there would be a medium-term recovery (2 – 10 years) from any loss of habitat, disturbance to spawning and nursery areas, or the loss of individuals, as a result of activities occurring during the operational phase. The effect would result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.2.1.2 Magnitude of Impact – DBS East and DBS West Together

218. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase for both Projects is 823,800m². This represents the footprint affected by 613,800m² of seabed disturbance from jack-up activities, array cable repair events (17 x 6,000m²), inter-platform cable events (6 x 6,000m²) and Offshore Export Cable repair events (12 x 6,000m²) combined across the life of the Projects, and is approximately 0.003% of the total Fish and Shellfish Ecology Study Area.

219. The worst case scenario for both Projects combined is less than that assessed for the construction phase. The loss of individuals as a result of temporary habitat disturbance and direct damage would be expected to fully recover within the medium-term (2 – 10 years), accounting for the worst case scenario footprint of direct damage (e.g. crushing) and disturbance. The effect would result in a change that is noticeable, but remains within the natural variation of background conditions for the given effect. Therefore, the magnitude of impact is considered low.

10.6.2.1.3 Sensitivity of Receptor

220. The sensitivity for fish and shellfish receptor groups have been assessed in section 10.6.1.1.3.

221. Elasmobranch species are considered to have a low sensitivity to temporary habitat disturbance and direct damage.

222. Demersal and pelagic fish species are considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

223. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and therefore no impact pathway for temporary habitat disturbance and direct damage exists for these species. They are considered to have a negligible sensitivity to temporary habitat disturbance and direct damage.

224. Shellfish are considered to have a medium sensitivity to temporary habitat disturbance and direct damage.

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

225. The low magnitude of impact for DBS East as the worst case scenario , combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

226. The low magnitude of impact for DBS East as the worst case scenario , combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

227. The low magnitude of impact for DBS East as the worst case scenario, combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.1.5 Significance of Effect – DBS East and DBS West Together

228. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

229. The low magnitude of impact for both Projects DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms.

230. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that temporary habitat disturbance and direct damage has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.2 Impact 2: Increase in Local Suspended Sediment Concentrations and Sediment Settlement

231. There is the potential for temporary increases in local SSC via cable repair and / or remediation works on the array cables, Inter-Platform Cables, and / or Offshore Export Cables. The sediments of the Offshore Development Area have a very low concentration of fine sediments, and therefore any suspension is predicted to be short-term, localised, and within the extent of natural variation for that area.

232. It should be noted that this impact would occur episodically and be highly localised to the individual locations of operation and maintenance events over the full duration of the operational period, not as a single event. The worst cases presented below represent the combined volume of SSC from all operation and maintenance events.

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

233. The worst case scenario for area of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational phase of DBS East and DBS West is 1,666,500m² (1,534,500m² for jacking-up activities, 108,000m² for array cable repairs, 24,000m² for inter-platform cable repairs, and 84,000m² for Offshore Export Cable repairs). Sediment plume modelling undertaken for the construction phase (see section 10.6.1.2) has been used to determine a worst case scenario for the operational phase.

234. Modelling for construction activities such as seabed preparation or foundation installation indicates average SSCs in the Array Areas will increase by 2mg/l above background at the seabed surface, decreasing to 0.5mg/l above background near the seabed. SSCs return to baseline conditions within a maximum of 5km of the area of disturbance. The disturbance effects at each wind turbine location are last for no more than a few hours. For the Offshore Export Cable Corridor modelling predicted SSCs would reach average concentrations 5mg/l above baseline at the seabed. Sediment plumes are expected to return to background levels within 7km of the Offshore Export Cable Corridor, settling up to four hours following works along the Offshore Export Cable Corridor, and up to seven hours after works within the Array Areas. For the operational phase works are anticipated to be of a greatly reduced scale and frequency, as indicated by the total volume of displaced sediment.

235. Due to the short-term and localised nature of the impact pathway, the loss of individuals as a result of an increase in SSC and sediment settlement would be expected to fully recover within the short term (0 – 2 years), accounting for the worst case scenario volume of sediment mobilised by DBS East or DBS West in Isolation. However, the effect would be slightly elevated compared to background conditions and would remain within the range of natural variation. Therefore, the magnitude of impact is considered low, as a precaution.

10.6.2.2.2 Magnitude of Impact – DBS East and DBS West Together

236. The worst case scenario for area of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational phase of both Projects together is 3,485,000m² (3,069,000m² for jacking-up activities , 204,000m² for array cable repairs, 72,000m² for inter-platform cable repairs, and 144,000m² for Offshore Export Cable repairs).

237. When evaluating the two Projects combined, the total number of potential repairs is just under double that of any Project individually as this scenario considers reduction of 12,000m² for array cable repairs over the Projects lifetime. However, it is unlikely that the number of repairs at any one time would increase significantly. Therefore, although the total volume of sediment disturbed with each repair would be the same as for either Project in isolation, there is more likelihood of less time between repairs, and therefore between disturbance events.

238. Based on modelling, suspended sediment peaks are not expected to exceed 250mg/l up to 1km from the export cable corridor settling within a period of days, with sediment deposition outside of the direct impact site predicted to range between 0.05m and 0.005m.

239. Due to the short-term and localised nature of the impact pathway, the loss of individuals as a result of an increase in SSC and sediment settlement would be expected to fully recover within the short term (0 – 2 years), accounting for the worst case scenario volume of sediment mobilised by both Projects together. However, the effect would be slightly noticeable compared to background conditions, and would remain within the range of natural variation. Therefore, the magnitude of impact is considered low, as a precaution.

10.6.2.2.3 Sensitivity of Receptor Groups

240. The sensitivity for fish and shellfish receptor groups have been assessed in section 10.6.1.2.3.

241. Adult elasmobranch, demersal fish, pelagic fish, and migratory fish species are considered to have a negligible sensitivity to an increase in SSC and sediment settlement.

242. The eggs and / or larvae of elasmobranchs, demersal fish, and pelagic fish species are considered to have a medium sensitivity to an increase in SSC and sediment settlement.

243. Shellfish species are considered to have a medium sensitivity to an increase in SSC and sediment settlement.

10.6.2.2.4 Significance of Effect – DBS East and DBS West in Isolation

244. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **negligible** effect, and is therefore not significant in EIA terms.

245. The low a magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms.

246. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.2.5 Significance of Effect – DBS East and DBS West Together

247. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase SSC and sediment settlement during the operational phase has a **negligible** effect, and is therefore not significant in EIA terms.

248. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement during the operational phase has a **minor adverse** effect, and is therefore not significant in EIA terms.

249. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that an increase in SSC and sediment settlement in the operational phase has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.3 Impact 3: Release of Sequestered Contaminants Following Sediment Disturbance

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

250. As described within section 10.6.1.3, site specific survey has demonstrated contamination of sediments across the Offshore Development Area is limited with levels of contaminants generally below sediment quality guideline thresholds. In addition, the nature of sediments (sands and gravels with limited fines components) across the Offshore Development Area significantly reduces the potential for accumulation of contaminants.

251. Due to the localised, short-term disturbance of sediments, and the low likelihood of significant contamination within the Offshore Development Area, the magnitude of impact is considered negligible.

10.6.2.3.2 Magnitude of Impact – DBS East and DBS West Together

252. Based on modelling of sediment suspension and studies of contaminant levels and sediment types across the Offshore Development Area, it is considered that both the level of suspended sediment release (expected to be localised, short-term, and episodic) and the levels of contaminants would be low. Therefore, the magnitude of impact is considered negligible.

10.6.2.3.3 Sensitivity of Receptor Groups

253. The sensitivity for fish and shellfish receptor groups have been assessed in section 10.6.1.3.3.

254. All fish and shellfish receptor groups are therefore considered to have a low sensitivity to the release of sequestered contaminants following sediment disturbance.

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

255. The negligible adverse magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.3.5 Significance of Effect – DBS East and DBS West Together

256. The negligible adverse magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that the release of sequestered contaminants following sediment disturbance has a **negligible** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.4 Impact 4: Impacts on Fish and Shellfish Species as a Result of Underwater Noise and Vibration

257. During the operational phase of the Projects, noise has the potential to be produced via vibrations associated with the rotating machinery in the wind turbines. This noise may then be transmitted into the seabed and local water column. Noise produced via this mechanism is considered to be non-impulsive and continuous. Modelling undertaken within the **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)** assumes that all wind turbines associated with the Projects are operational 24 hours per day, and that receptors would not exhibit fleeing behaviour. Exposure thresholds for fish with a swim bladder used in hearing are presented in **Table 10-25**.

Table 10-25 Impact Thresholds for Fish With a Swim Bladder Used in Hearing Relating to Operational Noise of Wind Turbine (SPL_{RMS} *= Sound Pressure Level Route Mean Square)*

Unweighted SPLRMS (Popper et al., 2014)	Wind Turbine (small)	Wind Turbine (large)
Recoverable injury 170dB (48 hours) Unweighted SPL_{RMS}	< 50m	< 50m
Temporary Threshold Shift 158dB (12 hours) Unweighted SPL_{RMS}	< 50m	< 50m

258. Additional noise may be produced during the operational phase via the same impact pathways identified during the construction phase of the Projects (see section 10.6.1.4). Underwater noise scenarios that are expected to occur during operation (e.g. maintenance vessel noises), have the potential to occur during day-to-day maintenance, repair, and / or emergency works associated with the Projects following commissioning. Impact piling and UXO clearance are not anticipated post-construction. Underwater noise emissions within these categories would occur primarily during the construction phase of the Projects, and therefore the assessments provided within section 10.6.1.4 represents the worst case scenario for these impacts in the operations phase of the Projects.

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

259. Noise exposure associated with operation of the DBS West wind turbines, at both TTS and recoverable injury, present thresholds of <50m following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, it is not considered likely that this would result in impacts to any receptor groups. Therefore, when considering effects associated with operational noise, the impact on fish and shellfish is considered negligible. Underwater noise associated with potential maintenance works and vessel traffic has the potential to occur during the operational phase as a result of maintenance activities. These impacts are assessed within section 10.6.1.4 and are determined to be negligible.

260. Therefore, the magnitude of impact for underwater noise and vibration during operation is considered to be negligible.

10.6.2.4.2 Magnitude of Impact – DBS East and DBS West Together

261. Noise exposure associated with operation of both DBS East and DBS West wind turbines together, for both TTS and recoverable injury present thresholds of <50m following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, it is not considered likely that this would result in impacts to any receptor groups. Therefore, when considering effects associated with operational noise, the impact on fish and shellfish is considered negligible. Underwater noise associated with potential maintenance works and vessel traffic has the potential to occur during the operational phase as a result of maintenance activities. These impacts are assessed within section 10.6.1.4 and are determined to be negligible.

262. Therefore, the magnitude of impact for underwater noise and vibration during operation is considered to be negligible.

10.6.2.4.3 Sensitivity of Receptor Groups

263. As presented within **Table 10-25**, the most sensitive receptor group, fish with a swim bladder used in hearing, would need to remain <50m for a wind turbine for >48 hours to experience recoverable injury. The sensitivity of the most sensitive fish and shellfish receptor group to this type of underwater noise and vibration is considered negligible.

264. Sensitivities associated with piling, UXO and other noise sources are assessed within section 10.6.1.4. Impacts resulting from underwater noise during the operations phase of the Projects are likely to be limited both spatially and temporally, and recovery of any given stock is likely to occur rapidly. Fish with a swim bladder used in hearing are determined as having a medium sensitivity to underwater noise and vibration, with all other receptor groups presenting a low sensitivity to underwater noise and vibration.

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

265. The negligible magnitude of impact for DBS West (or DBS East), combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration at the operation phase have a **minor adverse** effect, and is therefore not significant in EIA terms.

266. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with negligible magnitude of impact, results in the assessment that impacts associated with noise and vibration at the operation phase have a **negligible adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.4.5 Significance of Effect – DBS East and DBS West Together

267. The negligible magnitude of impact for DBS West (or DBS East), combined with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment, that impacts associated with noise and vibration at the operation phase have a **minor adverse** effect, and is therefore not significant in EIA terms.

268. All other fish and shellfish receptor groups present low sensitivity of effect, which combined with negligible magnitude of impact, results in the assessment, that impacts associated with noise and vibration at the operation phase have a **negligible adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.5 Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area.

269. Commercial fishing within operational wind farms is not restricted under UK legislation. It has been assumed that during the operational phase, all cables would be buried, or have external cable protection. Therefore, the only material loss of fishing grounds would be at locations where infrastructure is built out during the construction phase. As determined within **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**, this assessment has been made on the assumption that the Dogger Bank SAC Byelaw is revoked to present a worst case assessment. Therefore, the degree to which fishing activity is restricted within the Array Area is determined primarily by gear type of individual vessels, as well as the risk tolerance of individual skippers.

270. Whilst not restricted through any legal mechanism (with the exception of any temporary 500m safety zones surrounding ongoing cable repair and / or remediation works), fishing activities within the Array Areas, individual decisions made by skippers with their own perception of risk would contribute to the likelihood of whether their fishing would resume within the Array Areas. The dimension and type of fishing gear deployed would be a significant contributor to risk perception, in addition to specific weather and tidal conditions.

271. Gear types that are both mobile and interact directly with the seabed pose the highest risk of entanglement. Therefore, dredge and otter trawl gear types are most likely to reduce in frequency within the Array Areas. However, as determined within **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**, there remains the potential for resumed fishing within the Array Area and between wind turbines, where allowed by local byelaws.

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

272. As the potential for fishing for all gear types remains throughout the operational phase of both DBS East and DBS West independently, it cannot be determined that any proportion of the Array Area would experience a reduction in fishing pressure when considering the worst case scenario. The impact is considered to be lower than that anticipated for the construction phase. The impact is not anticipated to result in any effect, with no change noticeable from natural variation. Therefore, the magnitude of impact is considered negligible.

10.6.2.5.2 Magnitude of Impact – DBS East and DBS West Together

273. As the potential for fishing for all gear types remains throughout the operational phase of DBS East and DBS West together, it cannot be determined that any proportion of the Array Area would experience a reduction in fishing pressure when considering the worst case scenario. The impact is anticipated to not result in any effect with no change noticeable from natural variation. Therefore, the magnitude of impact is considered negligible.

10.6.2.5.3 Sensitivity of Receptor

274. It is possible that a reduction in trawling activity within the region may allow for spawning and nursery grounds to establish due to the reduction in disturbance. These spawning grounds have the potential to result in an increase in fish and shellfish biomass in the Fish and Shellfish Ecology Study Area.

275. In the adult life stage, many of the species comprising the Fish and Shellfish Ecology receptor groups exhibit a high degree of motility. Whilst an area of reduced fishing pressure may reduce the mortality of individuals, individuals are unlikely to remain within an area of such limited size for a period long enough to allow for a measurable change at the population level.

276. Further, whilst it is possible that a reduction in fishing pressure within the Array Area may occur, this is dependent of the risk tolerance of individual skippers. Therefore, in a worst case scenario no given area of habitat likely to benefit from this impact can be determined. Fish and shellfish receptor groups are therefore considered to be entirely tolerant and / or adaptable to the effect, with no change anticipated. All fish and shellfish receptor groups are therefore considered to have a negligible sensitivity to reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area.

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

277. The negligible magnitude of impact for DBS East and DBS West in isolation, combined with the negligible sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas, and increased fishing pressure outside of the Array Area has a **negligible** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.5.5 Significance of Effect – DBS East and DBS West Together

278. The negligible beneficial magnitude of impact for the Project (DBS East and DBS West), combined with the negligible sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a **negligible** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.6 Impact 6: Permanent Loss of Habitat and / or Change in Habitat Type as a Result of Changes in Substrate Composition

279. Permanent loss of habitat and / or change in habitat type during the operational phase would occur due to the presence on the seabed of foundations, array cables, Offshore Export Cables, scour and cable protection.

280. Impacts assessed within this section would be present from the moment of installation, noting that this would be during the construction phase of the Project. However, as impacts may remain throughout the operational lifetime of the Project, they have been included within the section of the chapter.

281. Some structures may be removed during decommissioning; however, it is not known to what extent removal would occur. It is anticipated that all structures above the seabed would be removed and it is possible that some infrastructure would remain under the seabed. As a precautionary measure, habitat loss has been considered here as permanent.

10.6.2.6.1 Magnitude of Impact - DBS East or DBS West in Isolation

282. The worst case scenario for permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase of DBS East is 2.09km^2. This represents approximately 0.007% of the total Fish and Shellfish Ecology Study Area. This is the worst case habitat loss for the total Array Area (0.89km^2) and the total Offshore Export Cable Corridor (1.20km^2) as presented within **Table 10-1**. This value includes all seabed infrastructure including foundations, scour protection, cable protection, and cable and pipeline crossings that will result in a change from pre-construction seabed composition.

283. The worst case scenario for permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase of DBS West is $1.91km^2$. This represents approximately 0.007% of the total Fish and Shellfish Ecology Study Area. This is the worst case habitat loss for the total Array Area ($0.92km^2$) and the total Offshore Export Cable Corridor ($0.99km^2$) as presented within **Table 10-1.** This value includes all seabed infrastructure including foundations, scour protection, cable protection, and cable and pipeline crossings that will result in a change from pre-construction seabed composition.

284. Of the two Projects, DBS East represents the worst case scenario in isolation. The assessment of permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition, would therefore assume this worst case scenario for either Project.

285. The Fish and Shellfish Ecology Study Area covers $26,858km^2$. The worst case scenario for permanent loss of habitat ($2.09km^2$) represents approximately 0.007% of the total Fish and Shellfish Ecology Study Area. The permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase would occur, and the effects would not be reversed within the lifespan of the Project. However, the effect would result in a change that is unnoticeable from background conditions, due to it representing a small percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered low.

10.6.2.6.2 Magnitude of Impact – DBS East and DBS West Together

286. The worst case scenario for permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase of both Projects is $4.19km^2$. This represents approximately 0.015% of the total Fish and Shellfish Ecology Study Area. This is the worst case habitat loss for the total Array Areas ($2.05km^2$) and the total Offshore Export Cable Corridor ($2.14km^2$).

287. The magnitude of permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition may be slightly reduced if construction of DBS East and DBS West is sequential, and not concurrent. This may allow local populations to displace into nearby areas that are not under construction, noting that there would remain a minimum three year period of construction where overlap occurs. However, as the loss of habitat is permanent, the potential for recolonisation is removed. If concurrent, local populations would be displaced from a greater area, and changes to the sediment may be higher.

288. The total worst case scenario area is 4.19km², which represents approximately 0.015% of the total Fish and Shellfish Ecology Study Area. The permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition associated with the operational phase would occur, and the effects would not be reversed within the lifespan of the Project. However, the effect would result in a change that is unnoticeable from background conditions due to it representing a small percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered low.

10.6.2.6.3 Sensitivity of Receptor Groups

289. Habitat loss from the installation of sub-sea infrastructure or from changes in substrate composition is likely to affect species that are of low mobility, or those with demersal life stages of high habitat specificity. Species at a higher trophic level that do not necessarily interact with the seabed, but that prey on these impacted species, may also be impacted by this effect.

290. Elasmobranch species are present in the area, including demersal species such as thornback rays and blonde rays. However, these species are considered to have a high tolerance and adaptability to impacts of habitat loss and / or changes in substrate due to their high mobility and wide, relatively flexible ranges. No elasmobranch spawning grounds overlap with the Fish and Shellfish Ecology Study Area, and although there are some elasmobranch nursery areas identified, these are concentrated in the southern portion, with no overlap of the Array Area or Offshore Export Cable Corridor. Elasmobranch species are generally considered to have a high tolerance and adaptability to habitat loss and / or disturbance to spawning and nursery areas due to their high mobility. Prey species are typically bound by the specific habitats and spatial locations in which they reside; whereas elasmobranchs have relatively larger ranges that provide a degree of flexibility, should prey species become less prevalent in certain areas. Elasmobranch species have a level of adaptability and tolerance to permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition that are anticipated to recover to baseline levels within 2 - 10 years. Elasmobranch species are therefore considered to have a low sensitivity to permanent loss of habitat and / or change in habitat type as a result of changes in substrate.

291. Within the Offshore Development Area, permanent loss of habitat and / or change in habitat type as a result of changes in substrate are likely to affect demersal fish species. Demersal species common in the area include anglerfish, Atlantic cod, Dover sole, blue whiting, European hake, plaice, ling, whiting, bass, and sandeel species. Sandeel species are of particular

concern as they are an important prey species for birds, and are sensitive to changes in the seabed across all life stages. As discussed in section 10.5.3.2 and section 10.5.3.3, sandeel and Atlantic herring have a heightened sensitivity to any disturbance of the seabed due to their life histories and particularly their spawning strategies, and are therefore considered more sensitive to temporary habitat disturbance and direct damage. Both Array Areas contain areas characterised as having a potential for sandeel habitat. However, DBS West is predominantly classed as having a high potential, while DBS East is predominantly medium potential, Therefore DBS West is the worst case scenario both for permanent habitat loss and also for potential sandeel habitat. There are also medium to high potential spawning areas, and isolated areas of very high spawning potential, present within the Offshore Export Cable Corridor. Demersal fish species in the area are species of national importance that are anticipated to recover to baseline levels within 2 - 10 years. Demersal fish species are therefore considered to have a medium sensitivity to permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.

292. Pelagic fish also have spawning grounds that overlap with the worst case scenario footprint for permanent loss of habitat and / or change in habitat type as a result of changes in substrate. Although most pelagic species have pelagic spawning strategies, others (including Atlantic herring) have demersal spawning strategies, that increase their sensitivity to disturbance of the seabed and habitat loss. As these fish preferentially select certain seabed types, loss of these preferred sediments for spawning, may result in negative impacts on the population. The DBS East Array Area is predominantly classed as having no potential for Atlantic herring spawning, however, the DBS West Array Area is classed as having no to medium potential. Therefore, of these two sites, DBS West represents the worst case scenario. The Offshore Export Cable Corridor is classed as having no to high herring spawning potential, as well as isolated patches of very high spawning potential. Pelagic fish species in the area are species of national importance that are anticipated to recover to baseline levels within 2 - 10 years. Pelagic fish species are therefore considered to have a medium sensitivity to permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.

293. Migratory fish species are not considered to be dependent on seabed sediment composition at any stage of their life-history, and therefore no impact pathway for permanent loss of habitat and / or change in habitat type as a result of changes in substrate exists for these species. Following exposure, no change in the receptor population is anticipated. Migratory fish species are therefore considered to have a negligible sensitivity to permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.

294. Shellfish species present in the area (including European lobster, brown crab, king and queen scallops, Norway lobster and common whelk) are likely to be impacted by permanent loss of habitat and / or change in habitat type as a result of changes in substrate. These species are predominantly reliant on the seabed habitat following their pelagic larval stage. As such, they have a lower tolerance and lower adaptability to loss of habitat or changes in the substrate. However, shellfish species may have higher fecundity compared to demersal fish species, and therefore a higher potential for population recovery following disturbance. Importantly, shellfish are of high commercial value in the area encompassing both Projects. Following exposure, shellfish populations are anticipated to recover to baseline levels within 2 - 10 years. Shellfish are therefore considered to have a medium sensitivity to permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.

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

295. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

296. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West, as well as the worst case for sandeel and Atlantic herring spawning), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups with demersal spawning, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

297. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.6.5 Significance of Effect – DBS East and DBS West Together

298. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

299. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups with demersal spawning, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

300. The low magnitude of impact for both Projects (DBS East and DBS West), combined with the medium sensitivity of effect for the shellfish receptor group, results in the assessment that permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.7 Impact 7: EMF Effects Arising From Cables

301. Electromagnetic fields (EMFs) may impact fish and shellfish species within the Offshore Development Area. EMFs are produced when electricity passes through a conductor (e.g. sub-sea cables), and have the potential to cause barrier / attraction effects dependent on the species, and the spatial scale of EMF. EMF comprises both an electric field (E field) and a magnetic field (B field), which may interact with or disrupt fish and shellfish species that use these phenomena for navigation or foraging (through specialised organs). The E field is confined within the cable itself through the use of insulating and shielding layers. This assessment therefore relates to B fields only.

302. The strength of the EMFs produced by underwater cables is dependent on a variety of factors including distance from the cable, whether the cable is in sediment or sea water, speed and direction of water flow, and strength of the magnetic field (the electric field is confined by the insulating layer of the cable). EMF strength dissipates rapidly with increasing distance from the source; for example, the average wind farm array cable buried 1m below the seabed would decrease from 7.85μT directly next to the cable (0m) to 1.47μT at 4m distance (Normandeau *et al*., 2011). Localised heating of sea water may occur, but this is limited to distances of tens of cm, and is likely to be of small magnitude, therefore no additional impact is predicted from heating effects (Boehlert and Gill, 2010; Moray Offshore Windfarm Ltd, 2018).

303. Total volume of EMF for each worst case scenario is calculated within this section. Calculations for EMF assume a worst case burial depth of 0.5m, a cable diameter of 0.3m, and that EMF remains detectable up to a distance of 4m from the cable surface. Cables laid on the seabed surface would be covered with external cable protection, therefore, no receptor species would be exposed within 0.5m of the source.

304. This EMF volume is contextualised by presenting it as a percentage of the total volume of the water column within the Array Areas, Inter-Platform Cabling Corridor and Offshore Export Cable Corridor for each Development Scenario. This 'water column volume' has been calculated based on the footprint of and the Array Areas and Offshore Export Cables during the construction phase, multiplied by water depth. Water depth varies across the Offshore Development Area, and therefore the following average water depths are used throughout this assessment:

- DBS East = 23.3m;
- DBS West =28.4m; and
- Offshore Export Cable Corridor = 45.9m.

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

305. The worst case scenario for cable properties with the potential to cause EMF effects during the operational phase of DBS East is 701km of cable length, with a minimum burial depth of 0.5m. The worst case for Offshore Export Cables is 376km of cable (two cables of 188km length), with a maximum voltage of 525kV direct current (DC), whereas the worst case for array cables is 325km cable length with a maximum voltage of 132kV.

306. The worst case scenario for cable properties with the potential to cause EMF effects during the operational phase of DBS West is 631km of cables length, with a minimum burial depth of 0.5m. The worst case for Offshore Export Cables is 306km of cable (two cables of 153km length) with a maximum voltage of 525kV direct current (DC), whereas the worst case for array cables is 325km cable length with a maximum voltage of 132kV.

307. Of the two Projects, the DBS East represents the worst case scenario in isolation. The assessment of EMF effects arising from cables during the operational phase would therefore assume this worst case scenario.

308. Based on the cable properties for DBS East, the worst case volume of water containing detectable EMF from buried (0.5m) array cables is 7.45km^3. This represents 0.06% of the water volume within the DBS East Array Area (11,521.85km^3).

309. The worst case volume of water in the water column containing identifiable EMF from buried Offshore Export Cables associated with DBS East is 8.62km^3. This represents 2.50% of the local water column volume associated with the Offshore Export Cable Corridor (344.7km^3).

310. The total worst case volume of water containing identifiable EMF associated with DBS East cables is 16.06km^3. This represents 0.14% of the local water column volume associated with the footprint of the DBS East array cables and Offshore Export Cables (11,866.60km^3). EMF would be present throughout the operational lifespan of the Projects. However, this would result in a change that is unnoticeable from background conditions due to it representing a negligible percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered negligible.

10.6.2.7.2 Magnitude of Impact – DBS East and DBS West Together

311. The worst case scenario for cable properties with the potential to cause EMF effects during the operational phase of both Projects together (DBS East and DBS West) is 1,332km of all cable with a minimum burial depth of 0.5m. The worst case for Offshore Export Cables is 682km of cable length, with a maximum voltage of 525kV DC, whereas the worst case for array cables is 650km cable length, with a maximum voltage of 132kV.

312. Based on the cable properties for both Projects combined (DBS East and DBS West), the worst case volume of water containing detectible EMF from buried (0.5m) array cables is 14.89km^3. This represents 0.06% of the local water column volume associated with the array cables of both Projects combined (25,516.2km^3).

313. The worst case volume of water in the water column containing identifiable EMF from buried Offshore Export Cables is 15.63km³. This represents 2.50% of the water column volume associated with the Offshore Export Cables of both Projects combined (12,516.5km³).

314. The total worst case volume of EMF for all cables is 30.52km³. This represents 0.12% of the water column volume containing detectable EMF associated with the array cables and Offshore Export Cables of both Projects combined (26,141.87km³). EMF would be present throughout the operational lifespan of the Projects. However, this would result in a change that is unnoticeable from background conditions due to it representing a negligible percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered negligible.

10.6.2.7.3 Sensitivity of Receptor Groups

315. Elasmobranchs are considered the most sensitive receptor group to EMF effects, due to the presence of electrosensitive sensory organs, such as the Ampullae of Lorenzini, used for navigation and to detect electric fields associated with prey species. It is not fully understood whether the detection of EMFs by elasmobranchs may cause a barrier effect, or an attractive effect, or whether this may vary dependent on EMF magnitude. In some elasmobranch species (e.g. thornback rays), EMF detection may be used by embryos within the egg case to detect potential predators and modify behaviour (Ball *et al*., 2015). In this example, EMF disruption may interrupt oxygen regulation within the egg case, or may increase predation. Although only a small total area of the wider Fish and Shellfish Ecology Study Area would be impacted by EMF effects from array cables or Offshore Export Cables, ray species are common within the Fish and Shellfish Ecology Study Area, and elasmobranchs rely heavily on electrosensitive sensory organs. Elasmobranch species show limited tolerance to EMF effects and may be exposed throughout the duration of the operational phase. However, this group are highly mobile and are likely to move away from the source, and the receptor population is anticipated to recover to baseline levels within 2 - 10 years. Therefore, elasmobranch species are considered to have a medium sensitivity to EMF effects from cables.

316. Other fish receptor groups (e.g. pelagic, demersal, and migratory) are comparatively less reliant on electrosensitivity and are highly mobile and / or exhibit flexibility in their range of habitats. It is therefore likely that these species, if displaced by EMF effects, would find suitable habitat elsewhere in the offshore area, or in the wider Fish and Shellfish Ecology Study Area. Although barrier effects on migratory fishes are not predicted to occur for most species, European eel are thought to utilise magnetic fields for navigation and have been shown to exhibit behavioural responses to EMFs at high magnitude (Westerberg & Lagenflet, 2008). However, this response occurs at an order of magnitude greater than those planned for the Projects, and these species spend the majority of their time in the upper water column while migrating and are thus outside of the predicted spatial extent of any EMFs generated by buried cables. Demersal, pelagic, and migratory fish species therefore have a high level of adaptability and tolerance to EMF effects during the operational phase, and are anticipated to recover to baseline levels within one year following exposure. Therefore, demersal, pelagic, and migratory species are considered to have a low sensitivity to EMF effects from cables.

317. Shellfish species have been shown to react variably to EMFs, both through physiological and behavioural responses. Most research on these responses has been performed in laboratory settings, and at EMF levels orders of magnitude greater than the average wind farm array cable buried 1m below the seabed (7.85μT) (Normandeau *et al*., 2011). For example, brown crabs exhibited responses at 500 - 1,000μT, but only limited responses below 250μT (Scott *et al*., 2021). Similarly, European lobster have been shown to modify their behaviour (proportion of large turns, and height above seabed) in response to EMFs, but only at 65.3μT (eight times higher than average for array cables) (Hutchinson *et al*., 2020). In the same species, although EMFs were found to disrupt larval development success, this was at a magnitude 350 times greater (2.8mT) than the average for array cables. Shellfish species are therefore expected to be entirely tolerant and adaptable to EMF effects at the level anticipated for the operational phase, and no change in the receptor population is anticipated following exposure. It is therefore concluded that shellfish species are considered to have a negligible sensitivity to EMF from sub-sea cables.

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

318. The negligible adverse magnitude of impact for DBS East (as the worst case scenario assigned to both DBS East and DBS West), combined with the medium sensitivity of effect for the elasmobranch receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **minor adverse** effect, and are therefore not significant in EIA terms.

319. The negligible adverse magnitude of impact for DBS East (as the worst case scenario assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the demersal, pelagic, and migratory fish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms.

320. The negligible adverse magnitude of impact for DBS East (as the worst case scenario assigned to both DBS East and DBS West), combined with the negligible sensitivity of effect for the shellfish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.2.7.5 Significance of Effect – DBS East and DBS West Together

321. The negligible adverse magnitude of impact for both Projects together, combined with the medium sensitivity of effect for the elasmobranch receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **minor adverse** effect, and are therefore not significant in EIA terms.

322. The negligible adverse magnitude of impact for both Projects together, combined with the low sensitivity of effect for the demersal, pelagic, and migratory fish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms.

323. The negligible adverse magnitude of impact for both Projects together, combined with the negligible sensitivity of effect for the shellfish species receptor group, results in the assessment that EMF effects arising from cables during the operational phase have a **negligible** effect, and are therefore not significant in EIA terms. No additional mitigation measures are considered to be required.

10.6.3 Potential Effects During Decommissioning

324. 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 within the most recent guidance, policy and legislation.

325. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, and the details would be agreed with the relevant authorities at the time of decommissioning. Offshore decommissioning is likely to include the removal of all of the wind turbine components and part of the foundations (those above sea level), removal of some or all of the array and Offshore Export Cables. Scour and cable protection would likely be left in situ. There would be no piling or UXO clearance.

326. 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 habitat disturbance to fish and shellfish species and spawning and / or nursery grounds;
- Increase in local SSC and sediment settlement;
- Release of sequestered contaminants following sediment disturbance; and
- Impacts on fish and shellfish species as a result of noise and vibration.

327. Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition, is assessed as an operational impact because it begins when the operation phase starts, following full installation of wind farm infrastructure.

328. The magnitude of decommissioning effects would be comparable to, or less than, the construction phase. Accordingly, given that the impacts were assessed to be of no greater than minor adverse significance for the identified Fish and Shellfish Ecology receptors during the construction phase, it is anticipated that the same would be true for the decommissioning phase as a reasonable worst case.

10.7 Assessment of Cumulative Effects

329. As detailed in section 10.4.4, this section presents an assessment of cumulative effects in relation to fish and shellfish ecology.

10.7.1 Screening for Cumulative Effects

330. Cumulative effects can be defined as incremental effects on that same receptor from other proposed and reasonably foreseeable schemes and developments in combination with the Projects. This includes all schemes that result in a comparative effect that is not intrinsically considered as part of the existing environment and is not limited to offshore wind projects.

331. The overarching method followed in identifying and assessing potential cumulative effects is set out in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** and **Volume 7, Appendix 6-2 Offshore Cumulative Assessment (application ref: 7.6.6.2).** The overall approach is based upon the Planning Inspectorate Advice Note Seventeen: Cumulative Effects Assessment (PINS, 2017) and Phase III Best Practice by Natural England and DEFRA (Parker *et al*., 2022). The approach to the CEA is intended to be specific to the Projects and takes account of the available knowledge or the environment and other activities around the Offshore Development Area.

332. The CEA has followed a four-stage approach developed from the Planning Inspectorate Advice Note Seventeen. These stages are set out in Table 1-1 of **Volume 7, Appendix 6-2 Offshore Cumulative Assessment (application ref: 7.6.6.2).** Stage four of this process, the CEA assessment is undertaken in two phases. The first step in the CEA is the identification of which residual impacts assessed for the Projects on their own have the potential for a cumulative impact with other plans, projects and activities. This information is set out in **Table 10-26** which sets out the potential impacts assessed in this chapter and identifies the potential for cumulative effects to arise, providing a rationale for such determinations. Only potential impacts assessed in section 10.6 where the potential for cumulative effects has been identified (minor, moderate or major), have been taken forward to the final CEA (i.e. those assessed as 'negligible' or 'no change' are not taken forward, as there is no potential for them to contribute to a cumulative effect). Each project has been considered on a case by case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial / temporal scales involved.

Table 10-26 Potential Cumulative Effects

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Construction			
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	No	High	These impacts are of limited spatial and temporal extent, relative to the identified fish and shellfish receptor groups within the Fish and Shellfish Ecology Study Area. Management plans will be developed to further mitigate impacts as described within **Table 10-3**.
Impact 2: Increase in Local Suspended Sediment Concentrations and Sediment Settlement.	No	High	
Impact 3: Release of Sequestered Contaminants Following Sediment Disturbance.	No	High	
Impact 4: Impacts on Fish and Shellfish Species as a Result of Noise and Vibration.	Yes	High	Underwater noise from other developments within the region have the potential to overlap with impacts produced during construction associated with the Projects.
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area	No	High	Impacts associated with fishing pressure are of limited spatial and temporal extent, relative to the identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area.

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
Operation & Maintenance			
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	No	High	These impacts are of limited spatial and temporal extent, relative to the identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area. Management plans will be developed to further mitigate impacts as described within **Table 10-3**.
Impact 2: Increase in Local Suspended Sediment Concentrations and Sediment Settlement.	No	High	
Impact 3: Release of Sequestered Contaminants Following Sediment Disturbance.	No	High	
Impact 4: Impacts on Fish and Shellfish Species as a Result of Noise and Vibration.	Yes	High	Underwater noise from other developments within the region have the potential to overlap with impacts produced during operation associated with the Projects.
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area	No	High	Impacts associated with fishing pressure are of limited spatial and temporal extent, relative to the identified Fish and Shellfish receptor groups within the Fish and Shellfish Ecology Study Area.
Impact 6: Permanent Loss of Habitat and /	Yes	High	Permanent habitat loss in combination with

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
or Change in Habitat Type as a Result of Changes in Substrate Composition.			similar loss associated with other developments in the region may result in a significant effect.
Impact 7: EMF Effects Arising from Cables.	No	High	The spatial extent of EMF is anticipated to remain within the immediate vicinity of Project cables, with burial minimising impact to negligible significance for most receptor groups.
Decommissioning			
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	No	High	These impacts are of limited spatial and temporal extent, relative to the identified fish and shellfish receptor groups within the Fish and Shellfish Ecology Study Area. Management plans will be developed to further mitigate impacts as described within **Table 10-3**.
Impact 2: Increase in Local Suspended Sediment Concentrations and Sediment Settlement.	No	High	
Impact 3: Release of Sequestered Contaminants Following Sediment Disturbance.	No	High	
Impact 4: Impacts on Fish and Shellfish Species as a Result of Noise and Vibration.	Yes	High	Underwater noise from other developments within the region have the potential to overlap with impacts produced during

Impact	Potential for Cumulative Effects	Data Confidence	Rationale
			decommissioning associated with the Projects.

10.7.2 Schemes Considered for Cumulative Impacts

333. The second phase of the CEA is a project specific assessment of the potential for any significant cumulative effects to arise due to the construction and / or operation and maintenance of the Projects. To do this, a short-list of schemes for the CEA has been produced relevant to [fish and shellfish ecology following the approach outlined in **Volume 7, Offshore Cumulative Assessment Appendix 6-2 (application ref: 7.6.6.2).** The second phase of this assessment is only undertaken if the first phase identifies that cumulative effects are possible.

334. The CEA has been based on information available on each relevant scheme as of January 2024. It is noted that further information regarding the identified schemes may become available in the period up to construction, or may not be available in detail at all prior to construction. The assessment presented here is therefore considered to be conservative, with the level of impacts expected to be reduced compared to those presented here.

335. Schemes have been assigned a tier, based on information used within the CEA. A seven tier system, based on the guidance issued by Natural England and Defra (Parker *et al.*, 2022), has been employed as presented in **Volume 7, Offshore Cumulative Assessment Appendix 6-2 (application ref: 7.6.6.2).**

336. This approach has been agreed via EIA Scoping and consultation with technical working groups and follows advice from Natural England. Further information on the methodology can be found in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6**).

337. Types of schemes that could potentially be considered for the cumulative assessment of fish and shellfish include:

- Other offshore wind farms;
- Strategic plans;
- Protected Areas;
- Carbon Capture Storage (CCS);
- Marine aggregate extraction;

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

338. With respect to these types of schemes, for those that are fully operational (ie. Tier 1 schemes) at the time of this assessment, the cumulative assessment methodology considers them to be part of the baseline conditions for the surrounding area (and assumes that any residual effect has been captured within the baseline). As such, it is not expected that the Projects would contribute to cumulative effects with these existing activities and, therefore, these have not been the subject of further assessment.

339. For schemes that are not currently fully operational, i.e. those in planning / pre-construction stages, or even where construction may have commenced but not yet be complete, these are screened in for further assessment in the final cumulative assessment.

340. For schemes that are not currently fully operational, i.e. those in planning / pre-construction stages, or even where construction may have commenced but is not yet complete, these are screened in for further assessment in the final cumulative assessment.

341. Schemes screened in for assessment in the CEA, and their distance to the Array Areas and Offshore Export Cable Corridor for the Projects are provided below in **Table 10-27.**

Table 10-27 List of Schemes Screened for Further Assessment in the Final CEA

Tier	Schemes	Closest distance to (km):	
		Export Cable Corridor	Array Area
Offshore Wind Farms and associated export cables			
1	Westermost Rough	24	112
1	Westermost Rough export cable	25	118
1	Humber Gateway	44	120
1	Humber Gateway export cable	41	124
2	Sofia	49	35

Tier	Schemes	Closest distance to (km):	
		Export Cable Corridor	Array Area
2	Sofia export cable	18	15
2	Dogger Bank A	20	8
2	Dogger Bank A export cable	0.25 (export cable corridor overlaps with the Projects 1km Construction Buffer Zone)	4
2	Dogger Bank B	20	17
2	Dogger Bank B export cable	0.25 (export cable corridor overlaps with the Projects 1km Construction Buffer Zone)	8
3	Dogger Bank C	73	56
3	Dogger Bank C export cable	17	15
3	Hornsea Project Three	62	45
3	Hornsea Project Three export cable	62	45
3	Hornsea Project Four	30	41
3	Hornsea Project Four export cable	0km (export cable corridor crosses the Projects)	41
6	Dogger Bank D	11	68 (estimated)
6	Dogger Bank D export cable	11	0 (export cable corridor runs adjacent to DBS East Array Area
Carbon Capture and Storage			
1	Northern Endurance	12	37

Tier	Schemes	Closest distance to (km):	
		Export Cable Corridor	**Array Area**
1	Northern Endurance pipeline	0 (pipeline crosses the Projects Offshore Export Cable Corridor)	45
1	CCS North Sea Leasing Round SNS Area 1 - Licence CS020 & CS025	0 (overlaps Projects Offshore Export Cable Corridor and Array Areas)	
1	CCS North Sea Leasing Round SNS Area 3 – Licence CS028	0 (overlaps Projects Offshore Export Cable Corridor)	92
1	CCS North Sea Leasing Round – SNS Area 5	46	26
1	CCS North Sea Leasing Round – SNS Area 6	35	69
1	CCS North Sea Leasing Round – SNS Area 7	30	8
Subsea Cables			
1	Viking Link Interconnector	44	29
3	Eastern Green Link 2 (EGL2)	2	77
6	Eastern Green Link 3 (EGL3)	0 (potentially crosses Projects Offshore Export Cable Corridor)	Not available
6	Eastern Green Link 4 (EGL4)	0 (potentially crosses Projects Offshore Export Cable Corridor)	Not available
7	Aminth Energy Interconnector*	Not available	Not available
7	Continental Link*	Not available	Not available

Tier	Schemes	Closest distance to (km):	
		Export Cable Corridor	Array Area
7	National Grid HND Bootstrap*	Potentially within the Array Areas	Not available

**Cable route not yet finalised*

342. The CEA assumes the worst case scenario for fish and shellfish ecology. Therefore, the construction, operation, and decommissioning of DBS West and DBS East concurrently and / or in sequence is assessed within the CEA.

10.7.3 Potential Cumulative Effects during Construction

10.7.3.1 Impact 4: Impacts on fish and shellfish species as a result of noise and vibration

343. There is the potential for cumulative effects to occur as a result of noise and vibration associated with the Projects in combination with other users and developments.

344. The schemes identified in **Table 10-27** have been considered and further screened in or out of the noise and vibration cumulative assessment during construction based on the temporal and spatial scales involved, and the nature of the noise-generating activities. The construction period considered for the cumulative assessment spans 2027 - 2031 inclusive. This range is based on the programme assumption for a phased build, which represents the worst case scenario in terms of duration for impulsive noise-generating activities (e.g., UXO clearance, piling).

345. Certain impacts on fish and shellfish species as a result of noise and vibration are not carried forward in the assessment of cumulative effects, due to the localised nature of the impacts. Similarly, impacts that have been assessed as having a negligible significance from the Projects are not considered to have the potential for a significant cumulative impact with other projects. The impacts not considered for the cumulative assessment are:

- Mortality and Potential Mortal Injury: these impacts are localised and where mortality occurs there is no residual pathway for cumulative effects;

- Temporary Injury: these impacts are predicted to be spatially and temporally limited;
- UXO clearance: UXO clearance is predicted to occur largely through deflagration, with clearance events extremely short in duration;
- Disturbance from geophysical / geotechnical surveys: disturbance impacts are predicted to be minimal, highly localised, and extremely short in duration; and
- Disturbance from non-impulsive noise-generating activities: disturbance is predicted to be highly localised and of negligible significance.

346. The impacts that are carried forward for assessment are therefore:

- Temporary Threshold Shift (TTS);
- Disturbance (based on 135 dB re 1 μPa^2s SEL_{ss} threshold).

347. Certain schemes that are screened in for cumulative effects through other impact pathways may be screened out for cumulative effects from noise and vibration. The schemes that are brought forward for assessment are those that have either a construction or operational period that overlaps with the construction period for DBS. Cumulative effects from noise and vibration are most likely to occur with schemes that have an overlapping construction period, due to the impulsive noise generated through piling activities, however projects in the operational phase may also produce impulsive noise through piling activities that may be required for repairs to infrastructure. The schemes considered for the cumulative assessment are listed in **Table 10-28**.

Table 10-28: List of schemes Screened for Assessment of Cumulative Effects from Underwater Noise and Vibration

Tier	Scheme	Construction Overlap	Project Phase
Offshore Wind Farms and associated export cables			
1	Westermost Rough	N/A	Operational
1	Westermost Rough export cable		
1	Humber Gateway	N/A	Operational

Tier	Scheme	Construction Overlap	Project Phase
1	Humber Gateway export cable		
2	Sofia	2024 Q1 – 2026 Q4	Construction
2	Sofia export cable		
2	Dogger Bank A	2022 Q3 – 2024 Q4	Construction
2	Dogger Bank A export cable		
2	Dogger Bank B	2023 Q2 – 2025 Q3	Construction
2	Dogger Bank B export cable		
3	Dogger Bank C	2024 Q2 – 2026 Q3	Consented
3	Dogger Bank C export cable		
3	Hornsea Project Three	2026 Q1 – 2029 Q3	Consented
3	Hornsea Project Three export cable		
3	Hornsea Project Four	2029 Q1 – 2032 Q1	Consented
3	Hornsea Project Four export cable		
6	Dogger Bank D	2027 Q1 – 2029 Q4	Scoping
6	Dogger Bank D export cable		
Carbon Capture and Storage			
1	Northern Endurance	Storage from 2026	Option for Lease
1	CCS North Sea Leasing Round SNS Area 1 - Licence CS020 & CS025	Not available	Leased

Tier	Scheme	Construction Overlap	Project Phase
1	CCS North Sea Leasing Round SNS Area 3 – Licence CS028	Not available	Leased
1	CCS North Sea Leasing Round – SNS Area 5	Not available	Leased
1	CCS North Sea Leasing Round – SNS Area 6	Not available	Leased
1	CCS North Sea Leasing Round – SNS Area 7	Not available	Leased
Sub-sea Cables			
1	Viking Link Interconnector	2027 Q2 – 2031 Q5	Operational
6	EGL 2	2024 Q1 – 2029 Q4	Scoping
7	EGL 3	Not available	Scoping
7	EGL 4	Not available	Scoping
7	Aminth Energy Interconnector	Not available	
7	Continental Link	Not available	
7	National Grid HND Bootstrap	Not available	

348. The 135 dB re 1 μPa²s SEL_{ss} disturbance threshold is based on a single strike, and represents an instantaneous behaviour response, as opposed to a response to a cumulative noise source (e.g. SEL_{cum}). Due to the impulsive nature and extremely short duration of single pile strikes, there is a negligible likelihood for additive effects for single strikes, particularly across multiple projects where strikes are outwith a single array. The combined impact of single strikes within a greater area causing an exodus of fish from the region is not considered realistic, as the 135 dB re 1 μPa²s SEL_{ss} disturbance threshold was not observed to elicit a swimming away or fleeing response in fish, but rather a change in school density (or change in orientation) in 50% of schools (Hawkins *et al.*, 2014). Furthermore, herring have been observed to be tolerant to impulsive sources in areas of high ambient noise (Peña *et al.*, 2013). Therefore, although the area encompassed by the 135dB re 1μPa²s behavioural response threshold is extensive it is not considered to represent a realistic area of effect.

349. Impact pathways for cumulative effects with projects that are in their operational phase are only present if the projects are undergoing repairs, and if those repairs require additional piling. Furthermore, the piling activities must occur simultaneously with piling activities at DBS. The likelihood of this impact pathway being present at any one time is exceedingly low, particularly for cumulative effects with more than one other project.

10.7.3.1.1 Magnitude of effect

350. Hornsea Project Three and Hornsea Project Four have a construction phase that overlaps with construction at DBS therefore it is possible, although unlikely, that piling activities may occur at the same time.

351. Embedded mitigation measures are in place with seasonal restrictions on piling along the Offshore Export Cable Corridor between August and October due to Atlantic herring spawning. These measures will limit piling events to periods where spawning is not predicted in the Offshore Export Cable Corridor (November-July). Impact piling and UXO noise sources pertain to discrete events, with noise and vibrations emissions occurring in the medium term (2 – 10 years). With these measures, effects associated with underwater noise and vibration via impact piling and UXO within the Offshore Export Cable Corridor or Array Area are likely to result in a change in underwater noise that is outside the natural variation, however the noise sources are discrete events that will occur in the medium term (2 – 10 years) during the construction period. Therefore the magnitude of impact for underwater noise and vibration is considered low.

10.7.3.1.2 Receptor Sensitivity

352. The sensitivity of fish and shellfish receptor groups to underwater noise and vibration varies based on the presence or absence of a swim bladder to inner-ear connection, with fish having a swim bladder used in hearing being most intolerant to underwater noise (Popper *et al*., 2014). This receptor group also has no adaptability to underwater noise and vibration as the impact is a result of physiological traits. Recovery of this receptor group to baseline levels following exposure is likely to occur within 2 - 10 years. Fish with a swim bladder used in hearing are therefore determined to have a medium sensitivity, in line with the determination made within section 10.6.1.4.

353. All other fish receptor groups, including fish eggs and larvae, and shellfish species, have an increased tolerance to underwater noise and vibration. Whilst species within these receptor groups are of importance within the North Sea, their populations are likely to recover to baseline levels within one year due to the high fecundity of the majority of fish and shellfish species, and the limited area over which these impacts would result in individual mortalities. Therefore, all other fish and shellfish receptor groups are determined to have a low sensitivity to underwater noise and vibration.

10.7.3.1.3 Significance of Impact

354. The likelihood of single piling strikes occurring at multiple projects concurrently within an overlapping distance is considered to be extremely low, and there is predicted to be high recoverability to TTS and behavioural disturbance. With mitigation, the cumulative magnitude of this impact is considered to be low. Combined with the medium sensitivity of effect for fish with a swim bladder used in hearing, the cumulative assessment of impact from underwater noise and vibration has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.7.4 Potential Cumulative Effects during Operation

10.7.4.1 Impact 4: Impacts on fish and shellfish species as a result of noise and vibration

10.7.4.1.1 Magnitude of effect

355. The cumulative magnitude of operation effects would be comparable to, or less than, the construction phase. Impact pathways only exist during the operational phase in the unlikely event that repairs involving piling are required. With mitigation, cumulative effects associated with underwater noise and vibration are likely to result in a change that within natural variation, due to the absence of Atlantic herring undertaking spawning activities at the time. Noise sources pertain to discrete events, with noise and vibrations emissions occurring in the medium term (2 – 10 years). Therefore, the magnitude of impact for underwater noise and vibration is considered low.

10.7.4.1.2 Receptor Sensitivity

356. For the Fish and Shellfish Ecology receptors identified during the construction phase (detailed in section 10.6.1.4), it is anticipated that the same would be true for the operational phase. Fish with a swim bladder used in hearing are determined to have a medium sensitivity.

10.7.4.1.3 Significance of Impact

357. Impacts would only occur if repairs are performed that require piling activity. With mitigation, the cumulative magnitude of this impact is considered to be low. Combined with the medium sensitivity of effect for fish with a swim bladder used in hearing, the cumulative assessment of impact from underwater noise and vibration has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.7.4.2 Impact 6: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition

10.7.4.2.1 Magnitude of effect

358. A cumulative permanent loss of habitat is anticipated to occur as a result of infrastructure associated with the Projects in combination with other users and developments. Worst case values of permanent habitat loss anticipated from the Project alongside the equivalent values relating to projects included within **Table 10-27** (where relevant) are presented within **Table 10-29**, all of which fall entirely or partially within the Fish and Shellfish Ecology Study Area. Note that a number of these developments would fall only partially within the Fish and Shellfish Ecology Study Area, with the table presenting total habitat loss across the full extent of each development.

359. Values have been sourced from the most recent revisions of relevant Environmental Statements where available. Selected values represent the worst case scenario for each development, with actual values having the potential to experience reduction prior to construction.

Table 10-29 Total area of worst case permanent / long term habitat loss anticipated for developments fully or partially within the Fish and Shellfish Ecology Study Area

Tier	Scheme	Worst case predicted permanent habitat loss (km^2)
Offshore Wind Farms and Export Cables		
N/A	Dogger Bank South + export cable	2.05 + 2.14
1	Westermost Rough*	0.02
2	Sofia + export cable	3.73 +1.34
2	Dogger Bank A + export cable	4.59 +1.36
2	Dogger Bank B + export cable	4.59 +1.36
3	Dogger Bank C + export cable	3.73 +1.34
3	Hornsea Project Three + export cable	2.86 + 1.34
3	Hornsea Project Four*	3.7
6	Dogger Bank D	Not available
Carbon Capture and Storage		
3	Northern Endurance	3.58
7	CCS North Sea Leasing Round SNS Area 1 - Licence CS020 & CS025	Not available
7	CCS North Sea Leasing Round SNS Area 3 – Licence CS028	Not available
7	CCS North Sea Leasing Round – SNS Area 5	Not available

Tier	Scheme	Worst case predicted permanent habitat loss (km²)
7	CCS North Sea Leasing Round – SNS Area 6	Not available
7	CCS North Sea Leasing Round – SNS Area 7	Not available
Sub-sea Cables		
2	Viking Link Interconnector	2.86
6	EGL 2	2.40
7	EGL 3	Not available
7	EGL 4	Not available
Total		**43.12**

** Export cable worst case predicted permanent habitat loss value not available*

360. A total value of 43.12km^2 represents 0.16% of the total Fish and Shellfish Ecology Study Area, itself comprising a total of 26,858km^2 across ICES rectangles 37F1, 37F2, 38F1, 38F2, 36E9, 37E9, 37F0, 37F1, 38F0, 38F1 and 36F0.

361. The permanent loss of habitat associated with the Projects in combination with wider developments is considered an irreversible effect that is certain to occur. However, the effect would result in a change that is unnoticeable from background conditions due to it representing a small percentage of the wider Fish and Shellfish Ecology Study Area. Therefore, the magnitude of impact is considered low.

10.7.4.2.2 Receptor Sensitivity

362. The sensitivity of fish and shellfish receptor groups to permanent habitat loss is determined by a number of factors including life histories, habitat requirements and species extent. The most sensitive receptor groups to permanent habitat loss are demersal and pelagic fish species, specifically those species that rely on specific seabed types for spawning and habitat. In particular, sandeel and Atlantic herring present a greater level of sensitivity to this impact than other species within the region. The sensitivity of these receptors is therefore considered to be medium, in line with the determination made within section 10.6.2.6.3.

10.7.4.2.3 Significance of Impact

363. As only a small component of the Fish and Shellfish Ecology Study Area and associated seabed habitat is likely to undergo permanent loss, the cumulative magnitude of this impact is considered to be low. Combined with the medium sensitivity of effect for the demersal fish, and pelagic fish receptor groups with demersal spawning, the cumulative assessment of impact from permanent loss of habitat and / or change in habitat type as a result of changes in substrate has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.7.5 Potential Cumulative Effects during Decommissioning

10.7.5.1.1 Magnitude of effect

364. The cumulative magnitude of decommissioning effects would be comparable to, or less than, the construction phase. There would be no piling or UXO clearance, therefore, the magnitude of impact for underwater noise and vibration is considered to be negligible.

10.7.5.1.2 Receptor Sensitivity

365. For the identified fish and shellfish ecology receptors during the construction phase (detailed in section 10.6.1.4), it is anticipated that the same would be true for the decommissioning phase. Fish with a swim bladder used in hearing are determined to have a medium sensitivity.

10.7.5.1.3 Significance of Impact

366. The cumulative magnitude of this impact is considered to be low. Combined with the medium sensitivity for fish with a swim bladder used in hearing, the cumulative assessment of impact from underwater noise and vibration has a **minor adverse** effect, and is therefore not significant in EIA terms.

10.8 Potential Monitoring Requirements

367. Monitoring requirements are described in **Volume 8, In-Principle Monitoring Plan (IPMP) (application ref: 8.23)** submitted alongside the DCO application and will be further developed and agreed with stakeholders prior to construction based on the IPMP and taking account of the final detailed design of the Projects.

368. Due to the potential for sandeel habitat within the region, and the confirmation of sandeel presence within the Array Areas by the benthic surveys undertaken to date, sandeel monitoring is included within the IPMP.

10.9 Transboundary Effects

369. Transboundary effects are defined as those where the effect passes beyond the UK EEZ into the receiving environment of another European Economic Area (EEA) state or on the interests of another EEA member state (e.g. offshore infrastructure, vessels), either directly or cumulative with neighbouring projects in the area.

370. There is the potential for transboundary effects to occur with regard to fish and shellfish ecology as a result of underwater noise and vibration (e.g. from piling operations or installation of infrastructure).

371. UXO clearance, for a high-order detonation with a donor charge, is not expected to cause mortality and potential mortal injury beyond 890m at 229dB (see section 10.6.1.4 and section 10.6.2.4).

372. Underwater noise with the potential to extend beyond the UK EEZ, into fish and shellfish habitats of the Netherlands, is only anticipated to be generated through piling activities. When considering piling, TTS for the most sensitive fish species (186dB; fish with a swim bladder) is expected to occur at a maximum range of 52km for a stationary receptor.

373. This impact is anticipated to be intermittent and short-term (maximum of five piles installed per 24 hours). Recovery of affected fish and shellfish populations is expected shortly after completion of piling, with a change that is unnoticeable from the natural variation. Due to the short-term nature of the transboundary effects, and that the TTS of any individuals from a given threshold area would be expected to fully recover within the short term (0 - 1 years), the magnitude of impact is considered negligible.

374. Fish and shellfish receptors in the Dutch EEZ, are at such a distance that exposure is anticipated to be limited and temporary. These receptors are therefore assessed as having a high level of tolerance and adaptability to the effect, and are anticipated to recover to baseline levels within one year. Fish and shellfish receptors are therefore assessed as having a low sensitivity.

375. The negligible adverse magnitude of transboundary effects, combined with the low sensitivity of effect for all receptor groups, results in the assessment that transboundary effects associated with noise and vibration have a **negligible** effect, and are therefore not significant in EIA terms.

10.10 Interactions

376. 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 10-30**, **Table 10-31** and **Table 10-32**. This provides a screening tool for which effects have the potential to interact. **Table 10-33** provides an assessment for each receptor (or receptor group) as related to these impacts.

377. Within **Table 10-33**, 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 10-30 Interactions Between Construction Impacts - Screening

Potential Interactions between Impacts					
Construction					
	Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	**Impact 2: Increase in local suspended sediment concentrations and sediment settlement.**	**Impact 3: Release of sequestered contaminants following sediment disturbance.**	**Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.**	**Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area**
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds		No	No	No	Yes
Impact 2: Increase in local suspended sediment concentrations and sediment settlement.	No		No	No	Yes
Impact 3: Release of sequestered contaminants following sediment disturbance.	No	No		No	No
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.	No	No	No		No
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area	Yes	Yes	No	No	

Table 10-31 Interactions Between Operation Impacts - Screening

Potential Interactions between Impacts							
Operation							
	Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	**Impact 2: Increase in local suspended sediment concentrations and sediment settlement**	**Impact 3: Release of sequestered contaminants following sediment disturbance**	**Impact 4: Impacts on fish and shellfish species as a result of noise and vibration**	**Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area**	**Impact 6: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.**	**Impact 7: EMF effects arising from cables.**
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds		Yes	Yes	Yes	Yes	Yes	Yes
Impact 2: Increase in local suspended sediment concentrations and sediment settlement	Yes		No	No	No	Yes	No
Impact 3: Release of sequestered contaminants following sediment disturbance	Yes	No		No	No	Yes	No
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration	Yes	No	No		No	Yes	Yes
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area	Yes	No	No	No		Yes	No
Impact 6: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.	Yes	Yes	Yes	Yes	Yes		Yes
Impact 7: EMF effects arising from cables.	Yes	No	No	Yes	No	Yes	

Table 10-32 Interactions Between Decommissioning Impacts - Screening

Potential Interactions between Impacts				
Decommissioning				
	Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	**Impact 2: Increase in local suspended sediment concentrations and sediment settlement**	**Impact 3: Release of sequestered contaminants following sediment disturbance**	**Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.**
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds		No	No	No
Impact 2: Increase in local suspended sediment concentrations and sediment settlement	No		No	No
Impact 3: Release of sequestered contaminants following sediment disturbance	No	No		No
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.	No	No	No	

Table 10-33 Interaction Between Impacts - Phase and Lifetime Assessment

Receptor	Highest Significance Level				
	Construction	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Fish and Shellfish	Minor Adverse	Minor Adverse	Minor Adverse	No greater than individually assessed impacts: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition, may increase the potential for interactions with other impacts within the operations phase of the Project, due to long-term operational period. However, all other potential impacts are of comparatively reduced duration, and are localised nature. Further, all potential impacts have been assessed as not significant (minor adverse to negligible). Therefore, none of the potential interactions identified with respect to Fish and Shellfish Ecology are expected to result in an increased significance of effect than has been assessed throughout this chapter.	No greater than individually assessed impacts: As determined within the phase assessment, all potential impacts have been assessed as not significant (minor adverse to negligible). Impacts are of limited temporal and / or spatial scale, limited the potential for inter-impact interactions across phases, including construction, operation, and decommissioning.

10.11 Inter-relationships

378. For fish and shellfish ecology potential inter-relationships between other topics assessed within this ES including **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**, **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)**, **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, and **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**. A summary of the potential inter-relationships between these topics is provided in **Table 10-34**.

Table 10-34 Fish and Shellfish Ecology Inter-relationships

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Construction			
Benthic Habitats – Prey availability	**Volume 7, Chapter 9 Benthic Habitats (application ref: 7.9)**	This chapter informs **Chapter 9 Benthic and Intertidal Ecology**.	The benthic environment hosts a wide range of prey species utilised by fish and shellfish receptors. Impacts on local benthic ecology may therefore lead to impacts on Fish and Shellfish Ecology.
Marine Mammals – Prey availability	**Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**	This chapter informs **Chapter 11 Marine Mammals**.	Fish and shellfish species act as a prey species for a wide range of marine mammal receptors. Impacts on Fish and Shellfish Ecology may therefore lead to impacts on Marine Mammals.
Commercial Fisheries – Stock availability	**Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**	This chapter informs **Chapter 13 Commercial Fisheries**.	Commercial fisheries rely on fish and shellfish availability. Impacts on Fish and Shellfish Ecology may therefore lead to impacts of Commercial Fisheries.
Suspended sediments and deposition	**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**	Impacts as a result of suspended sediment and deposition are assessed in sections 10.6.1.2 and 10.6.2.2.	Changes in SSC are assessed in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**. Changes in SSC and associated sediment settle-

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
			ment could have potential impacts on Fish and Shellfish Ecology.
Re-mobilisation of contaminated sediments	**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**	Re-mobilisation of contaminated sediments during construction is assessed in sections 10.6.1.3 and 10.6.2.3.	**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** 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 Fish and Shellfish Ecology.
Operation			
Benthic Habitats – Prey availability	**Volume 7, Chapter 9 Benthic Habitats (application ref: 7.9)**	This chapter informs **Chapter 9 Benthic and Intertidal Ecology**.	The benthic environment hosts a wide range of prey species utilised by fish and shellfish receptors. Impacts on local benthic ecology may therefore lead to impacts on Fish and Shellfish Ecology.
Marine Mammals – Prey availability	**Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**	This chapter informs **Chapter 11 Marine Mammals**.	Fish and shellfish species act as a prey species for a wide range of marine mammal receptors. Impacts on Fish and Shellfish Ecology may therefore lead to impacts on Marine Mammals.
Commercial Fisheries – Stock availability	**Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**	This chapter informs **Chapter 13 Commercial Fisheries**.	Commercial fisheries rely on fish and shellfish availability. Impacts on Fish and Shellfish Ecology may therefore lead to impacts of Commercial Fisheries.

Topic and Description	Related Chapter	Where Addressed in this Chapter	Rationale
Suspended sediments and settlement	**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**	Impacts as a result of suspended sediment and deposition are assessed in sections 10.6.1.2 and 10.6.2.2.	Changes in SSC are assessed in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**. Changes in SSC and associated sediment deposition could have potential impacts on Fish and Shellfish Ecology.
Re-mobilisation of contaminated sediments	**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**	Re-mobilisation of contaminated sediments during construction is assessed in sections 10.6.1.3 and 10.6.2.3.	**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** 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 Fish and Shellfish Ecology.
Decommissioning			
Inter-relationships for impacts during the decommissioning phase would be the same as those outlined above for the construction phase.			

10.12 Summary

379. This chapter has provided a characterisation of the existing environment for fish and shellfish ecology, based on existing data.

380. The assessment has determined that there would be up to **minor adverse** 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 Fish and Shellfish Ecology Study Area, and in many cases to just the area immediately surrounding project infrastructure.

381. A summary of the significance of effect assessment for Fish and Shellfish Ecology is provided within **Table 10-35**.

Table 10-35 Summary of Potential Likely Significant Effects on Fish and Shellfish Ecology

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect	Residual Cumulative Effect
Construction							
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	All	Low – Medium	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Impact 2: Increase in local suspended sediment concentrations and sediment settlement.		Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Impact 3: Release of sequestered contaminants following sediment disturbance.		Low	Negligible	Negligible	N/A	Negligible	N/A
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.		Low – Medium	Low	Minor Adverse	N/A	Minor Adverse	Minor Adverse
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area		Low	Low	Minor Adverse	N/A	Minor Adverse	N/A
Operation							
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds		Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Impact 2: Increase in local suspended sediment concentrations and sediment settlement.		Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Impact 3: Release of sequestered contaminants following sediment disturbance		Low	Negligible	Negligible	N/A	Negligible	N/A

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect	Residual Cumulative Effect
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration		Low – Medium	Negligible	Minor Adverse	N/A	Minor Adverse	Minor Adverse
Impact 5: Effect on Fish Stocks of Reduced Fishing Pressure Within the Array Areas and Increased Fishing Pressure Outside of the Array Area		Negligible	Negligible	Negligible	N/A	Negligible	N/A
Impact 6: Permanent loss of habitat and / or change in habitat type as a result of changes in substrate composition.		Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	Minor Adverse
Impact 7: EMF effects arising from cables.		Negligible – Medium	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Decommissioning							
Impact 1: Temporary Habitat Disturbance to Fish and Shellfish Species and Spawning and / or Nursery Grounds	All	Low – Medium	Negligible	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Impact 2: Increase in local suspended sediment concentrations and sediment settlement.		Negligible – Medium	Low	Negligible – Minor Adverse	N/A	Negligible – Minor Adverse	N/A
Impact 3: Release of sequestered contaminants following sediment disturbance		Low	Negligible	Negligible	N/A	Negligible	N/A
Impact 4: Impacts on fish and shellfish species as a result of noise and vibration.		Medium	Negligible	Minor Adverse	N/A	Minor Adverse	Minor Adverse

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