Muir Mhòr Offshore Wind Farm

Environmental Impact Assessment Report

Volume 2, Chapter 9: Benthic, Subtidal and Intertidal Ecology

Revision No.	Date	Reason for Issue	Author	Reviewer	Approver
01	22/11/2024	Final	GoBe Consultants Ltd.	GoBe Consultants Ltd.	MMOWF Ltd

Document Information	
Document ID	**MMH-GBE-A004-ENV-0006-202**
Revision	01
Date	22/11/2024

MUIR MHÒR
OFFSHORE WIND FARM

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Glossary

Term	Definition
Array Area	The area in which the generation infrastructure (including Wind Turbine Generators and associated foundations, and inter-array cables), Offshore Electrical Platform(s) and an interconnector cable will be located.
Baseline	The status of the environment at the time of assessment without the development in place.
Benthic Ecology	Benthic ecology encompasses the study of the organisms living in and on the sea floor, the interactions between them and impacts on the surrounding environment
Benthic Subtidal and Intertidal Ecology study areas	The benthic subtidal ecology study area is defined by the Array Area and the offshore ECC. The secondary Zone of influence (ZoI) encompasses a buffer of approximately 15 km around both the Array Area and offshore ECC. This buffer represents the area where secondary or indirect impact on the benthic environment might occur and is defined by the distance that suspended sediment plumes may be advected following disturbance and subsequently interact with benthic receptors. The benthic intertidal ecology study area is defined by the intertidal habitats up to the Mean High Water Springs (MHWS) mark within boundary of the Proposed Development.
Biotope	A region of habitat associated with a particular ecological community.
Cumulative effects	The combined effect of the Proposed Development acting cumulatively with the effects of a number of different projects, on the same single receptor/ resource.
Cumulative impact	Impacts that result from changes caused by other past, present, or reasonably foreseeable actions together with the Proposed Development
Design Envelope	A description of the range of possible elements that make up the Proposed Development's design options under construction, as set out in detail in the project description. This envelope is used to define the Proposed Development for Environmental Impact Assessment (EIA) purposes when the exact engineering parameters are not yet known. This is often referred to as the "Rochdale Envelope" approach.
Developer	Muir Mhòr Offshore Wind Farm Limited
E2	The ScotWind Plan Option Area where the Proposed Development is located
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of an impact with the sensitivity of a receptor, in accordance with defined significance criteria.
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 EIA Directive and EIA Regulations, including the publication of an Environmental Impact Assessment Report (EIAR).
EIA Directive	European Union 2011/92/EU of 13 December 2011 (as amended in 2014 by Directive 2014/52/EU).
EIA Regulations	Collectively the term used to refer to The Electricity Works (Environmental Impact Assessment) (Scotland) Regulations 2017, The Marine Works

Term	Definition
	(Environmental Impact Assessment) Regulations 2007, and The Marine Works (Environmental Impact Assessment) (Scotland) Regulations 2017.
Floating Foundations	The floating structures on which the Wind Turbine Generators are installed.
Foundation anchors	The structures which anchor the Floating Foundations to the seabed, connected to the foundation mooring.
Foundation mooring	The mooring structures which connect the Floating Foundations to the anchors.
Habitat Regulations	The Conservation (Natural Habitats, &c..) Regulations 1994, the Conservation of Offshore Marine Habitats and Species Regulations 2017 and the Conservation of Habitats and Species Regulations 2017
Haplotype	Haplotypes comprise a distinct combination of alleles inherited together from a single parent, which are shared within a family group/lineage.
Horizontal Directional Drilling (HDD)	A method of cable installation where the cable is drilled beneath a feature without the need for trenching.
Impact	An impact to the receiving environment is defined as any change to its baseline condition, either adverse or beneficial.
Inter-array cables	Cables which link the Wind Turbine Generators to each other and the Offshore Electrical Platform(s).
Interconnector cable	Cable which links the Offshore Electrical Platform(s) to one another, allowing for power to be transferred between the platforms
Intertidal	The intertidal zone, sometimes referred to as the littoral zone, is the area where the marine and terrestrial environments meet between the tide's highest and lowest points. Intertidal ecology encompasses the substrate found in that zone, as well as the flora and fauna there.
Landfall	The area between Mean High Water Springs (MHWS) and Mean Low Water Springs (MLWS) where the offshore export cables are brought onshore.
Mitigation	Mitigation measures, or commitments, are commitments made by the Proposed Development to reduce and/or eliminate the LSE to arise as a result of the Project. Mitigation measures can be embedded (part of the project design) or secondarily added to reduce impacts in the case of LSE.
Offshore Electrical Platform (OEP)	Offshore platform consisting of High Voltage Alternating Current (HVAC) equipment, details depending on the final electrical set up of the Project.
Offshore Export Cable Corridor (ECC)	The area within which the offshore export cables will be installed.
Offshore export cables	The subsea electricity cable circuits running from the Offshore Electrical Platform(s) to the landfall which will transmit the electricity generated by the offshore wind farm to the onshore export cables for transmission onwards to the onshore substation and the national electrical transmission system along with auxiliary cables such as fibre optic cables.
Offshore transmission infrastructure	The proposed transmission infrastructure comprising: Offshore Electrical Platform(s) and associated foundations and substructures; the interconnector cable, the offshore export cables; and the landfall area up to Mean High Water Springs (MHWS).
Project	Muir Mhòr Offshore Wind Farm – comprises the wind farm and all associated offshore and onshore components.

Term	Definition
Proposed Development	The offshore Muir Mhòr Offshore Wind Farm project elements to which this Offshore EIA Report relates.
Receptor	A distinct part of the environment on which effects could occur and can be the subject of specific assessments. Examples of receptors include species (or groups) of animals or plants, people (often categorised further such as 'residential' or those using areas for amenity or recreation), watercourses etc.
Subtidal	The region of shallow waters which are below the level of low tide.
Transboundary Effects	Transboundary effects arise when impacts from the development within one European Economic Area (EEA) state affects the environment of another EEA state(s).
Transition Joint Bays (TJBs)	The offshore and onshore cable circuits are jointed on the landward side of the sea defences/beach in Transition Joint Bays (TJBs). The TJBs are underground chambers constructed of reinforced concrete which provides a secure and stable environment for the cable. The TJBs have the potential to extend 1.5m above ground level.
Trenched technique	Trenching is a construction excavation technique that involves digging a narrow trench in the ground for the installation, maintenance, or inspection of pipelines, conduits, or cables.
Wind Turbine Generator (WTG)	The wind turbines that generate electricity consisting of tubular towers and blades attached to a nacelle housing mechanical and electrical generating equipment.
Worst Case Design Scenario (WCS)	The maximum design parameters of the combined Proposed Development assets that result in the greatest potential for change in relation to each impact assessed.

Acronyms

Term	Definition
AfL	Agreement for Lease
AL	Action Levels
BAC	Background Assessment Concentrations
BAP	Biodiversity Action Plan
BGS	British Geological Survey
BMAPA	British Marine Aggregate Producers Association
BSL	Benthic Solutions Limited
CBRA	Cable Burial Risk Assessment
CaP	Cable Plan
CPS	Cable Protection System
CEA	Cumulative Effects Assessments
Cefas	Centre for Environmental, Fisheries and Aquaculture Science
CIEEM	Chartered Institute of Ecology and Environmental Management
CMIP5	Coupled Model Intercomparison Project Phase 5
CMS	Construction Method Statement
CNS	Central North Sea
CPI	Carbon Preference Index
DDV	Drop Down Video
DP	Decommissioning Programme
DSLP	Development Specification and Layout Plan
DSFB	District Salmon Fishery Board
ECC	Export Cable Corridor
eDNA	Environmental DNA
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMF	Electromagnetic Fields
EMP	Environmental Management Plan
EU	European Union
EUNIS	European Nature Information System
FeAST	Feature Activity Sensitivity Tool
FMS	Fisheries Management Scotland
FOCI	Features of Conservation Interest
HDD	Horizonal Directional Drilling

Term	Definition
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
INNS	Invasive Non-Native Species
IPCC	Intergovernmental Panel on Climate Change
JNCC	Joint Nature Conservation Committee
JUV	Jack-Up Vessel
LoD	Limit of Detection
LSE	Likely Significant Effect
MarLIN	Marine Life Information Network
MBES	Multibeam Echo Sounder
MCCIP	Marine Climate Change Impacts Partnership
MD-LOT	Marine Directorate Licensing Operations Team
MESH	Mapping European Seabed Habitat
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MPA	Marine Protected Area
MPS	Marine Policy Statement
NC MPA	Nature Conservation Marine Protected Area
NES LBAP	Northeast Scotland's Local Biodiversity Action Plan
nm	Nautical Miles
NMP	National Marine Plan
NOAA	National Oceanic and Atmospheric Administration
O&M	Operation and Maintenance
OEP	Offshore Electrical Platform
OESEA3	Offshore Energy Strategic Environmental Assessment 3
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbons
PBDE	Polybrominated Diphenyl Ether
PEL	Probable Effects Level
PEMP	Project Environmental Monitoring Plan
PLGR	Pre-Lay Grapnel Run
PMF	Priority Marine Feature
POSEIDON	Planning Offshore Wind Strategic Environmental Impact Decisions
ppt	Parts Per Thousand
PSA	Particle Size Analysis

Term	Definition
RCP	Representative Concentration Pathways
RIAA	Report to Inform Appropriate Assessment
S-CHURS	Single Channel Ultra-High Resolution Seismic
SAC	Special Area of Conservation
SBES	Single-beam Echo Sounders
SBP	Sub-Bottom Profiling
SD	Standard Deviation
SEA	Strategic Environmental Assessment
SPA	Special Protection Area
SPM	Suspended Particulate Matter
SSC	Suspended Sediment Concentration
SSS	Side Scan Sonar
SSSI	Site of Special Scientific Interest
S-UHRS	Single Channel Ultra-High Resolution Seismic
TEL	Threshold Effects Limit
TOC	Total Organic Carbon
TOM	Total Organic Matter
UKCP	United Kingdon Climate Projection
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
VER	Valued Ecological Receptor
VMNSP	Vessel Management and Navigational Safety Plan
VMP	Vessel Management Plan
WCA	Wildlife and Countryside Act
WTGs	Wind Turbine Generators
ZoI	Zone of Influence

9. BENTHIC SUBTIDAL AND INTERTIDAL ECOLOGY

9.1. INTRODUCTION

9.1.1. Muir Mhòr Offshore Wind Farm Limited (hereafter referred to as 'the Developer') is proposing to develop the Muir Mhòr Offshore Wind Farm (hereafter 'the Project'). The Project is made up of both offshore and onshore components. The subject of this offshore Environmental Impact Assessment Report (EIAR) is the offshore infrastructure of the Project seaward of Mean High-Water Springs (MHWS) which is hereafter referred to as 'the Proposed Development'.

9.1.2. The Muir Mhòr Array Area covers an area of approximately 200 km^2 and is located approximately 63 km east of Peterhead on the east coast of Scotland. The offshore infrastructure of the Proposed Development includes Wind Turbine Generators (WTGs) and associated floating foundations, the Offshore Electrical Platform(s) (OEP(s)) and associated foundations, the inter-array cables, interconnector cable, offshore export cables and landfall.

9.1.3. This Chapter of the Offshore EIAR presents an assessment of the potential impacts and associated Likely Significant Effects (LSE) on benthic subtidal and intertidal ecology due to the construction, operation and decommissioning of the Proposed Development. It discusses appropriate mitigation and monitoring as required to address any identified significant effects.

9.1.4. This EIAR is accompanied by a Report to Inform Assessment (RIAA) (Muir Mhòr Offshore Wind Limited, 2024) which assesses LSE on designated European sites. Additionally, impacts on MPAs are assessed in Volume 3, Appendix 9.2 (Marine Protected Area Assessment Report).

9.1.5. This Chapter should be read alongside the following other Chapters and technical Appendices:

- Volume 1, Chapter 3 (Project Description);
- Volume 2, Chapter 7 (Marine and Coastal Processes);
- Volume 2, Chapter 8 (Marine Water and Sediment Quality);
- Volume 2, Chapter 10 (Fish and Shellfish Ecology);
- Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report); and
- Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports).

9.1.6. This Chapter covers:

- A description of the benthic habitats found in the benthic subtidal and intertidal ecology study areas;
- A description of the benthic fauna and flora distribution, abundance and diversity in the benthic subtidal and intertidal ecology study areas;
- Sensitive and protected species present in the benthic subtidal and intertidal ecology study areas;
- Assessment of LSE;
- Mitigation measures; and
- Proposed ongoing monitoring.

9.1.7. This Chapter refers to the design of the Proposed Development as described in Volume 1, Chapter 3 (Project Description).

9.2. PURPOSE OF THE CHAPTER

9.2.1. The primary purpose of the EIAR is defined in Volume 1, Chapter 1 (Introduction).

9.2.2. The key objective of this Chapter is to provide Scottish Ministers and statutory and non-statutory stakeholders the information required to assess for LSE on benthic subtidal and intertidal ecology. This assessment will consider those effects from the Proposed Development in isolation and in combination with effects from other plans and projects (cumulative effects).

9.2.3. This Chapter presents the following:

- A detailed description of current environmental baseline conditions relevant to benthic subtidal and intertidal ecology. These have been established from relevant literature, desk studies and project-specific studies (Table 9-5);
- Discussion of assumptions and any limitations with respect to the information used to define the baseline;
- Identification of potential impacts and any resulting LSE on benthic subtidal and intertidal ecology related to Proposed Development activities. This process is informed by the application of embedded commitments;
- Consideration of the need for any 'secondary' mitigation measures (in addition to embedded commitments) to avoid, minimise, reduce, or offset LSE on benthic subtidal and intertidal ecology from the Proposed Development;
- Consideration of any residual effects following application of secondary mitigation; and
- Identification of monitoring measures to support proposed mitigation.

9.2.4. Modelling undertaken in support of the Chapter and associated technical report has been presented in Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report).

9.3. LEGISLATION AND POLICY CONTEXT

9.3.1. Overarching legislation, policy, and guidance in relation to the EIAR for the Proposed Development is provided in Volume 1, Chapter 2 (Legislation and Policy) of the EIAR. A summary of legislation, policy and guidance directly relevant to benthic subtidal and intertidal ecology is provided below.

LEGISLATION AND POLICY

9.3.2. Relevant legislation and policy directly applicable to benthic subtidal and intertidal ecology is illustrated in Table 9-1 and Table 9-2, respectively.

Table 9-1 Legislation relevant to Benthic Subtidal and Intertidal Ecology

Legislation	Summary	How the Chapter has considered this
EU Habitats Directive (Directive 92/43/EEC) and associated implementing habitats regulations: • 1) The Conservation of Habitats and Species Regulations 2017 (as amended)1 • 2) Offshore Marine Conservation (Natural Habitats &c.) Regulations 2017 (as amended) • 3) Conservation (Natural Habitats, &c.) Regulations 1994 (as amended)	The EU Habitats Directive lists 11 marine habitats, eight of which are found in benthic environments. Special Areas of Conservation (SACs) have been designated in UK waters to meet the requirements outlined in Article 3 of the Directive and to contribute to the European network of conservation sites. 1) Implements species protection requirements of the Habitats Directive in Scotland, in relation to specific activities up to 12 nautical miles (nm), including applications for s36 consent. 2) Implements the requirements of the Habitats Directive in the UK offshore marine area (beyond 12 nm). 3) Implements species protection requirements of the Habitats Directive in Scotland on land and within 12 nm.	All relevant designated sites have been considered in Section 9.5 (Designated Sites) with their distances to the Proposed Development presented in Table 9-10. The benthic subtidal and intertidal habitats listed in Annex I of the Habitats Directive which occur in the benthic subtidal and intertidal ecology study areas in some form include: • Reefs (rocky and biogenic) 'Stony reef'; • Horse mussel (*Modiolus modiolus*) beds - (biogenic reef); and • Ross worm (*Sabellaria spinulosa*) - (biogenic reef). Table 9-11 includes the distribution of these habitats within the benthic subtidal and intertidal ecology study areas. Section 9.9 also considers impacts on designated sites from other plans and projects cumulatively with the Proposed Development.
The International Convention for the Control and Management of Ships' Ballast Water and Sediments (Ballast Water Management Convention) 2004	Aims to prevent the spread of harmful aquatic organisms from one region to another, by establishing standards and procedures for the management and control of ships' ballast water and sediments.	Guidelines set out within the Convention has been used to inform Volume 4, Appendix 2 (Outline Environmental Management Plan (EMP)) which contains an Outline Invasive Non-Native Species Management Plan (Annex B).
The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention).	The OSPAR Convention serves as the collaborative framework for 15 Western European governments dedicated to safeguarding the marine environment in the North East Atlantic region. In 2003, the UK government made a commitment to establish a well-managed and ecologically coherent network of Marine Protected Areas (MPA), commonly referred to as the OSPAR MPA commitment.	The distribution of OSPAR habitats within the benthic subtidal and intertidal ecology study areas is included within Table 9-11. The potential impacts arising from the Proposed Development on these habitats and species are assessed in Section 9.7. Protected habitats and species have been identified in

[1] The Habitats Directive (Council Directive 92/43/EEC) and certain elements of the Wild Birds Directive (Directive 2009/147/EC) (known as the Nature Directives) were transposed into domestic law by the 2017 Regulations. Following the UK's exit from the EU the Regulations were updated by the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019 to reflect that the UK was no longer part of the EU. Any references to Natura 2000 in the 2017 Regulations and in guidance now refers to the new national site network.

Legislation	Summary	How the Chapter has considered this
	As part of the UK's initial contribution to the OSPAR network, Marine SACs designated under the European Habitats Directive have been submitted. In 2008, OSPAR compiled a catalogue of marine habitats and species facing threats or decline in the northeast Atlantic.	paragraph 9.5.98 *et seq.* These habitats and species have been included in the assessment of significance for the Proposed Development alone (Section 9.7) and cumulatively with other plans and projects (Section 9.9). Additionally, this EIAR is accompanied by a RIAA (Muir Mhòr Offshore Wind Limited, 2024) which assesses LSE on designated European sites, and impacts on MPAs are assessed in Volume 3, Appendix 9.2 (Marine Protected Area Assessment Report).
Marine (Scotland) Act 2010	The Marine (Scotland) Act 2010 requires all regulators to ensure that there is no significant risk of hindering the achievement of the conservation objectives of a MPA before giving consent to an activity, plan, or project. A management intervention will be required if an ongoing activity presents a significant risk of hindering the achievement of a MPA's conservation objectives. This intervention will be practical and proportionate, using the most appropriate statutory mechanism to reduce the risk.	Designated sites of relevance to the Proposed Development as set out in paragraph 9.5.98 *et seq.* and assessed in Section 9.7. Potential impacts on MPAs are assessed in Volume 3, Appendix 9.2 (Marine Protected Area Assessment Report).
Marine and Coastal Access Act 2009	The Marine and Coastal Access Act 2009 provides devolved authority to Scottish Ministers for marine planning and conservation powers in the Scottish Offshore Region (from 12 to 200 nm). Under Section 66 of the Marine and Coastal Access Act 2009 (in the context of the Scottish Offshore Region), the Proposed Development requires a Marine License for the marine licensable activities beyond 12 nm.	Designated sites of relevance to the Proposed Development as set out in paragraph 9.5.98 *et seq.* and assessed in Section 9.7.

Table 9-2 Policy relevant to Benthic Subtidal and Intertidal Ecology

Policy	Summary	How/Where Chapter has considered this
Scottish National Marine Plan (NMP) (Scottish Government, 2015)	The Scottish National Marine Plan sets out policies and objectives requiring marine planners and decision-makers to consider the LSE of development on marine ecology and is useful to identify some of the key concerns and issues that should be addressed in any impact assessment. This plan covers the management of both Scottish inshore waters (out to 12 nm) and offshore waters (12 to 200 nm). The following General Policies are considered relevant to Benthic Ecology: GEN 9: Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species; (b) Not result in significant impact on the national status of Priority Marine Features (PMFs); and (c) Protect and, where appropriate, enhance the health of the marine area. GEN 10: Opportunities to reduce the introduction of INNS to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made. GEN 21: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed as part of the decision making and plan implementation process.	This Chapter considers the LSE from the Proposed Development in Section 9.7. Protected areas, species, and PMFs have been identified in paragraph 9.5.98 *et seq.* These have been included in the assessment of significance for the Proposed Development alone (Section 9.7) and cumulatively with other plans and projects (Section 9.9). The LSE associated with marine INNS arising from the Proposed Development are considered in Section 9.7 (Impact 7). This Chapter also includes a Cumulative Effects Assessment (CEA), which considers the impacts of the Array alongside other plans, projects, and activities (see Section 9.9).
United Kingdom (UK) Marine Policy Statement (MPS) (HM Government, 2011)	The MPS is the framework for making decisions that impact the marine environment in the United Kingdom, and it contributes to sustainable development in the marine area. General MPS policies: Ensure a sustainable marine environment which promotes healthy, functioning marine ecosystems and protects marine habitats, species and our heritage. The marine environment plays an important role in mitigating climate change. Biodiversity is protected, conserved and where appropriate recovered and loss has been halted. Offshore wind MPS policies: Marine businesses are acting in a way which respects environmental limits and is socially responsible.	Section 9.7 analyses the magnitude of impacts and the sensitivity of benthic receptors to determine if the relevant impacts represent a significant Impact on these receptors. The assessment considers how changes to the baseline environment due to climate change may influence the predictions made in the impacts assessment, as part of the future baseline in Section 9.5.124 *et seq.* Section 9.7 presents assessments of the significance of the impacts of the development on benthic receptors. Where appropriate, mitigation measures are presented to reduce the impacts to an acceptable level.

Policy	Summary	How/Where Chapter has considered this
National Planning Framework 4 (NPF4)	NPF4 serves as Scotland's overarching spatial strategy, outlining the spatial principles, regional priorities, national developments, and planning policies. There is a policy requirement to deliver clear biodiversity enhancement and proposals will only be supported where it can be demonstrated that the proposal will conserve, restore and enhance biodiversity, including nature networks so they are in demonstrably better state than without intervention.	As will be detailed within the Onshore EIAR (currently being prepared), there are onshore enhancement objectives which include to expand and create new woodland, create species rich grasslands and create an open water feature, details of which will be presented in Outline Biodiversity Enhancement Plan Technical Appendix 5.5 of the Onshore EIAR.
Sectoral Marine Plan for Offshore Wind Energy (Scottish Government, 2020)	The Strategic Environmental Assessment (SEA) and Habitats Regulations Appraisal (HRA) indicate that area E2 is a significant foraging zone for kittiwake and razorbill and may serve as important spawning grounds for fish species such as herring, cod, whiting, plaice, and sand eel. This suggests a potential connection between benthic habitats and the prey species vital for these bird species. Regional cumulative effects should include the LSE on benthic habitats, bird populations, cetaceans, navigational safety, seascape, landscape, and commercial fisheries. The SMP for Offshore Wind Energy includes measures to mitigate likely significant effects at various scales.	This Chapter includes a CEA, which considers the impacts of the Proposed Development alongside other plans, projects, and activities (see Section 9.9) on benthic habitats. The conclusion of no significant impact to benthic resources signifies that there should be no significant impact on those species that rely on benthic prey availability.

GUIDANCE

9.3.3. The characterisation of the benthic ecology baseline and the assessment of LSE have been made with specific reference to the following guidance and publications:

- Joint Nature Conservation Committee (JNCC), Marine Monitoring Handbook, (Davies *et al*, 2001);
- Centre for Environment, Fisheries and Aquaculture (Cefas), Guidelines for Data Acquisition to Support Marine Environmental Assessments for Offshore Renewable Energy Projects (Cefas, 2012);
- NatureScot guidance on marine INNS (NatureScot, 2022);
- Scottish PMFs (Scottish Government, 2014);
- Scottish Biodiversity Strategy 2045 (Scottish Government, 2022);
- A Review of Assessment Methodologies for Offshore Wind Farms (Maclean *et al*., 2009);
- Guidance and publications from Scottish Natural Heritage (SNH) and Marine Scotland on PMF and MPA search features (SNH, 2012);
- Marine Scotland, Consenting and Licensing Guidance: For Offshore Wind, Wave and Tidal Energy Applications (Scottish Government, 2018); and
- CIEEM, Guidelines for Ecological Impact Assessment in the UK and Ireland Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018).

9.4. CONSULTATION

9.4.1. Ongoing statutory and non-statutory consultation and incorporation of feedback is an integral part of developing a robust EIAR. The Offshore Scoping Report for the Proposed Development (Volume 3, Appendix 5.1 (Offshore Scoping Report)) was submitted to the Marine Directorate – Licensing Operations Team (MD-LOT) in June 2023. MD-LOT issued a detailed response to the Scoping Report’s content in the September 2023 Scoping Opinion (Volume 3, Appendix 5.2 Offshore Scoping Opinion)), covering its own opinion on the Scoping Report as well as the statutory and non-statutory consultees’ advice on each topic.

9.4.2. Table 9-3 presents pertinent comments from the Scoping Opinion pertaining to benthic subtidal and intertidal ecology received to date, accompanied by a response detailing how these comments have been addressed within the EIAR.

9.4.3. Further detail on the overall EIA stakeholder consultation process and actions is presented in Volume 1, Chapter 5 (Consultation).

Table 9-3 Consultation relevant to Benthic Subtidal and Intertidal Ecology

Date	Consultee and Type of Consultation	Description/ Issues Raised	How this has been considered in this Chapter
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers note that the study area may be refined post-scoping based on further modelling and consultation.	The benthic subtidal and intertidal ecology study areas have been refined post-scoping based on further modelling work considering tidal ellipses and sediment deposition as detailed within paragraph 9.5.1 *et seq*. The final study areas are presented spatially in Figure 9-1.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers are also broadly content with the data sources used to characterise the baseline as listed in the Scoping Report, however, highlight NatureScot representation regarding additional data sources and guidance which should be fully considered.	A full list and context of additional data sources used to conduct this EIAR is provided in Table 9-5, which includes those listed by NatureScot Pearch & Kimber (2020); Feature Activity Sensitivity Tool (FeAST); and National Marine Plan Interactive and Nobel-Jones *et al.* (2018).
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers further highlight NatureScot comments on environmental DNA (eDNA) sampling which should be fully implemented.	eDNA samples were taken during the site-specific surveys to inform the baseline environment (see Table 9-4). NatureScot and MD-LOT were consulted on several occasions to agree the methodology for the eDNA sampling as requested (Meeting minutes: Catch up call, 17 August 2023).
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers are broadly content that the receptors related to benthic subtidal and intertidal ecology have been identified in Section 8.4 of the Scoping Report, however, refer the Developer to NatureScot representation regarding the potential for *S. spinulosa* reefs to be present in the region.	The baseline environmental characterisation for *S. spinulosa* reef is detailed in Section 9.5. *S. spinulosa* were recorded in the site-specific surveys. Small patches of *S. spinulosa* were of low elevation and spatial coverage and were therefore, according to criteria detailed by Gubbay (2007), considered not to constitute Annex I reef habitat.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	As there is a risk of potentially introducing and/or spreading INNS the Scottish Ministers disagree that this should be scoped out for the operation and maintenance phase.	An assessment of LSE of marine INNS for the operation and maintenance (O&M) phase is included in paragraph 9.7.121 *et seq*.

Date	Consultee and Type of Consultation	Description/ Issues Raised	How this has been considered in this Chapter
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	As there is a risk of potentially introducing and spreading marine INNS during the operation and maintenance phase, particularly due to biofouling (and cleaning procedures) on the floating structures, the Scottish Ministers advise that this impact must be scoped in for assessment.	An assessment of LSE of INNS for the O&M phase is included in paragraph 9.7.121 *et seq*.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers do not agree that indirect effects on benthic ecology from Electromagnetic Field (“EMF”) effects generated by inter-array and export cables should be scoped out for the operation and maintenance phase. The Scottish Ministers refer the Developer to NatureScot representation on this and advise that the representation should be fully considered and this aspect scoped in.	As requested by NatureScot, the effects from EMFs during the O&M phase have been scoped in and an assessment of the LSE arising from of EMFs is included in paragraph 9.7.136 *et seq.*
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers also highlight the Scottish Fishermen’s Federation representation that boulder relocation effects should be scoped in. This should be considered by the Developer.	Where boulders are relocated this will be in close proximity to the removal location and therefore an assessment of environmental impacts is deemed unnecessary.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers also highlight the representations from District Salmon Fishery Board (DSFB) and (Fisheries Management Scotland) FMS regarding disturbance and degradation of the benthic environment and advise these representations should be considered by the Developer.	Effects on benthic habitats have been quantified and assessed in Section 9.7. Furthermore, consideration has been given to the effects on important habitats for feeding and shelter for the marine phase of sea trout (a PMF) and any area that might impact early feeding opportunities for all diadromous species. These are discussed in Volume 2, Chapter 10 (Fish and Shellfish Ecology).
September 2023	Fisheries Management ~ Scotland (FMS) Scoping Responses	The FMS representation regarding aggregation effects of construction of wind turbines should be considered by the Developer.	The assessment of new hard substrate in relation to biodiversity changes is presented and assessed in paragraph 9.7.90 *et seq.*, and the effect this has on aggregation effects on fish is assessed in Volume 2, Chapter 10 (Fish and Shellfish Ecology).

Date	Consultee and Type of Consultation	Description/ Issues Raised	How this has been considered in this Chapter
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers agree with NatureScot representation that the assessment should quantify, where possible, the likely impacts to benthic PMF species and that it should assess whether these could lead to a significant impact on the national status of the PMFs.	PMFs have been identified in paragraph 9.5.98 *et seq.* These have been included in the assessment of significance for the Proposed Development alone (Section 9.7) and cumulatively with other plans and projects (Section 9.9).
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers also agree with NatureScot comments regarding *S. spinulosa* reefs and advise that the recommendations regarding this must be fully considered and assessed in the EIA Report.	The baseline environment for *S. spinulosa* reef is detailed in Section 9.5. *S. spinulosa* were recorded in the site-specific surveys. Small patches of *S. spinulosa* were of low elevation and spatial coverage and were therefore, according to criteria detailed by Gubbay (2007), considered not to constitute Annex I reef habitat. An assessment of the LSE arising from the Proposed Development on *S. spinulosa* is detailed in Section 9.7.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers advise that consideration should also be given to indirect impacts on birds, fish and marine mammals, where appropriate.	Indirect impacts on birds, fish and marine mammals have been considered within the EIAR within Volume 2, Chapter 10 (Fish and Shellfish Ecology), Volume 2, Chapter 11 (Offshore Ornithology) and Volume 2, Chapter 12 (Marine Mammals). The conclusion of no significant impact to benthic resources from effects associated with the Proposed Development (Table 9-43) signifies that, in turn, should be no significant impact on those species that rely on benthic prey availability.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	Regarding cumulative impacts, the Scottish Ministers highlight, and agree with NatureScot comments that LSE do not need to spatially overlap to have cumulative impacts.	The inclusion of cumulative effects was developed following the assessment of project alone impacts as presented within Section 9.7. As detailed within Section 9.9 certain impacts assessed for the project alone are not considered in the cumulative assessment due to: • The highly localised nature of the impacts (i.e., they occur entirely within the footprint of the Proposed Development only);

Date	Consultee and Type of Consultation	Description/ Issues Raised	How this has been considered in this Chapter
			• Management measures in place for the Proposed Development will also likely be in place on other projects reducing the risk of impacts occurring; and/or • Where the LSE from the Proposed Development alone has been concluded to be negligible.
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers advise that the NatureScot representation regarding this must be fully considered and implemented, including that impacts which are potentially widespread, such an EMF, should be scoped into the cumulative impact assessment.	EMF is not considered within the cumulative impact assessment as the project alone spatial magnitude is considered negligible as detailed within Section 9.7 (Impact 8).
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers are generally content with the embedded commitments described in Section 8.5 of the Scoping Report, however, highlight the NatureScot comments regarding the full range of mitigation measures and published guidance being considered and published in the EIA Report and advise that this must be fully implemented.	Embedded commitments are detailed in Table 9-16. As there is a commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development and have therefore been considered in the assessment (see Section 9.7).
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers also advise the Developer that the EIA Report should provide details on how INNS will be considered, monitored and recorded, as well as being taken account of in biosecurity plans for each phase of the development.	Volume 4, Appendix 2 (Outline EMP) contains an Outline Invasive Non-Native Species Management Plan (Annex B). An assessment of LSE of marine INNS for the O&M phase is included in paragraph 9.7.121 *et seq.*
September 2023	Scottish Ministers ~ Scoping Opinion (via. MD-LOT)	The Scottish Ministers highlight NatureScot comments regarding EMF impacts from dynamic cables and advise that collaboration and contribution to strategic monitoring should be considered.	The effects from EMFs for the O&M phase have been scoped in and an assessment of the LSE arising from of EMFs is included in paragraph 9.7.136 *et seq*.
September 2023	Scottish Ministers ~ Scoping	The Scottish Ministers agree that transboundary impacts in relation to benthic subtidal and intertidal ecology can be scoped out from further consideration.	Noted.

Date	Consultee and Type of Consultation	Description/ Issues Raised	How this has been considered in this Chapter
	Opinion (via. MD-LOT)		
September 2023	Nature Scot ~ Scoping Opinion	Nature Scot recommended consideration of the inclusion of the following data sources and guidance documents in the EIAR: • Pearce, B. and Kimber, J. (2020). The Status *of S. spinulosa* Reef off the Moray Firth and Aberdeenshire Coasts and Guidance for Conservation of the Species off the Scottish East Coast. Scottish Marine and Freshwater Science Vol 11 No 17, 100pp • Feature Activity Sensitivity Tool (FeAST) • National Marine Plan Interactive (NMPi) • JNCC Monitoring Guidance for Marine Benthic Habitats (Noble-James *et al.*, 2018)	The following data sources and guidance has been included within this EIAR, where relevant.
September 2023	Nature Scot ~ Scoping Opinion	Nature Scot agreed that they were generally content that all receptors related to benthic subtidal and intertidal ecology have been identified in Section 8.4 of the Scoping Report. However, as well as PMFs, there is the potential for *S. spinulosa* reefs to be present in this region. These reefs are of conservation value under OSPAR and Annex 1 of the Habitats Directive. The presence of *S. spinulosa* reefs should be recorded during the benthic surveys. There is a gap in knowledge regarding the distribution of these reefs in Scottish waters and any records are invaluable."	Thee baseline environment for *S. spinulosa* reef is detailed in Section 9.5. *S. spinulosa* were recorded in the site-specific surveys. Small patches of *S. spinulosa* were of low elevation and spatial coverage and were therefore, according to criteria detailed by Gubbay (2007), considered not to constitute Annex I reef habitat. An assessment of the LSE arising from the Proposed Development on *S. spinulosa* is detailed in Section 9.7.

9.5. BASELINE ENVIRONMENT

9.5.1. This Section presents the current baseline for benthic subtidal and intertidal ecology within the benthic subtidal and intertidal ecology study areas and the wider CNS region. The baseline has been characterised through site specific surveys (Table 9-4) and desk-based sources (Table 9-5).

STUDY AREA

9.5.2. For the purposes of this report, the benthic subtidal and intertidal ecology study areas (as presented in Figure 9-1) have been defined by the following:

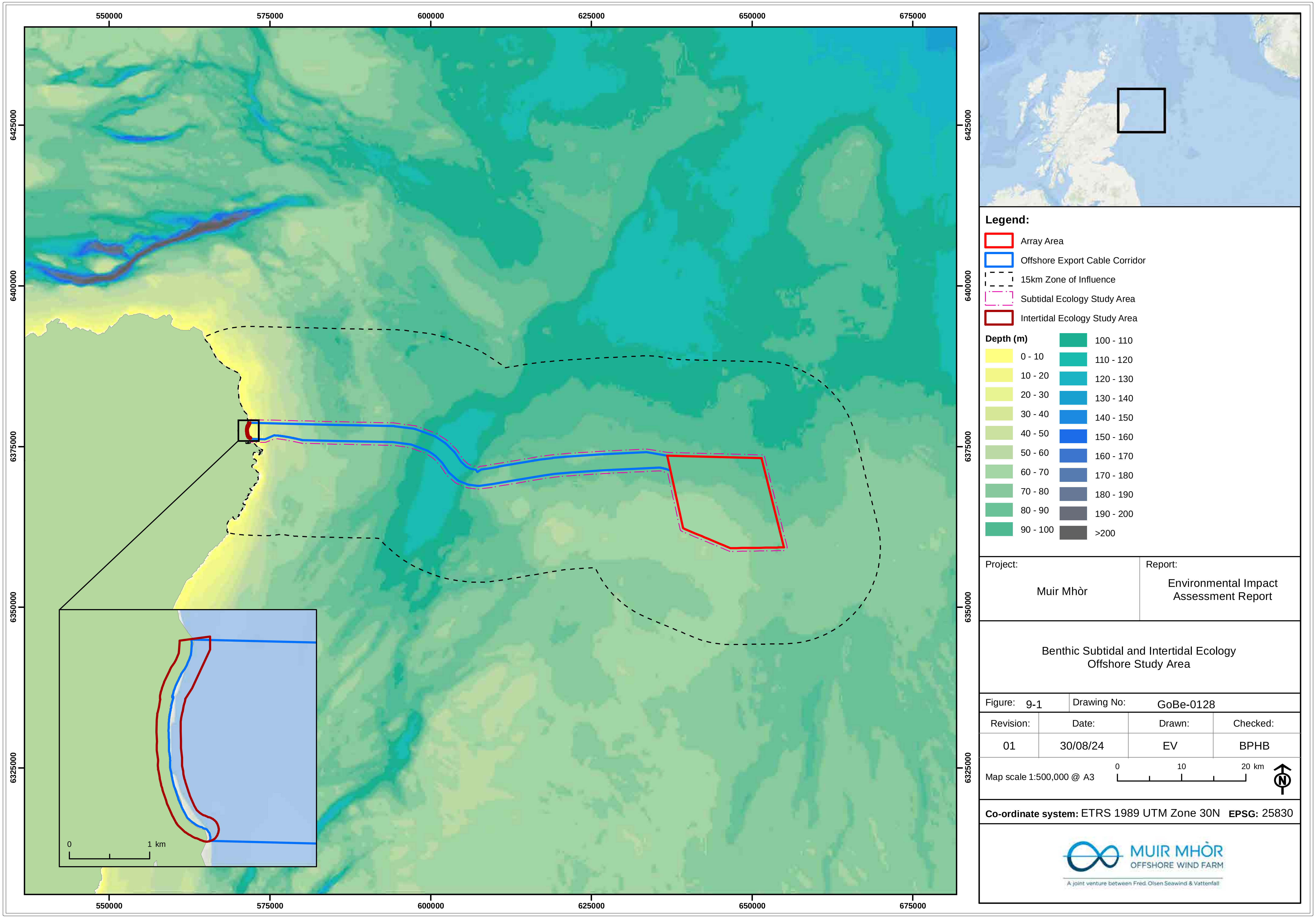
- The benthic subtidal ecology study area includes the Array Area and the offshore ECC (where site specific survey data were collected):
  - The Array Area (LOT 1)[2] covers an area of 200 km^2 located approximately 63 km east of Peterhead on the Aberdeenshire coast, in the Central North Sea (CNS); and
  - The Offshore ECC (LOT 2)[3] runs approximately 67 km from the Array Area to a landfall just north of Peterhead.
- The secondary Zone of influence (ZoI) encompasses a buffer of approximately 15 km around both the Array Area and offshore ECC. This buffer represents the area where secondary or indirect impact on the benthic environment might occur and is defined by the distance that suspended sediment plumes may be advected following disturbance and subsequently interact with benthic receptors. This was determined as the spring tidal excursion ellipse which has been defined from numerical modelling as a distance of 15 km, see Volume 2, Chapter 7 (Marine and Coastal Processes); Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report); and Volume 3, Appendix 7.2 (Marine Processes Modelling Report).
- Benthic intertidal ecology study area seaward of MHWS (LOT 3)[4] – offshore ECC landfall.

9.5.3. The offshore infrastructure includes WTGs and associated floating foundations, foundation moorings and anchors, OEP(s) and associated foundations, inter-array cables, interconnector cables and offshore export cables.

[2] LOT 1 refers to surveys carried out to characterise the Array Area for the purposes of the EIAR. Surveys conducted by EGS (2023a).

[3] LOT 2 refers to surveys carried out to characterise the offshore ECC for the purposes of the EIAR. Surveys conducted by EGS (2023b).

[4] LOT 3 refers to surveys carried out to characterise the intertidal area for the purposes of the EIAR. Survey carried out by EGS (2023b).



Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

METHODOLOGY

9.5.4. Baseline data to inform the benthic subtidal and intertidal ecology assessment was collected using the following methods.

SITE-SPECIFIC SURVEYS

9.5.5. Site-specific surveys were carried out to provide an up-to-date characterisation of the habitats and species occurring within the boundary of the Proposed Development to inform assessment of benthic subtidal and intertidal ecology. The details of the survey sampling and locations are shown in Table 9-4.

SUBTIDAL

9.5.6. To characterise the features of the seabed, geophysical surveys were undertaken between March-August 2023 (LOT 1 & 2). Around the Array Area (LOT 1), there was a 150 m buffer zone within which full survey coverage was required. A further 500 m buffer boundary was given as the limit for survey operations. Methods employed are outlined in with full details provided in Volume 3, Appendix 9.1 (Offshore Environmental Baseline Survey Reports).

9.5.7. A subtidal benthic ecology survey was developed based upon a review of the data acquired during the geophysical survey. Subsequently, a survey was undertaken across the Array Area and offshore ECC between July-August 2023 with biological and physicochemical samples collected with a combination of grab sampling and Drop Down Video (DDV). The distribution of sampling sites and the strategy adopted are shown in Figure 9-2 and full details of survey methodologies and sample analysis are presented within Volume 3, Appendix 9.1 (Offshore Environmental Baseline Survey Reports), and summarised in Table 9-4.

INTERTIDAL

9.5.8. Intertidal surveys were carried out in April 2023 to characterise the intertidal marine habitats. Sampling was a combination of walkover and collection of sediment samples for biological and physicochemical analyses. Information relating to the intertidal survey scope is provided in Table 9-4 and the area covered by the intertidal survey is indicated in Figure 9-6.

9.5.9. The comprehensive details of site-specific survey methods and sample analysis are outlined in Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports).

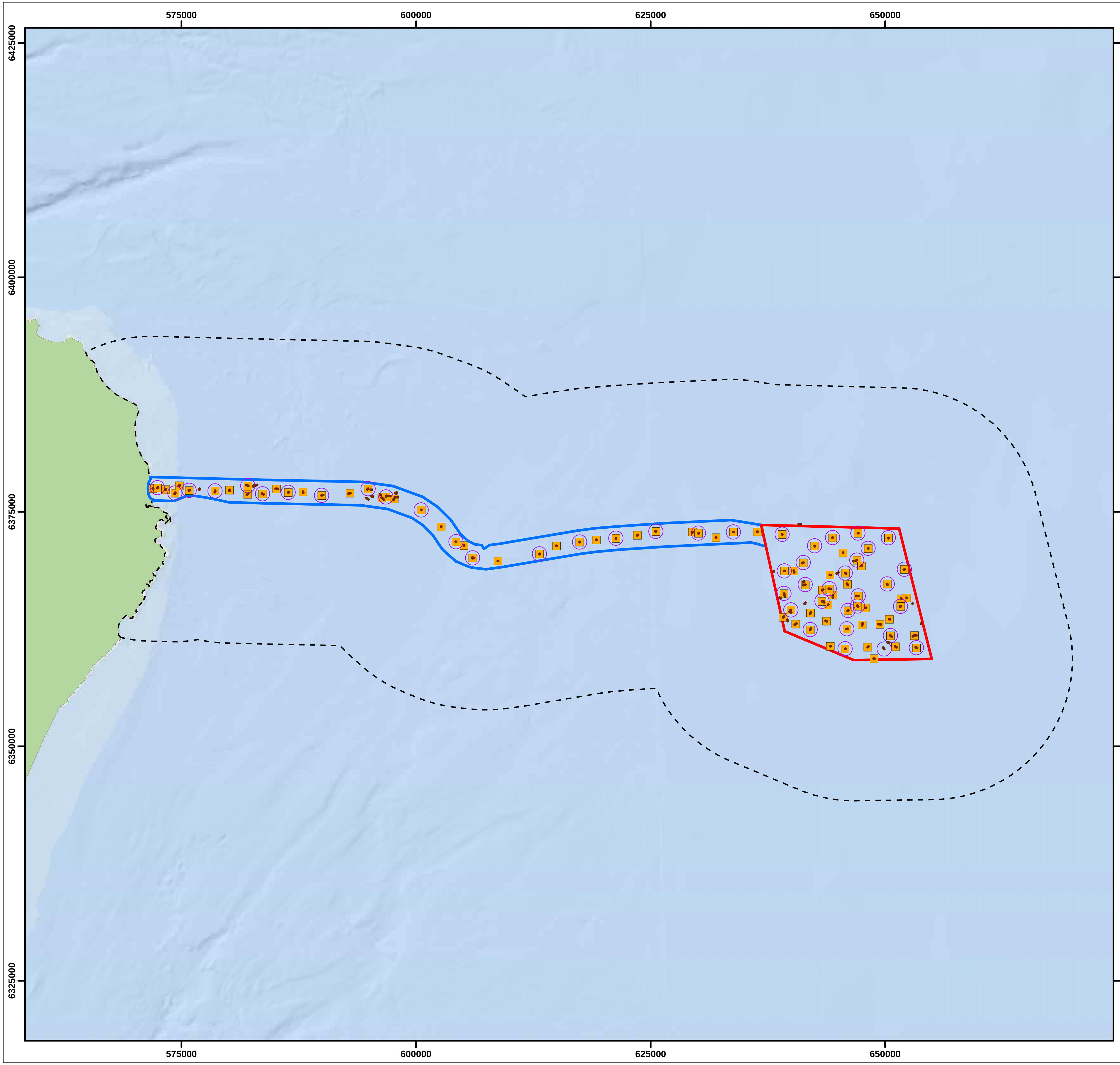
DESKTOP STUDY

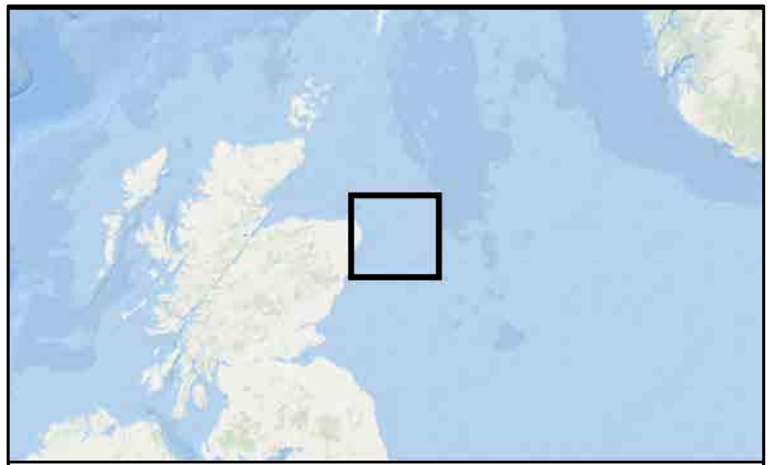
9.5.10. Information on the benthic subtidal and intertidal communities within the benthic subtidal and intertidal ecology study areas and secondary ZoI was collected through a detailed desktop review of existing literature and data sources. These existing data sets and literature are presented in Table 9-5.

Table 9-4 Site-specific surveys undertaken to inform Benthic Subtidal and Intertidal Ecology

Survey	Summary	Coverage of Proposed Development Study Area
Site-specific geophysical survey data conducted by EGS International Ltd (Benthic Solutions commissioned to undertake environmental and intertidal surveys): Volume 3, Appendix 9.1 (Preliminary Geophysical & Environmental Survey 2023: Results and Interpretation Report: OWF (LOT 1)); and Volume 3, Appendix 9.1 (Preliminary Geophysical & Environmental Survey 2023: Results and Interpretation Report: ECC (LOT 2 & LOT 3)).	Geophysical survey using echo sounder Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS) [300 kHz and 600 kHz], sub-bottom profiler (SBP) [upper 5-10 m of the seabed], magnetometry and Single Channel Ultra-High Resolution Seismic(S-UHRS) [min. depth 25 m below seabed].	Full coverage within the benthic subtidal and intertidal ecology study areas.
Site-specific benthic survey data conducted by EGS International Ltd (Benthic Solutions commissioned to undertake environmental and intertidal surveys): Volume 3, Appendix 9.1 (Environmental Baseline Report: OWF (LOT 1)); and Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & 3)).	Benthic sediment grab samples were collected with 0.1 m^2 dual van Veen grab with a 0.01 m^2 mini Hamon grab (back up for coarse sediment) and a 0.1 m^2 Day Grab (for marginal weather conditions) at locations within the Array Area (49 stations) and offshore ECC (30 stations) and nearshore ECC (nine stations). All benthic grab samples were subject to infaunal species analysis and Particle Size Analysis (PSA) as well as chemical contaminants analysis at six of the nearshore ECC stations, and all of the Array Area and offshore ECC stations. Camera transects were co-located with grab sampling locations: 50 within the Array Area (14 were then targeted for suspected sediment boundaries or features of interest) ranging from 40 m – 380 m in length), and 41 within the offshore ECC, and one in the nearshore ECC (85 m – 180 m in length).	Full coverage within the benthic subtidal and intertidal ecology study areas.
Site-specific intertidal survey data conducted by EGS International Ltd (Benthic Solutions commissioned to undertake environmental and intertidal surveys): Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & LOT 3)); and	Intertidal survey was across a 2 km stretch of coastline (1 km north and 1 km south of landfall). Nine approximately 200 m transects were surveyed with sediment samples (PSA and macrofauna) taken at fifteen stations. Macrofauna samples were taken from an area of 20 x 20 x 10 cm which were sieved using 0.5 mm and 1 mm mesh sieves. Once the sample had been extracted further material was collected to a depth of up to 30 cm depth (where possible in wet collapsing sand). Chemistry samples were	Full coverage within the benthic intertidal ecology study area.

Survey	Summary	Coverage of Proposed Development Study Area
Volume 3, Appendix 9.1 (Operations Report (LOT 3) Intertidal Environmental Survey).	taken at seven locations. A drone survey was conducted consisting of two flights covering the landward extent of the beach (concentrating on the grassland, dunes and other landward features), and the low tide (times to coincide with spring low water). The two series of imagery were then combined into one mosaic, covering the entire beach front, from low water to the shoreside dunes and landward extent.	
Legislative species protection assessment Volume 3, Appendix 9.1 (Environmental Baseline Report: OWF (LOT 1)); and Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & 3)).	A legislative species protection assessment was conducted by Benthic Solutions Limited (BSL) staff which identified any species that are afforded protection under several legislative conventions/ directives implemented in the UK, including Scottish PMF and the Scottish Biodiversity List. The assessment was conducted using the epifauna recorded from review of the underwater video footage and taxonomic analysis which were inputted into a database developed by BSL staff to identify protected species/habitats.	Full coverage within the benthic subtidal and intertidal ecology study areas.
Site-specific eDNA Survey. Benthic Solutions, 2023: Volume 3, Appendix 9.1 (Environmental Baseline Report: OWF (LOT 1)); and Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & 3)).	A program of water and sediment sampling was undertaken for eDNA analysis with the aim of ground-truthing the variation in seabed sediments and associated biota across the benthic subtidal ecology study area. Benthic sediment grab samples were collected with a dual van Veen (0.1 m^2) and sub-sampled and water column samples were taken with a 5 L Niskin bottle. eDNA sampling was conducted within the Array Area (25 stations), nearshore (three stations), and offshore ECC (15 stations).	Representative coverage within the benthic subtidal ecology study area.





Legend:

- Array Area
- Offshore Export Cable Corridor
- 15km Zone of Influence
- Grab Sampling Locations
- eDNA Sampling Locations
- Video Transects

Project:	Report:
Muir Mhòr	Environmental Impact Assessment Report

Overview of Subtidal Environmental Sampling Undertaken

Figure:	9-2	Drawing No:	GoBe-0129

Revision:	Date:	Drawn:	Checked:
01	30/08/24	EV	BPHB

Map scale 1:400,000 @ A3 — 0 5 10 km

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

MUIR MHÒR OFFSHORE WIND FARM

A joint venture between Fred. Olsen Seawind & Vattenfall

Table 9-5 Key sources of Benthic Subtidal and Intertidal Ecology literature and data

Source, Author, and Year	Summary	Coverage of Proposed Development Study Area
Existing Offshore Wind Farm (OWF) Data		
Hywind OWF: EIAR (Statoil, 2015)	An EIAR submitted in 2015 in relation to the Hywind OWF, detailing the baseline conditions of site-specific surveys and likely environmental effects of the project on the features present within the direct and surrounding areas.	Located within the benthic subtidal ecology study area, overlapping with the offshore ECC and 35.6 km from the Array Area.
Hywind OWF: Environmental Survey Report (MMT, 2013)	A site-specific survey report detailing the results from the marine environmental survey along the export corridor and within the development site for the Hywind OWF.	Located within the benthic subtidal ecology study area, overlapping with the offshore ECC and 35.6 km from the Array Area.
Beatrice OWF: Post-Construction Monitoring Year 1 (2020): Benthic Grab Survey Report (APEM, 2021).	A site-specific benthic grab survey at the Beatrice OWF site in October 2020 as part of the year two post construction surveys for the project.	Located 94.7 km to the north of the Proposed Development in the Moray Firth. Included to provide broader context and insights into sedimentary habitats within the region.
Beatrice OWF: Post-Construction Monitoring Year 2 (2021): Benthic Grab Survey Report (APEM, 2022).	A site-specific benthic grab survey at the Beatrice OWF site in June 2021 as part of the year two post construction surveys for the project.	Located 94.7 km to the north of the Proposed Development in the Moray Firth. Included to provide broader context and insights into sedimentary habitats within the region.
Moray Offshore Renewables Ltd EIAR: Subtidal Ecology Characterisation (Fugro EMU Ltd, 2014).	A site-specific subtidal survey report for the Moray Firth OWF sites of the subtidal benthic ecology of the proposed cable route corridor and transmission infrastructure, the subtidal benthic ecology of the proposed cable route corridor and transmission infrastructure.	Moray West and Moray East OWFs located 85.5 km and 77.6 km, respectively, to the north of the Proposed Development in the Moray Firth. Included to provide broader context and insights into sedimentary habitats within the region.
Moray Offshore Renewables Ltd EIAR: Benthic Ecology Characterisation Survey (EMU Limited, 2011).	A site-specific benthic ecology survey report for the Moray Firth OWF sites (including the Moray East OWF) and defining the benthic environment within the array area.	Moray West and Moray East OWFs located 85.5 km and 77.6 km, respectively, to the north of the Proposed Development in the Moray Firth. Included to provide broader context and insights into sedimentary habitats within the region.

Source, Author, and Year	Summary	Coverage of Proposed Development Study Area
Publicly Available Datasets		
EMODnet Broad-Scale Seabed Habitat Map for Europe (EMODnet, 2021).	Broad-scale seabed habitat map for Europe.	Covers all European waters.
Information on species of conservation interest (JNCC, 2007)	Species specific data, of native species of conservation interest.	This data source provides species specific data of native species of conservation interest.
Cefas OneBenthic Baseline Tool (OneBenthic database, 2020)	Collates time-series data collected around active dredging license areas.	Provides coverage of the benthic subtidal and intertidal ecology study areas.
Sitelink (NatureScot, 2024)	SiteLink provides comprehensive information on key Protected Areas in Scotland, including site boundaries, designated features, and supporting documents. It also includes data on site management agreements, consultation cases, and links to relevant external resources.	Covers all Scottish waters.
Planning Offshore Wind Strategic Environmental Impact Decisions (POSEIDON) Project	Strategic environmental baseline data and spatial models for key benthic species and the habitats most vulnerable to offshore wind impact. The project outputs will help guide future offshore wind development rounds and feed into wider marine planning and can be applied to the Project.	Covers all British waters.
Sectoral Marine Plan: Regional Local Guidance Offshore Wind Energy in Scottish Waters: Regional Locational Guidance (Scottish Government, 2020)	This report gives a broad overview of protected species, types of benthic habitat and substrate, and dominant species in a regional context.	Covers all Scottish waters.
JNCC MPA Mapper	The JNCC MPA mapper is an interactive resource containing information on the MPAs designated in UK and Crown Dependency waters.	Covers all Scottish waters.
The Marine Scotland National Marine Plan Interactive Maps (Scottish Government, 2023)	• Spatial data relating to benthic subtidal and intertidal ecology on the Marine Scotland National Marine Plan Interactive Maps; • NatureScot (2018): Ocean Quahog; and • Mapping European Seabed Habitat (MESH) project data. | 2023 | Marine Scotland	Covers all Scottish waters.

Source, Author, and Year	Summary	Coverage of Proposed Development Study Area
The Marine Life Information Network (MarLIN, 2023)	To distinguish species sensitivity and impact assessment synthesis.	Covers all British waters.
Feature Activity Sensitivity Tool (FeAST) (NatureScot, 2023)	This tool has been used to evaluate impacts on the Southern Trench and Turbot Bank Nature Conservation MPAs (NC MPA) resulting from the Proposed Development. It offers an initial assessment to determine if a proposed plan, project, or ongoing activity might affect a protected feature within the site. FeAST examines pressures linked with common marine activities and delivers a detailed evaluation of how sensitive features are to these pressures. If a feature is known to be sensitive to associated pressures, a human activity is deemed capable of affecting it more than insignificantly. These sensitivity assessments within FeAST are crucial in the early stages of planning or executing a project, aiding in the consideration of the LSE caused by an activity.	Covers all Scottish waters.
MPA Network information (Scottish Government, 2023a)	A definition and overview of the Scottish MPA Network.	Covers all Scottish waters.
Kelp bed data (Scottish Government, 2018a)	Scottish kelp bed habitat data layers.	Covers all Scottish waters.
Burrowed mud data (Scottish Government, 2018b)	Scottish burrowed mud habitat data layers.	Covers all Scottish waters.
Ocean Quahog data (Scottish Government, 2018b)	Records of ocean quahog in Scottish waters data layers.	Covers all Scottish waters.
Reports or Literature		
Descriptions of Scottish PMFs (Tyler-Walters *et al*, 2016)	Full descriptions of PMF species and associated habitats.	Covers all Scottish waters.

Source, Author, and Year	Summary	Coverage of Proposed Development Study Area
The Status of *Sabellaria spinulosa* Reef off the Moray Firth and Aberdeenshire Coasts and Guidance for Conservation of the Species (Pearce and Kimber, 2020)	The Scottish Marine Energy Research Programme has initiated research to verify the presence of S. spinulosa (commonly known as *S. spinulosa*) in reef formations along the eastern coast of Scotland. It has been shown by this study that four sites off the Aberdeenshire coast support significant areas of reef, and one of the best examples being the Southern Trench NC MPA area.	Located in the benthic subtidal ecology study area. Overlaps with the offshore ECC.
Towards Quantitative Spatial Models of Seabed Sediment Composition (Stephens and Diesing, 2015)	This study aims to predict seabed substrate composition across the North Sea, English Channel, and Celtic Seas using legacy grain-size data and environmental predictors. Employing a statistical regression model, it achieves approximately 66-71% variability explanation and an 83% accuracy in predicting sediment composition, with potential for further improvements.	Includes the North area up to approximately 58.44°N and the United Kingdom's parts of the English Channel and the Celtic Seas.
A big data approach to macrofaunal baseline assessment, monitoring, and sustainable exploitation of the seabed (Cooper and Barry, 2017)	This study compiles data from 777 grab surveys to create a dataset of benthic macrofauna and sediments (33,198 samples). It analyses spatial and temporal patterns in faunal distribution around the UK and identifies factors influencing these patterns, such as sediment composition. The dataset helps improve sustainability by identifying conditions favourable amidst activities affecting sediment composition. Additionally, it explores various big data applications and potential uses of the dataset.	Covers large parts of the UK continental shelf.

DESCRIPTION OF BASELINE ENVIRONMENT

9.5.11. The following sections provide the broad regional characterisation of the benthic subtidal ecology and intertidal ecology within the secondary ZoI and wider CNS region before focussing on the site-specific data within the boundary of the Proposed Development (Figure 9-1).

9.5.12. Detailed baseline descriptions, univariate and multivariate analyses are presented within the technical appendices that accompany this chapter, including spatial representations and figures. The subsequent Sections outline the physical attributes and subsequently address the benthic fauna and related habitats within the Array Area and offshore ECC and intertidal areas. The following Section provides a summary of the detail within those reports and therefore must be read in conjunction with Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports).

9.5.13. The regional assessment of species utilised data from nearby OWF projects and publicly available sources. Specifically, insights from the Hywind OWF, situated approximately 35.6 km from the Array Area and overlapping with the offshore ECC, were incorporated. Although the Moray West OWF, Moray East OWF, and Beatrice OWF are located at distances from the Proposed Development of 85.5 km, 77.6 km, and 94.7 km, respectively, without spatial overlap, their data were utilised to provide broader context and insights into sedimentary habitats within the region.

9.5.14. Throughout this Chapter the identified biotopes are referenced using their classification codes and classification titles.

BATHYMETRY SEABED FEATURES

REGIONAL CONTEXT

9.5.15. The Proposed Development is within the CNS with the Array Area located approximately 63 km off the Aberdeenshire coastline. The site is 295 km north of Dogger Bank, the shallowest point of the North Sea at approximately 15 m below sea level (Quante *et al.*, 2016). Northwards from Dogger Bank the basin declines smoothly towards the shelf edge down to a depth of approximately 200 m. The Array Area is in water depths of between 60 and 100 m.

9.5.16. The Array Area is located directly along the western boundary of the Turbot Bank NC MPA, a large sandbank characterised by coarse sediments and where water depths range from 55 to 91 m (Eggleton *et al.*, 2019).

9.5.17. The eastern part of the offshore ECC passes through the Southern Trench NC MPA which is an enclosed seabed basin with a length of 58 km and is up to 250 m deep located in the southeastern part of the outer Moray Firth, approximately 10 km north of the Fraserburgh-Banff coastline (Brooks *et al.*, 2013). The Southern Trench NC MPA acts as a sink for fine grain sediments (Holmes *et al.*, 2004). To the north of the Southern Trench NC MPA is an isolated plateau where water depths range from approximately 40 to 50 m. Seabed photography in this region indicated that the seabed is characterised by well-rounded pebbles, cobbles and boulders (Holmes *et al.*, 2004).

ARRAY AREA

9.5.18. Bathymetric data from the geophysical survey indicated the topography of the Array Area to be varied with depths ranging between 62 m and 97.7m (Figure 9-1). The deepest Section of the Array Area is found in the northeastern corner where sediments are comprised of sands. From here the seafloor gradually shelves towards the southwestern extent of the site to the shallowest point on the south-west boundary where sediments gradually transition to slightly coarser, gravelly sand. The southwest Section comprises gravel ribbons, making for a more heterogenous sediment composition compared to the northern parts of the Array Area.

9.5.19. Multiple large boulders with associated scour patterns were sporadically distributed across the Array Area, with a higher concentration of elevated hard contacts observed in the southern Section of the site associated with coarser gravelly sand and sandy gravel habitats. Some of these have the potential to be categorised as sensitive stony reef structures (discussed further in paragraph 9.5.113).

OFFSHORE EXPORT CABLE CORRIDOR

9.5.20. Water depths in the offshore ECC survey range between 20 m at stations closest to the shore to 120 m in the Buchan Deep. To the east of the Buchan Deep depths remain relatively consistent, ranging from 80 to 90 m. Figure 9-1 provides an overview of the bathymetry along the whole of the offshore ECC route.

9.5.21. The deepest Section of the offshore ECC area traverses the Forties C to Cruden Bay pipeline corridor. From that area eastwards towards the Array Area there is a fairly steep change of 35 m depth over approximately 3 km down to 85 m, with depth being less variable from this point to the Array Area.

9.5.22. The offshore ECC seabed shifts from megarippled sand near the shore to sandy gravel further out, with a transition to predominantly sandy seabed around 22 km offshore. Coarse sediment patches are observed amidst sand, with increased reflectivity indicating coarser substrate around 34 km offshore. Sandwaves are present near the Array Area.

9.5.23. Areas of potential *S. spinuloa* reef represented by cobbles encrusted with *S. spinulosa* and also *S. spinulosa* rubble or debris forming coarse seabed substrate were recorded in the offshore ECC. These were assessed against criteria detailed by Gubbay (2007) and Hendrick and Foster-Smith (2006) which indicated that these did not constitute Annex I biotic reef features. (Section 8.6, Volume 3, Chapter 9 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & LOT 3)),

9.5.24. Geophysical surveys indicated that boulders had a sporadic distribution across the offshore ECC with a higher concentration of elevated hard contacts observed close to the nearshore end of the offshore ECC associated with gravelly areas of seabed. Another area of slightly higher concentration of potential boulders was found to occur amongst the sand waves near the eastern end of the offshore ECC adjacent to the Array Area.

9.5.25. Numerous boulders or clusters of cobbles and boulders were also recorded along 22 camera transects within the offshore ECC. Resemblance of these to Annex I stony reef was investigated using the criteria proposed by Irving (2009) which indicated 19 occurrences of ‘Low reef’ and no occurrences of ‘Medium reef’. Section 8.1, Volume 3, Chapter 9 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & LOT 3)).

SEDIMENT CHARACTERISTICS

REGIONAL CONTEXT

9.5.26. The seabed sediments that characterise the CNS include large swathes of seabed characterised by sands and coarse sediments (EMODnet, 2022).

9.5.27. Site-specific surveys undertaken in the same region of the North Sea as the Proposed Development indicated the prevalence of similar sediment characteristics. For instance, PSA analysis of sediments in the vicinity of Moray West OWF, located 144 km north-west of the Array Area, indicated that sediments to be predominantly sandy with variable proportions of gravel and mud (Moray Offshore Wind Limited, 2023).

9.5.28. Similarly, sediment data collected in relation to the Hywind OWF, 36 km west of the Array Area and just to the north of the offshore ECC overlapping the benthic subtidal ecology study area indicated the presence of sandy mud with patches of mixed coarse sand, gravel and shell material with cobbles, boulders and exposed bedrock observed at nearshore sites (MMT, 2013).

9.5.29. Cefas seabed sediment modelling data indicates that the Array Area is mainly characterised by sand and muddy sand, with patches of coarse sediments located towards the south of the Array Area (Cefas, 2016). The Cefas modelling indicates that the offshore ECC is mainly characterised by sand and muddy sand, with a band of coarse sediment present to the west.

9.5.30. A review of the EUSeaMap (2021) data indicates the presence of two broadscale sediment habitats within the Array Area following a review of the EUSeaMap (2021) data Figure 9-3:

- Deep circalittoral sand in the north of the Array Area; and
- Deep circalittoral coarse sediment in the south of the Array Area.

9.5.31. The EUSeaMap (2021) data indicated that there were five main broadscale habitats present within the offshore ECC (Figure 9-3) as follows:

- The offshore ECC was mainly characterised by deep circalittoral sand with patches of circalittoral coarse sediment;
- There is a strip of deep circalittoral coarse sediments across the southwest of the offshore ECC towards the Array Area; and
- The inshore region of the ECC is dominated by deep circalittoral coarse sediment with smaller areas of Atlantic and Mediterranean high energy circalittoral rock, Atlantic Mediterranean moderate energy circalittoral rock, faunal communities on deep moderate energy circalittoral rock, deep circalittoral sand and circalittoral fine sand.

9.5.32. There are also smaller areas of Atlantic and Mediterranean high energy circalittoral rock, Atlantic and Mediterranean moderate energy circalittoral rock, deep moderate energy circalittoral rock, and deep circalittoral sand and circalittoral fine sand in the offshore ECC.

9.5.33. EUSeaMap (2021) data corresponds to Cefas (2015) data which indicated the offshore region of the offshore ECC to be dominated by sand and muddy sand, with a band of coarse sediments in the inshore region to the south, which is closer to the Array Area (Figure 9-3).

9.5.34. The intertidal area along the north-east coast of Scotland from Fraserburgh in the north to St Cyrus in the south is described by Irving (1996) as being comprised a mixture of extensive stretches of sand, interspersed with rocky shores backed by cliffs. In terms of exposure to weather and wave action, this coastal region is classified as high energy and is generally regarded as exposed (JNCC, 2014).

9.5.35. The intertidal zone between Peterhead and Cruden Bay which encompasses the landfall for the Proposed Development is characterised by bays with a mixture of sandy and gravelly sediments and a backdrop of cliffs. MagicMap also highlights that there are rock platforms between the sand inlets and bays across this stretch of coastline (MagicMap, 2023).

9.5.36. Site-specific surveys carried out for the Hywind OWF project included intertidal surveys of the landfall site at Peterhead, which lies within the Proposed Development benthic intertidal ecology study area. The landfall area was described as being dominated by outcropping bedrock subject to strong tidal waves, with the low shore bedrock being covered with large kelp beds with different species of red seaweed.

ARRAY AREA

9.5.37. Granulometric analysis of sediments collected during site-specific surveys for the Proposed Development indicated a heterogeneous sediment type across the Array Area with sands prevalent in the northern half of the area where the seabed was characterised by megaripples and sand waves with megaripples. Here sediments were classified according to the British Geological Survey (BGS) modified Folk Sediment Classification (Long, 2006) as predominantly sand or slightly gravelly sand.

9.5.38. Coarser sediments were recorded in the southern half of the Array Area with gravelly sand and sandy gravel the dominant sediment categories recorded. The proportion of fines was consistently low throughout the Array Area.

9.5.39. Additional information regarding sediment characteristics throughout the benthic subtidal and intertidal ecology study areas can be found in Volume 3, Appendix 7.1 (Marine and Coastal Process Technical Report), Volume 2, Chapter 7 (Marine and Coastal Processes), and Volume 2, Chapter 9 (Marine Water and Sediment Quality).

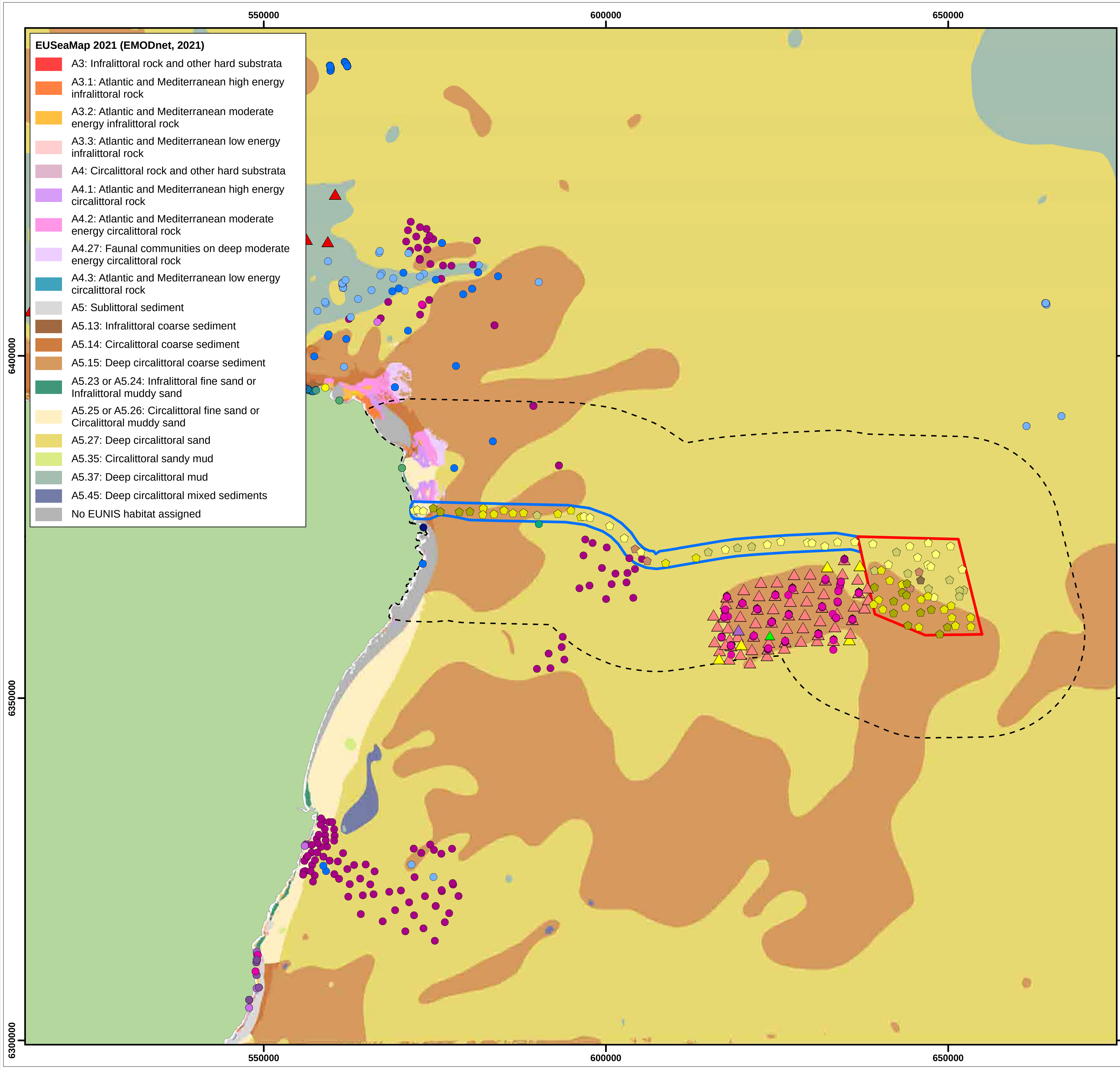
OFFSHORE ECC

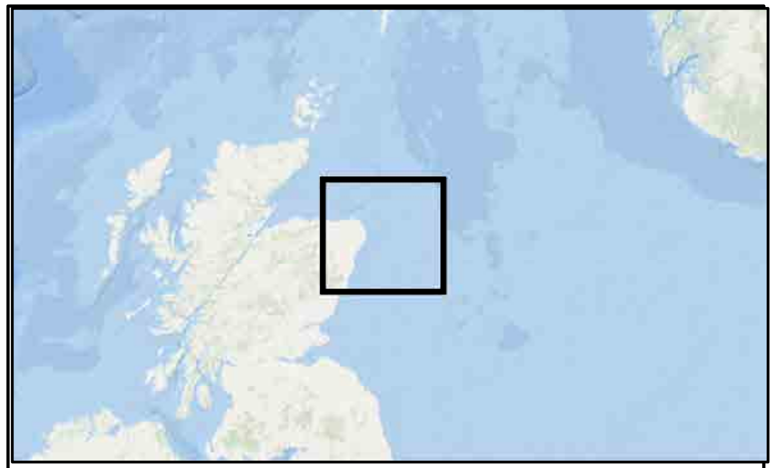
9.5.40. Granulometric analysis indicated that sediments across the offshore ECC survey were predominantly sandy in nature with varying proportions of gravel. Sediments at sites adjacent to the shore were classified as medium sand, although immediately further offshore material became coarser as sandy gravel was recorded. Subsequently, sediments became less coarse in an easterly direction with gravelly sand and then sands recorded. Sediments within the Buchan Deep were classified as fine sand.

INTERTIDAL

9.5.41. The benthic intertidal ecology study area was 1,000 m either side of the offshore ECC with the region mainly consisting of sand habitat.

9.5.42. Intertidal sediments were categorised into three Folk classifications (15 stations), with the highest proportion being ‘Sand’ (87%). The classifications across stations were as follows: ‘Sand’ (13 stations out of 15 stations), ‘Slightly Gravelly Sand’ (one station) ‘Muddy Sand’ (one station).





Legend:

- Array Area
- Offshore Export Cable Corridor
- 15km Zone of Influence

Habitat Survey Point Data (EUNIS) (EMODnet, 2021)

A1, A1.1, A1.2, A1.3, A1.4, A2.1, A2.2, A2.4, A3.1, A3.2, A3.3, A3.7, A4.1, A4.2, A4.7, A5.1, A5.2, A5.3, A5.4, A5.6, B3.1

OneBenthic Faunal Data Points (Cefas, 2019)

A2a, C1a, D2a, D2b, D2c

Sediment Grab Samples - Folk Class (EGS, 2023)

Sand, Slightly Gravelly Sand, Gravelly Sand, Sandy Gravel, Muddy Sandy Gravel, Gravelly Muddy Sand

Project:	Report:
Muir Mhòr	Environmental Impact Assessment Report

Predicted European Nature Information System (EUNIS) Habitats and Faunal Point Data for the Proposed Development and Surrounding Area

Figure: 9-3	Drawing No: GoBe-0130		
Revision:	Date:	Drawn:	Checked:
01	30/08/24	EV	BPHB

Map scale 1:550,000 @ A3 — 0 10 20 km

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

MUIR MHÒR OFFSHORE WIND FARM

A joint venture between Fred. Olsen Seawind & Vattenfall

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

SEDIMENT CHEMISTRY

9.5.43. Sediment bound contaminant concentrations have been assessed against Cefas chemical Action Levels (AL) (sometimes known as sediment action levels) for the disposal of dredged material). ALs are used as part of a weight of evidence approach to decision-making on the disposal of dredged material at sea. The AL are therefore not 'pass/fail' criteria but triggers for further assessment. In general, contaminant levels in dredged material below AL 1 (AL1) are of no concern and are unlikely to influence the licensing decision. However, dredged material with contaminant levels above AL 2 (AL2) are generally considered unsuitable for sea disposal due to potential toxicity. Dredged material with contaminant levels between AL1 and AL2 requires further consideration and testing before a decision can be made.

9.5.44. To determine likely biological effects sediment bound contaminant levels are also examined here by the Threshold Effects Level (TEL) / Probable Effect Level (PEL) approach developed by Environment Canada (CCME, 1995 & 1999). The TEL of a substance is the concentration below which sediment bound material is not considered to represent a significant hazard to marine organisms. The PEL represents the lowest concentration of a substance that is known to have an adverse effect on marine organisms.

9.5.45. Further detail on the sediment and water quality is provided in Volume 2, Chapter 8 (Marine Water and Sediment Quality) (paragraphs 8.5.25 *et seq*.).

REGIONAL

9.5.46. In the CNS, sediment contamination levels are historically highest at inshore estuary and coastal sites close to industrial sources of pollution (Sheahan *et al.* 2001). However, high levels of Total Hydrocarbons (THCs) are also found offshore in the immediate vicinity of oil and gas installations. The levels of some metals (lead (Pb), vanadium (V), copper (Cu) and iron (Fe)) are lower in the northern North Sea (where the Proposed Development is located) in comparison to the southern North Sea.

9.5.47. Sediments with larger particle sizes tend to be less likely to be associated with elevated concentrations of anthropogenic contaminants compared to finer sediment (for example coarse sand compared to mud). Hydrocarbons are often closely correlated to the spatial distribution of fine sediment types (such as muds and silts). Metal concentrations in sediments are generally higher in the coastal zone and around estuaries, decreasing offshore, indicating that river input and run-off from land are important sources. As noted above, the sediments within the benthic subtidal and intertidal ecology study areas have been characterised as predominately sands and gravels and as such, it is not expected that these will contain highly elevated concentrations of anthropogenic contaminants, see Volume 2, Chapter 8 (Marine Water and Sediment Quality).

9.5.48. Analysis of sediment samples from the Moray West OWF (Moray OWF (West) Limited, 2018) found metal concentrations below then relevant TELs and consequently no adverse biological effects would be expected to occur. Polycyclic Aromatic Hydrocarbon (PAH) levels were generally low, mostly below the Limit of Detection (LOD), though acenaphthene, acenaphthylene, and dibenzo(ah)anthracene LODs slightly surpassed the relevant TELs i.e. concentrations at which exposure is likely to affect some sensitive species *et al*. An environmental assessment for Moray East indicated sediment contaminants were largely at concentrations that were below guideline levels and standards (Chapter 4.1, Moray Offshore Renewables Limited, 2018). Assessments in the North Sea have shown low mean concentrations of Polybrominated Diphenyl Ethers (PBDEs) (<1 µg.kg-1 dry weight) that are frequently below the detection levels. (OSPAR, 2009).

ARRAY AREA

9.5.49. Analysis of sediment bound contaminant data for the Array Area determined that all concentrations were below AL1 including metals, PCBs and PAHs.

9.5.50. All reported sediment bound concentrations of all of organic compounds were below the relevant TELs where available. Similarly, sediment bound metal concentrations were lower than relevant TELs with the exception of arsenic (As) where the TEL was exceeded at five sites located in the southern half of the Array Area. The arsenic concentrations recorded as above the TEL (8.6 mg/kg to 14.1 mg/kg) were within the range of <0.15mg/kg to 135 mg/kg reported from elsewhere in the North Sea (Whalley *et al*., 1999). As the highest As concentration was only one third of the relevant PEL (41.6 mg/kg) these exceedances of the TEL are not considered to represent a significant hazard to marine biota.

9.5.51. Sediment analysis included measurements of Total Organic Matter (TOM), Total Organic Carbon (TOC), moisture content, and carbonate content.

9.5.52. TOM levels exceeded background standards (UK Offshore Operators Association (UKOOA) (2001) 50th percentile for background sediments in the CNS at most Array Area survey sampling stations, with the highest TOM concentration recorded at one sampling station in the south-west of the Array Area (sampling station OWF_26_SEC_DNA).

9.5.53. TOC in surface sediments is crucial for benthic fauna but can reduce species richness if excessive. TOC levels were low (0.23% - 0.46%, mean 0.32% ± 0.07 Standard Deviation (SD)), with no significant correlation to sediment characteristics. Terrestrial and primary production sources contribute to TOC levels, but due to the small proportion of fine sediments TOC was at moderate levels.

9.5.54. Moisture content was relatively consistent across the Array Area (mean 20.69% ± 5.66 SD) with the exception at one sampling station in the south-west of the Array Area (sampling station OWF_26_SEC_DNA) (7%) which likely reflected the higher gravel content at the station.

9.5.55. Carbonate content is expressed as the percentage concentration of carbonate minerals within a sediment sample. The carbonate content ranged from 4.4% to 41.2% and similar to TOM, showed a positive Spearman's correlation with gravel.

OFFSHORE ECC

9.5.56. Analysis of sediment bound contaminant data for the offshore ECC determined that all concentrations were below AL1 including metals, PCBs and PAHs.

9.5.57. All reported sediment bound concentrations of all of organic compounds were below the relevant TELs where available. Similarly, sediment bound metal concentrations were lower than relevant TELs with the exception of arsenic (As) where the TEL was exceeded at three sites located in the southern half of the Array Area. The arsenic concentrations recorded as above the TEL (10.9 mg/kg to 22.8 mg/kg) were within the range of <0.15mg/kg to 135 mg/kg reported from elsewhere in the North Sea (Whalley *et al*., 1999). As the highest As concentration was slightly over half of the relevant PEL (41.6 mg/kg) these exceedances of the TEL are not considered to represent a significant hazard to marine biota.

INTERTIDAL

9.5.58. Analysis of sediment bound contaminant data for the benthic intertidal ecology study area determined that all concentrations were below AL1 including metals, PCBs and PAHs.

9.5.59. The majority of sediment bound PAH levels in intertidal sediments were below the relevant TELs. However, at two sites in the southern half of the benthic intertidal ecology study area levels of several PAHs exceeded the relevant TELs, although none were above the relevant PELs. Where the TELs were exceed the reported PAH concentrations represented less than one quarter of the relevant PELs these exceedances of the TELs are not considered to represent significant hazards to marine biota.

SEABED HABITAT AND COMMUNITIES

REGIONAL

9.5.60. A review of epifaunal data from the CNS, including the outer Moray Firth (approximately 140 km to the west of the Array Area), noted a diverse and abundant sessile fauna of hydrozoans, bryozoans and tube-dwelling polychaetes, while mobile fauna were represented by crustaceans such as the hermit crab *Pagurus bernhardus* and echinoderms such as *Asterias rubens* (Callaway *et al.,* 2002). Jennings *et al.* (1999) classified the mobile epifaunal community as a 'central' North Sea sub-group, dominated by *A. rubens, P. bernhardus* and the shrimp *Crangon allmanni*, while the sessile epifauna belonged to a 'north' North Sea subgroup and was dominated by the hydroid *Hydrallmania falcata* and the bryozoan *Flustra foliacea*.

9.5.61. Survey data from SEA 5 for the outer Moray Firth (DTI, 2004) noted that sediments in the area ranged from generally coarse sediment to muddy sediment, and very fine to fine sands (becoming finer with depth). A relatively consistent macrofauna was reported, with dominant taxa including species characteristic of stable fine sands such as the polychaete worm *Galathowenia oculata*, the echinoid *Echinocyamus pusillus* and the amphipods *Ampelisca tenuicornis* and *Harpinia antennaria*.

9.5.62. Benthic communities in the CNS are primarily shaped by the seabed substrata with habitats characterised by mobile sand supporting communities typically low in species diversity, featuring sturdy organisms like annelid worms and rapidly burrowing bivalves (Barne *et al*., 1998; Jones *et al*., 2004). Mixed substrata with coarse components provide microhabitats supporting a diverse range of species, including epibenthic flora and fauna (Jones *et al*., 2004)

9.5.63. Offshore portions of the benthic subtidal ecology study area to the west of the Array Area were characterised using OneBenthic datasets as having the following macrofaunal assemblages described by Cooper *et al.* (2019):

- **A2a** – characterised by Sabellariidae, Spionidae, Polynoidae, Terebellidae, Nemertea, Phyllodocidae, Lumbrineridae, Pholoidae, Cirratulidae, Capitellidae, Syllidae, Semelidae and Porcellanidae. This group is likely to be located on sublittoral coarse sediment and / or sublittoral mixed sediments;
- **C1a** – characterised by the polychaetes Spionidae, Terebellidae, Serpulidae, Syllidae, Capitellidae, Cirratulidae, Lumbrineridae, Sabellariidae, Nemertea, Glyceridae and the nematode family Nemertea. This group is likely to be located on a variety of sandy substrates;
- **D2a** – represented a faunal assemblage characterised by the polychaetes Spionidae, Glyceridae, Terebellidae, Capitellidae, Phyllodocidae and the nematode family Nemertea. This group is likely to be located on a variety of sandy substrates;
- **D2b** – characterised by Spionidae, Amphiuridae, Nephtyidae, Lumbrineridae, Oweniidae, Cirratulidae, Capitellidae, Nemertea, Semelidae, Ampharetidae. D2b is widely found across the northern North Sea and Celtic Shelf, is typically associated with deep water, low bottom temperature, muddy habitats with low bottom current flows, high salinity and low chlorophyll; and

- **D2c** – represented a faunal assemblage characterised by polychaetes including Nephtyidae, Spionidae and Opheliidae. All of which are typically found in sands and muddy sands.

9.5.64. Areas of the benthic subtidal ecology study area immediately to the south of the offshore ECC were characterised using OneBenthic datasets as having the following macrofaunal assemblages described by Cooper *et al*. (2019):

- **C1b**– group is likely to be found on a variety of sandy substrates and is characterised by polychaetes Spionidae, Terebellidae, Serpulidae, Syllidae, Capitellidae, Cirratulidae, Lumbrineridae, Sabellariidae, Phyllodocidae, Polynoidae, Scalibregmatidae, and Pholoidae and Theamphipod family Ampeliscidae;
- **D2a** – represented a faunal assemblage characterised by the polychaetes Spionidae, Glyceridae, Terebellidae, Capitellidae, Phyllodocidae and the nematode family Nemertea. This group is likely to be located on a variety of sandy substrates;
- **D2b** – characterised by Spionidae, Amphiuridae, Nephtyidae, Lumbrineridae, Oweniidae, Cirratulidae, Capitellidae, Nemertea, Semelidae, Ampharetidae. D2b is widely found across the northern North Sea and Celtic Shelf, is typically associated with deep water, low bottom temperature, muddy habitats with low bottom current flows, high salinity and low chlorophyll;
- **D2c** – represented a faunal assemblage characterised by polychaetes including Nephtyidae, Spionidae and Opheliidae. All of which are typically found in sands and muddy sands; and
- **D2d** - represented by a faunal assemblage characterised by low numbers of taxa including Spionidae, Bathyporeiidae, Nephtyidae, Magelonidae, Tellinidae. This group dominates in areas of high sand.

9.5.65. The Beatrice OWF located 150 km northwest of the Array Area, encompasses sediments characterised predominantly by sands, with small proportions of mud and gravel. The most dominant biotope recorded across the area during the post-construction survey in 2021 was '*E. pusillus, Ophelia borealis and Abra prismatica* in circalittoral fine sand' (EUNIS biotope code: MC5211) (BOWL, 2022), although it is worth noting that the biotope was '*Moerella* spp. with venerid bivalves in Atlantic infralittoral gravelly sand' (EUNIS biotope code: MB3233) had previously been commonly recorded across the area. Both biotopes are PMFs, and it is likely that natural spatial variation in the abundances of key taxa common to both biotopes is the driver underlying the temporal variation in the dominance of these biotopes across the Beatrice OWF site (BOWL, 2022).

9.5.66. Site-specific surveys conducted for the Moray East OWF, located 132 km northwest of the Array Area, identified the presence of five habitat biotopes. The habitats here included sublittoral sand and muddy sediments with patches of circalittoral coarse sediment, seapens and burrowing megafauna in circalittoral fine mud as well as cobbles, boulder and bedrock reef habitat with encrusting algae. Coarser sediments were also located across Moray West, with variable coarse/mixed sediments with sand or sandy gravel and patchy stones/cobble recorded at the eastern fringe. Occasional areas of more consolidated surface cobble were recorded including small area likely to be considered Annex I stony reef (EMU Limited, 2011).

9.5.67. The deeper water regions of the Moray West OWF ECC were characterised by areas of sandy mud or very muddy sand with an abundance of burrows and pits recorded. Taxa present included slender sea pen (*Virigularia mirabilis)*, curled octopus (*Eledone cirrhosa)* sparse hydroids/bryozoans and plaice *Pleuronectes platessa*. Areas of burrowed mud habitat were recorded, which is classified as a PMF. Inshore areas were characterised by relatively clean sublittoral sand with small portions of shell grit or fine gravel. There were also areas of coarse mixed sediments and some areas of cobbles and boulders, which were often characterised by patchy hydroid and/or bryozoan turf. Brittlestar beds were also recorded across the Moray West OWF ECC.

9.5.68. The following biotopes (or slight variants of) were recorded across the Hywind OWF ECC which is adjacent to the offshore ECC:

- *Laminaria hyperborea* with dense foliose red seaweeds on exposed Atlantic infralittoral rock (EUNIS code: MB1215);
- *S. spinulosa* with a bryozoan turf and barnacles on silty turbid Atlantic circalittoral rock (EUNIS code: MC12811);
- *F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed Atlantic circalittoral rock (EUNIS code: MC1216);
- *Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed Atlantic circalittoral rock (EUNIS code: MC12243); and
- Foliose red seaweeds with dense *Dictyota dichotoma* and/*or Dictyopteris membranacea* on exposed lower infralittoral rock (EUNIS code: MB12211).

9.5.69. The Hywind OWF EIAR (Statoil, 2015) reported the presence of a variety of species including burrowing brittlestars *Amphiura filiformis*, epifaunal brittlestars (*Ophiocten affinis*), amphipods (*Urothoe* spp*., Bathyporeia* spp*., and Harpinia* spp*.),* razor clams (*Antalis entalis*), and polychaetes (*Scoloplos armiger*, *Spiophanes* spp*., Diplocirrus glaucus, Owenia fusiformis,* and *G. oculata*). Sea urchins (*E. pusillus*) were also observed along the cable route.

9.5.70. As with the array area for Beatrice OWF, the post-construction monitoring benthic survey revealed that the most dominant biotope recorded during across the Beatrice ECC (located 94.7 km from the offshore ECC for the Proposed Development) was '*E. pusillus, O. borealis and A. prismatica* in circalittoral fine sand' (EUNIS code: MC5211) (APEM, 2022).

Table 9-6 Biotopes found across the secondary ZoI and wider CNS region informed by other OWFs

Biotope Name	EUNIS code (supersedes JNCC code)	JNCC code
Biotopes identified across the wider region during surveys for Hywind OWF (Equinor), Beatrice OWF (SSE Renewables, Repsol Neuvas Energias UK and Copenhagen Infrastructure Partners), Moray East OWF, Moray West OWF (EDP Renewables and ENGIE):		
L. hyperborea with dense foliose red seaweeds on exposed Atlantic infralittoral rock	MB1215	IR.HIR.KFaR.LhypR.Ft
S. spinulosa with a bryozoan turf and barnacles on silty turbid Atlantic circalittoral rock	MC12811	CR.MCR.CSab.Sspi.ByB
F. foliacea and colonial ascidians on tide-swept moderately wave-exposed Atlantic circalittoral rock	MC1216	CR.HCR.XFa.FluCoAs
Alcyonium digitatum with *Securiflustra securifrons* on tide-swept moderately wave-exposed Atlantic circalittoral rock	MC12243	CR.MCR.EcCr.FaAlCr.Sec
Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	MB12211	IR.HIR.KFar.FoR.Dic
E. pusillus, O. borealis and *A. prismatica* in circalittoral fine sand	MC5211	SS.SSa.CFiSa.EpusOborApri

Biotope Name	EUNIS code (supersedes JNCC code)	JNCC code
Seapens and burrowing megafauna in circalittoral fine mud	MC6216	SS.SMu.CFiMu.Spn.Meg
Grazed *L. hyperborea* forest with coralline crusts on upper infralittoral rock	MB121A3	IR.MIR.KR.Lhyp.GzFt
F. foliacea and *H. falcata* on tide-swept circalittoral mixed sediment	MC4213	SS.SMx.CMx.FluHyd
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	SS.SMx.OMx.PoVen
Atlantic circalittoral sand	MC52	SS.SSa.CFiSa
Atlantic infralittoral sand	MB52	SS.SSa.IFiSa
Sparse fauna in Atlantic infralittoral mobile clean sand	MB5231	SS.SSa.IFiSa.IMoSa

ARRAY AREA

9.5.71. A total of 10,135 individuals, representing 332 taxa were recorded in the singular replicate grab samples collected at 43 stations during site-specific surveys across the Array Area.

9.5.72. Annelida represented the most diverse and abundant group of animals with 157 taxa identified 39.9% of individuals recorded. Crustacea were represented by 90 taxa and 10.9% of the total individuals, molluscs by 55 taxa and 4.4% of individuals and echinoderms by ten taxa 10.4% of the total individuals. All other groups (Chaetognatha, Nematoda, Nemertea and Hemichordata) were represented by nine taxa (accounting for 24.6% of the total number of individuals).

9.5.73. The benthic communities identified from the faunal data collected during sites-specific surveys were fairly consistent with those identified previously as discussed above (see Table 9-7) with hornwrack (*F. foliacea*), hydrozoa/bryozoa, hermit crabs (*Pagurus* sp.) and flatfish (Pleuronectiformes) observed frequently across the Array Area. Other fauna such as queen scallop (*Aequipecten opercularis*) were also observed across the three habitats but less frequently overall.

9.5.74. The ‘Muddy Sand’ area in the northern of the Array Area featured some fauna unique to this habitat such as phosphorescent sea pen (*Pennatula phosphorea*).

9.5.75. Other sessile fauna was found across the survey site such as anemones (Actinaria) and these were found to often associate with hard substrate in the region such as cobbles and boulders. Echinoderms such as the common sea star (*A. rubens*), cushion star (*Porania pulvillus*) were observed frequently throughout the site whereas sea urchins (Echinoidea) were rarer.

9.5.76. The coarser areas of the Array Area featured hard substrate such as cobbles and boulders, with associated fauna at sufficiently high density to warrant a stony reef assessment to be undertaken on selected transects. However, when applying protocol detailed by Irving (2009) it was evident that most sampling potential reef habitats were 'Not a Reef,' with some small areas of 'Low Reef' and 'Medium Reef' patches which were characterised by cobbles and boulders encrusted with barnacles (Section 8.1, Volume 3, Appendix 9.1 (Environmental Baseline Report: (OWF LOT 1)). Overall, no areas of Annex I habitat reef habitat was identified in the Array Area.

9.5.77. The Infaunal Quality Index indicated that the communities at the majority of sites to be of either “High/Good” or “Good/Moderate” ecological status, with just one station classed as being of “Moderate/Poor” ecological status.

9.5.78. Sediment eDNA analyses revealed a wide range of species sequences from the samples. From these data, 23 different phyla were recorded in the 25 samples from sampling stations in the Array Area, with 254 different taxonomic units recovered. The analysis identified one protected species, the horse mussel (*Modiolus modiolus*) which is listed as a PMF but only when it is present as *M. modiolus* beds. No INNS were identified.

9.5.79. Within the Array Area three distinct biotope complexes were identified from the site-specific survey data (EGS International ltd., 2023):

- Areas of 'Muddy sand' and 'Sand' interpreted seabed features in the northern third of the Array Area were classified as the biotope complex 'Faunal communities of Atlantic circalittoral sand' (SS.SSa.CFiSa / EUNIS code: MC521).
- The southern two thirds of the Array Area was classified as the biotope complex 'Faunal communities in Atlantic offshore circalittoral coarse sediment' (SS.SCS.OCS / EUNIS code: MD321), equating to the interpreted seabed feature type of 'Slightly gravelly sand'.
- Areas of interpreted 'Mixed sediment' and 'Muddy, gravelly sand' seabed feature types were classified as the biotope complex 'Faunal communities in Atlantic offshore circalittoral mixed sediment' (SS.SMx.OMx / EUNIS code: MD421), whilst areas of interpreted 'Sandy gravel' seabed feature type were classified as a coarser variant of the overarching 'Offshore circalittoral coarse sediment' habitat type. Low density boulder fields (10-100 / hectare) which ranged in height from 0.3m to 5.2m were present across the site but did not form their own habitat type and instead were a component of the MD421 and MD321 complexes.

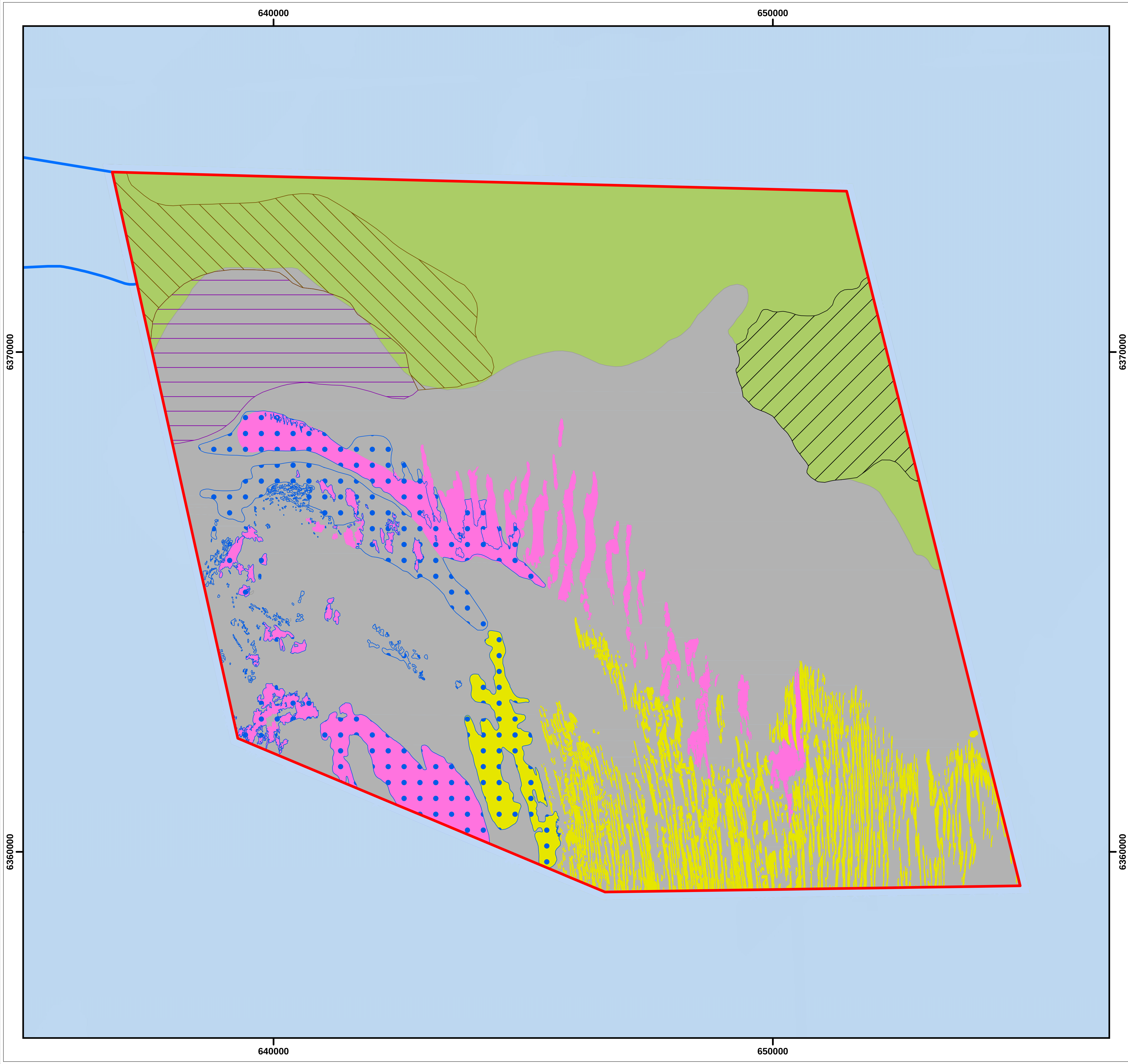
9.5.80. The identified biotope complexes and associated biotopes are detailed in Table 9-7.

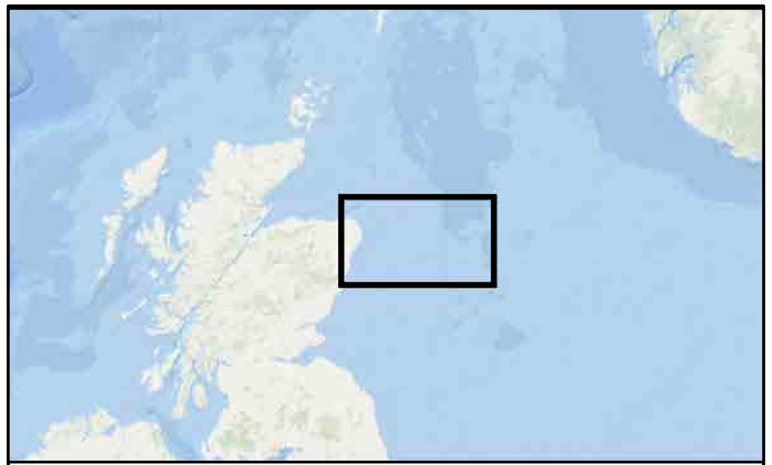
9.5.81. Full details of the site-specific survey undertaken in the Array Area are provided in Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports) - Environmental Baseline Report OWF (LOT 1).

Table 9-7 Assigned level 4 and 5 habitats throughout the Array Area in the benthic subtidal ecology study area.

Biotope Name	EUNIS code (supersedes JNCC code)	JNCC code	Location (please see Figure 9-4 for specific locations)
Offshore circalittoral sand	MD5	SS.SSa	Observed in the northern part of the Array Area and characterised a broad area.
Faunal communities of Atlantic circalittoral sand	MC521	SS.SSA.CMuSa	
E. pusillus, *O. borealis* and *A. prismatica* in circalittoral fine sand	MC5211	SS.SSa.CFiSa.EpusOborApri	
Circalittoral coarse sediment	MC3	SS.SCS	Observed across the south of the Array Area
Faunal communities in Atlantic offshore circalittoral coarse sediment	MD321	SS.SCS.OCS	
Glycera lapidum, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand	MD3211	SS.SCS.OCS.GlapThyAmy	
Faunal communities in Atlantic offshore circalittoral coarse sediment (coarser variant)	MD321	SS.SCS.OCS	Smaller areas in the south of the Array Area.

Biotope Name	EUNIS code (supersedes JNCC code)	JNCC code	Location (please see Figure 9-4 for specific locations)
G. lapidum, Thyasira spp. and *A. macroglossus* in offshore gravelly sand (coarser variant)	MD3211	SS.SCS.OCS.GlapThyAmy	
Circalittoral mixed sediment	MC4	SS.SMx	Observed in the centre and south-west part off the Array Area.
Faunal communities in Atlantic offshore circalittoral mixed sediment	MD421	SS.SMx.OMx	Smaller patches within the more widely distributed MC4 habitat type. Found on transects along other habitats such as MM_OWF_11_SEC and MM_OWF_15_SEC_R1
Polychaete-rich deep *Venus* community in circalittoral mixed sediment	MD4211	SS.SMx.OMx.PoVen	





Legend:

Array Area

Offshore Export Cable Corridor

Biotope

Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand

Glycera lapidum, *Thyasira spp.* and *Amythasides macroglossus* in offshore circalittoral gravelly sand (Coarser Variant)

Glycera lapidum, *Thyasira spp.* and *Amythasides macroglossus* in offshore circalittoral gravelly sand

Polychaete-rich deep Venus community in offshore circalittoral mixed sediments

Seabed Profile

Megaripples

Megaripples with Scour

Sandwaves with Megaripples

Ripples

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Environmental Habitats within the Array Area

Figure: 9-4	Drawing No: GoBe-0132		
Revision:	Date:	Drawn:	Checked:
01	03/09/24	EV	BPHB

Map scale 1:75,000 @ A3 — 0 1 2 km

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

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OFFSHORE ECC

9.5.82. A total of 12,210 individuals, representing 364 taxa were recorded from samples collected from 37 sites sampled across the offshore ECC during site-specific surveys.

9.5.83. Annelida was the most diverse and abundant group with 173 taxa and 37.1% of individuals identified. Crustacea were represented by 100 taxa and 9.8% of total individuals, molluscs by 61 taxa and 6.5% of total individuals and echinoderms by eight taxa and 12.1% of total individuals). Other groups (Chaetognatha, Nematoda, Nemertea, Hemichordata and Chordata) were represented by 10 taxa making up 14.7% of individuals.

9.5.84. The reef building ross worm (*S. spinulosa*) was seen at several stations within the offshore ECC, with noticeable aggregations visible in the geophysical data. The density of aggregations varied across these transects with multiple areas requiring further analysis to determine their potential conformity to EC Habitats Directive Annex I biogenic reef. However, these patches were of low elevation and coverage and were therefore according to criteria detailed by Gubbay (2007) were considered not to constitute Annex I reef habitat (Section 8.6, Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & LOT 3)).

9.5.85. In addition, the presence of several epifaunal assemblages associated with clusters of cobbles and boulders were encountered indicating potential Annex I stony reef habitat. However, when applying the protocols detailed by Irving (2009) it was evident that most sampling potential reef habitats were 'Not a Reef,' with some small areas of 'Low Reef' and 'Medium Reef' patches which were characterised by cobbles and boulders encrusted with barnacles (Section 8.1, Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & LOT 3)). Overall, no areas of Annex I habitat reef habitat was identified in the offshore ECC.

9.5.86. The Infaunal Quality Index values indicated the communities across the offshore ECC to be of either “High/Good” or “Good/Moderate” ecological status.

9.5.87. Sediment eDNA analyses along the offshore ECC revealed a wide range of species sequences from the samples. From these data, 26 different phyla were recorded in the 19 samples, with 253 different taxonomic units recovered. No INNS were identified to species level. The family Styelidae was identified and the INNS *Styela clava* belongs to this family, however this was not identified to species level.

9.5.88. Seabed feature types identified in the offshore ECC during the geophysical survey were assigned to seven biotope complexes, following ground-truthing survey and analysis of video footage and still photographs:

- The biotope complex ‘Faunal communities of Atlantic infralittoral sand’ (EUNIS code: MB521) was present closest to the shore with infaunal data indicating conformance with the biotope ‘*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand’ (EUNIS code: MB5233);
- ‘Faunal communities of Atlantic circalittoral coarse sediment’ (EUNIS code: MC321) occurred outside the nearshore sampling region and had an impoverished community best described as the biotope ‘*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel’ (EUNIS code: MC3212);
- In the offshore ECC, the seabed was classed as the biotope complex ‘Faunal communities of Atlantic circalittoral mixed sediment’ (EUNIS code: MC421) with the epifaunal community indicating a conformance to the biotope ‘*F. foliacea* and *H. falcata* on tide-swept circalittoral mixed sediment’ (EUNIS code: MC4214);

- In deeper waters when considering the habitat 'Faunal communities of Atlantic offshore circalittoral mixed sediment' (EUNIS code: MD421) the infaunal data indicated a conformance to 'Polychaete-rich deep *Venus* community in offshore mixed sediments' (EUNIS code: MD4211) due to a noticeable polychaete population including *Aonides paucibranchiata;*
- 'Faunal communities of Atlantic offshore circalittoral coarse sediment' (EUNIS code: MD321) was often recorded close to mixed sediment and the presence of species such as *Timoclea ovata* and *Exogone verugera* indicated a conformance to '*G. lapidum, Thyasira spp.* and *A. macroglossus* in offshore circalittoral gravelly sand' (EUNIS code: MD3211);
- At the deepest point in the offshore ECC as well as closest to the Array Area the biotope complex 'Faunal communities of Atlantic circalittoral sand' (EUNIS code: MC521) occurred, showing a conformance to the biotope *'E. pusillus, O. borealis* and *A. prismatica* in circalittoral fine sand' (EUNIS code: MC5211); and
- The final habitat recorded was the biotope complex 'Faunal communities of Atlantic offshore circalittoral sand' (EUNIS code: MD521) which had an assemblage characteristic of the biotope *'Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand' (EUNIS code: MD5212).

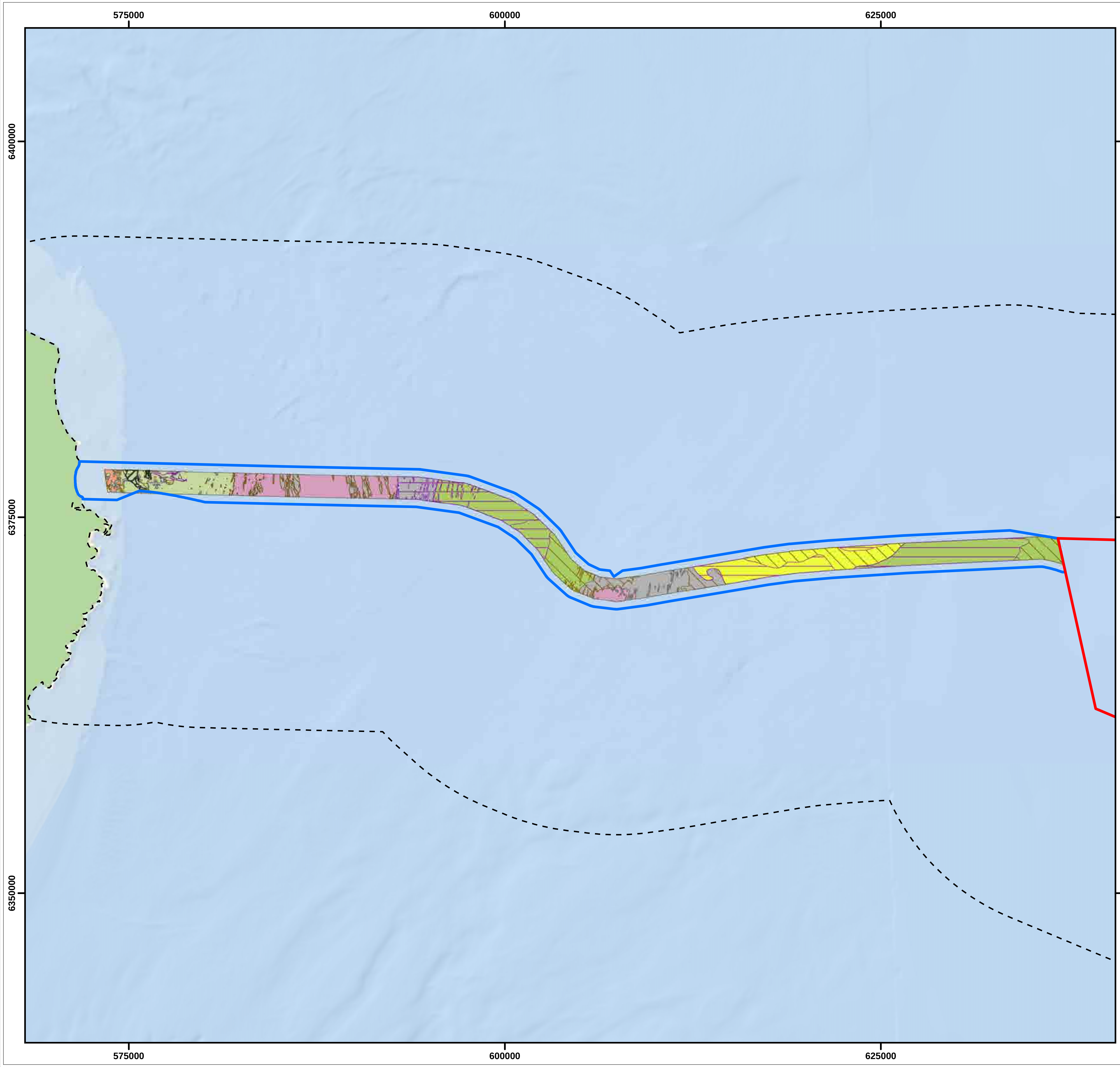
9.5.89. All EUNIS habitats found in the offshore ECC are listed in full in Table 9-8.

9.5.90. Full details of the site-specific survey undertaken in the offshore ECC are provided in Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports) - Environmental Baseline Report ECC & Intertidal (LOT 2 & 3).

Table 9-8 Assigned level 4 and 5 habitats throughout the offshore ECC within the benthic subtidal ecology study area

Biotope Name	EUNIS code (supersedes JNCC code)	JNCC code	Location (please see Figure 9-5 for locations of habitat)
Infralittoral sand	MB5	SS.SSa	Offshore and nearshore areas of the offshore ECC <20 m deep
Faunal communities of full salinity Atlantic infralittoral sand	MB523	SS.SSa.IFiSa	
Nephytys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand	MB5233	SS.SSa.IFiSa.NcirBat	
Faunal communities of Atlantic circalittoral mud	MC621	SS.SSa.CMuSa	Deeper areas of the offshore ECC close to the Array Area and in the area of the Buchan Deep
Faunal communities of Atlantic circalittoral sand	MC521	SS.SSa.CFiSa*	
Faunal communities in Atlantic offshore circalittoral sand	MD521	SS.SSa.OSa	Offshore and nearshore areas of the ECC in >20m deep
O. fusiformis and *A. filiformis* in deep circalittoral sand or muddy sand.	MD5212	SS.SSa.OSa.OfusAfil	
Circalittoral coarse sediment	MC3	SS.SCS	Typically located in transitional zones between areas of MC521
Faunal communities of Atlantic circalittoral coarse sediment	MC321	SS.SCS.CCS	

Biotope Name	EUNIS code (supersedes JNCC code)	JNCC code	Location (please see Figure 9-5 for locations of habitat)
M. fragilis, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel.	MC3212	SS.SCS.CCS.MedLumVen	and MD421 in the offshore ECC
Pomatoceros triqueter with barnacles and bryozoan crusts on Atlantic circalittoral unstable cobbles and pebbles	MC3211	SS.SCS.CCS.SpiB	
G. lapidum, *Thyasira* spp. and *A. macroglossus* in offshore circalittoral gravelly sand	MD3211	SS.SCS.OCS	
Circalittoral mixed sediment	MC4	SS.SMx	Present in the nearshore ECC
Faunal communities of Atlantic circalittoral mixed sediment	MC421	SS.SMx.CMx	
F. foliacea and *H. falcata* on tide-swept circalittoral mixed sediment	MC4214	SS.SMx.CMx.FluHyd	
Faunal communities in Atlantic offshore circalittoral mixed sediment	MD421	SS.SMx.OMx	Accounted for a significant proportion of the offshore ECC. Several >9 km from shore
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	SS.SMx.OMx.PoVen	
Atlantic offshore circalittoral coarse sediment	MD32	SS.SCS.OCS	Typically located in transitional zones between areas of MC521 and MD421 in the offshore ECC



Legend:

- Array Area
- Offshore Export Cable Corridor
- 15km Zone of Influence

Biotope

- *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand
- *Mediomastus fragilis*, *Lumbrineris spp.* and venerid bivalves in circalittoral coarse sand or gravel
- Polychaete-rich deep Venus community in offshore gravelly muddy sand
- *Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand
- *Glycera lapidum*, *Thyasira spp.* and *Amythasides macroglossus* in offshore gravelly sand
- *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment
- *Nephtys cirrosa* and *Bathyporeia spp.* in infralittoral sand

Seabed Profile

- Megaripples with Ripples
- Megaripples
- Sandwaves with Megaripples

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Environmental Habitats within the offshore ECC

Figure: 9-5	Drawing No: GoBe-0133		
Revision:	Date:	Drawn:	Checked:
01	03/09/24	EV	BPHB

Map scale 1:250,000 @ A3 — 0 5 10 km

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

MUIR MHÒR OFFSHORE WIND FARM

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INTERTIDAL

9.5.91. The area of the shore encompassed by the site-specific surveys is comprised primarily sandy habitats with more complex mosaic of rocky formations and various-sized stones at both the north and south extremes of the site. In the northern part, a mix of coarse sediment and stones provided homes for burrowing polychaetes and amphipods, while in the south boulders provided a more diverse habitat for biota due to the hard substrate and greater vertical variation. The central part of the area was predominantly sandy with coarser sand and shell fragments higher up the shore and finer sand lower down. These sandy substrates supported minimal epifauna, with burrowing infaunal species such as amphipods and polychaetes representing the characterising fauna.

9.5.92. Biotopes recorded from the rocky and mixed substrate habitats on the northern and southern fringes of the benthic intertidal ecology study area included:

- *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock (EUNIS Code MA12231) – recorded in the southern rocky outcrop, the barnacle *S. balanoides* dominated, with the limpet *P. vulgata* and the winkle *Littorina littorea* frequently occurring;
- *Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock (EUNIS Code MA1243) – observed on the rocky shores at the northern and southern extent of the benthic intertidal ecology study area below the barnacle and limpet layer, fucoids formed a distinct band along the rocky shore;
- *Fucus serratus* on moderately exposed lower eulittoral rock (EUNIS Code MA1244) - found both on the northern and southern extents of the benthic intertidal ecology study area this habitat, although it was more distinct on the southern shore due to larger boulders at this location;
- Ephemeral green and red seaweeds (freshwater influenced, or disturbed or organically enriched) on Atlantic littoral mixed substrata (EUNIS Code MA4211) – In both the northern and southern extents ephemeral green algae (*Ulva* sp.) were observed on cobbles and boulders as well as minimal red algae (*Porphyra* sp.) and few barnacles (*S. balanoides*); and
- Seaweeds in sediment-floored eulittoral rockpools (EUNIS Code MA1264) - shallow rockpools characterised by limited species of algae, such as *Ulva lactuca* and *Corallina officinalis* with a base of coarse sediment sheltering numerous molluscs, such as the periwinkles *Littorina* spp. and the limpet *P. vulgata*, and the beadlet anemone *Actinia equina*.

9.5.93. Infralittoral rock habitats were also observed in the northern and southern extremes of the benthic intertidal ecology study area being exposed at low spring water with the biotope '*Alaria esculenta* and *Laminaria digitata* on exposed Atlantic sublittoral fringe bedrock' (EUNIS Code MB12112) recorded.

9.5.94. Biotopes recorded from the sand habitats throughout the central Section of the benthic intertidal ecology study area included:

- Strandline communities on Atlantic littoral sand (EUNIS Code MA521) – a strandline consisting of deposited algal, kelp and some anthropogenic debris was present throughout the benthic intertidal ecology study area with sandflies often observed at this habitat as well as burrows of unknown origin in the sediment;

- Atlantic Littoral Mobile Sand (EUNIS Code MA523) – recorded throughout the mid to lower shore where, due to the extremely mobile, volatile nature of the beach, more diverse habitats were unable to develop. Characterised by a limited biota including polychaetes (*Scolelepis* sp.) and amphipods (*Bathyporeia pelagica, Haustorius arenarius, Pontocrates arenarius*) and isopods (*Eurydice pulchra*);
- Amphipods and *Scolelepis* spp. in Atlantic Littoral Medium-Fine Sand (EUNIS Code MA5233) – recorded throughout the upper to mid-eulittoral zone noted for characterisng polychaete *Scolelepis* sp.; and
- *P. arenarius* in Atlantic Littoral Mobile Sand (EUNIS Code MA52333) – Biotope recorded in the mid to lower shore characterised by the amphipod *P. arenarius.*

9.5.95. Two coastal habitats were recorded during the landfall inspections:

- Coastal Dunes and Sandy Shores (level 2 EUNIS habitat N1) - observed as a band above the mobile sandy beach the dunes were of medium height and vegetated with European marram grass (*Ammophila arenaria*); and
- Atlantic, Baltic and Arctic Sand Beach (level 3 EUNIS habitat N11) – this formed a sporadic, thin band of unvegetated sandy beach above the strandline and high-water mark.

9.5.96. All EUNIS habitats found in the benthic intertidal ecology study area are listed in full in Table 9-9.

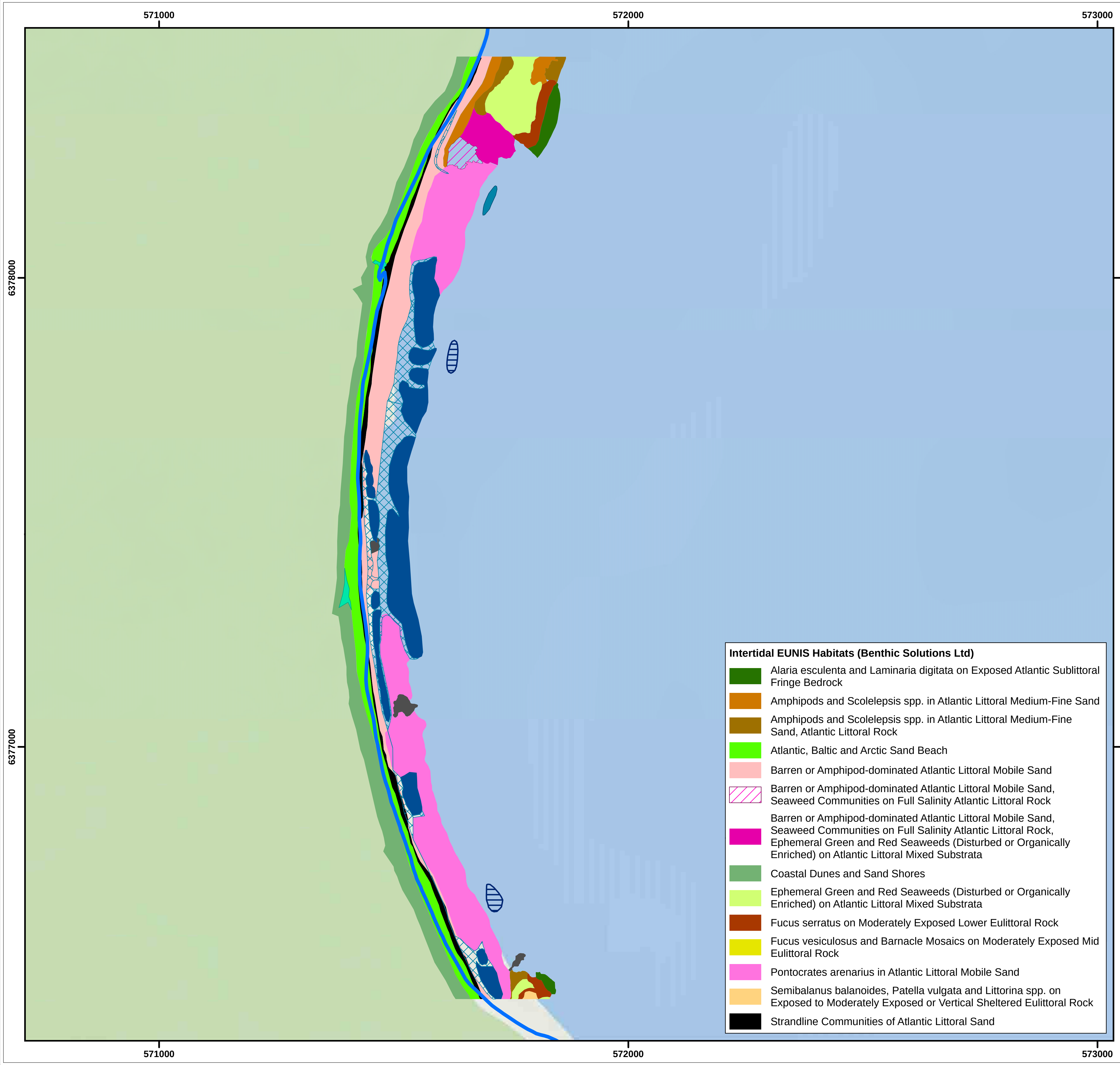
9.5.97. Full details of the site-specific survey undertaken in the benthic intertidal ecology study area are provided in Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports) - Environmental Baseline Report ECC & Intertidal (LOT 2 & 3).

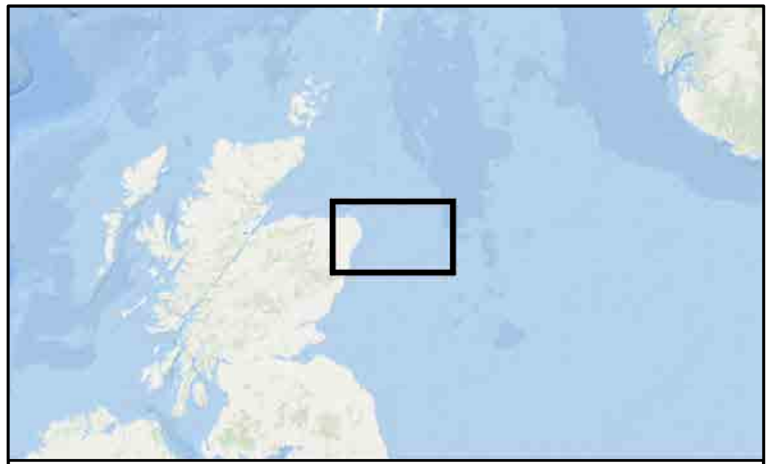
Table 9-9 Assigned level 4 and 5 habitats throughout the benthic intertidal ecology study area

Biotope name	EUNIS code (supersedes JNCC code)	JNCC Description	Location (please see Figure 9-6 for locations of habitat)
Mytilus edulis and/or barnacle communities on wave-exposed Atlantic littoral rock	MA122	LR.HLR.MusB	Visible above the fucoid layer on the southern rocky outcrop.
S. balanoides, *P. vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock	MA12231	LR.HLR.MusB.Sem.Sem	
Seaweed communities on full salinity Atlantic littoral rock	MA123	LR.HLR.FR	Both the northern and southern extent of the benthic intertidal ecology study area (Transect 1 and 9), where boulders and cobbles were more frequent.
Mussel and/or barnacle communities with seaweeds on Atlantic littoral rock	MA124	LR.MLR.BF	The rocky shores of the northern and southern extent of the benthic intertidal ecology study area below the barnacle and limpet layer.

Biotope name	**EUNIS code (supersedes JNCC code)**	**JNCC Description**	**Location (please see Figure 9-6 for locations of habitat)**
F. vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock	MA1243	LR.MLR.BF.FvesB	Directly below the above.
F. serratus on moderately exposed lower eulittoral rock	MA1244	LR.MLR.BF.Fser	Further down from the shore from MA1243. More distinct on the southern shore largely due to the larger boulders at this end of the benthic intertidal ecology study area (greater vertical range).
Communities on Atlantic littoral rockpools	MA126	LR.FLR.Rkp	Recorded in three transects (1, 8 and 9) and observed occasionally on areas of exposed bedrock and large boulders on the northern and southern extremities of the bay.
Seaweeds in sediment-floored eulittoral rockpools	MA1264	LR.FLR.Rkp.SwSed	
Ephemeral green and red seaweeds (freshwater influenced, or disturbed or organically enriched) on Atlantic littoral mixed substrata	MA4211	LR.FLR.Eph.EphX	The Northern most border (Transect 9), and the southernmost transect of the benthic intertidal ecology study area (Transect 1).
Strandline communities on Atlantic littoral sand	MA521	LS.LSa.St	Sand habitats composed the majority of the beach at Peterhead
Barren or amphipod-dominated Atlantic littoral mobile sand	MA523	LS.LSa.MoSa	Throughout the mid-lower shore.
Amphipods and *Scolelepsis* spp. In Atlantic littoral medium-fine sand	MA5233	LS.LSa.MoSa.AmSco	Upper to mid-eulitoral zone.
Pontocrates areanarius in Atlantic littoral mobile sand	MA52333	LS.LSa.MoSa.AmSco.Pon	Stations within the mobile sandy beach (MM_INT_01,02,03,07,08,09,11,13,14 and 15) which dominated the mid to lower shore.
Kelp and seaweed communities on Atlantic infralittoral rock	MB121	IR.HIR.KFaR	Uncovered habitat on the lower shore, survey conducted on a spring tide.
A. esculenta and *L. digitata* on exposed Atlantic sublittoral fringe bedrock	MB12112	IR.HIR.KFaR.Ala.Ldig	Confined to the northern and southern sides of the benthic intertidal ecology study area.

Biotope name	EUNIS code (supersedes JNCC code)	JNCC Description	Location (please see Figure 9-6 for locations of habitat)
Coastal dunes and sandy shores	N1	B1	Observed in a band above the mobile sandy beach.
Atlantic, Baltic and Arctic sand beach	N11	B1.2	A thin band of unvegetated sandy beach sporadically present above the strandline and high-water mark.





Legend:

- Offshore Export Cable Corridor

Intertidal Features (Benthic Solutions Ltd)

- Freshwater Influence
- Interpolated Ammodytes tobianus Sandbank
- Large Amount of Algal and Kelp Debris
- Mid-Eulittoral Sand Banks
- Observed Ammodytes tobianus Sandbank
- Rippled Sand Tidal Pools

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Intertidal Habitat Assessment for the Proposed Development

Figure: 9-6 | Drawing No: GoBe-0134

Revision:	Date:	Drawn:	Checked:
01	03/09/24	EV	BPHB

Map scale 1:8,000 @ A3 | 0 100 200 Meters | N

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

MUIR MHÒR OFFSHORE WIND FARM
A joint venture between Fred. Olsen Seawind & Vattenfall

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DESIGNATED SITES

9.5.98. This Section considers designated sites within the National Site Network i.e. Special Areas of Conservation (SAC) and Special Protection Areas (SPA) with benthic subtidal and intertidal ecology features, or nationally designated sites i.e. MPAs and SSSI. Those sites which are within the benthic subtidal and intertidal ecology study areas and have potential to interact with the Proposed Development are discussed below. The location of designated sites in the vicinity of the Proposed Development is shown in Figure 9-7.

9.5.99. The designated sites and features that are considered as part of the assessment of the Proposed Development are presented in Table 9-10, as well as relative distances form the offshore ECC and the Array Area.

ARRAY AREA AND OFFSHORE ECC

9.5.100. The Turbot Bank NC MPA is located adjacent to the southwestern boundary of the Array Area and to the south of the most easterly Section of the offshore ECC (Figure 9-7). This site is designated for sandeels which are closely associated with sand habitats and encompasses areas where high numbers of sandeels have been found. Sandeels play an important role in the wider North Sea ecosystem, providing a vital source of food for larger fish, seabirds and marine mammals. Turbot Bank NC MPA has the potential to act as a source of young sandeels for maintaining and restocking surrounding areas (JNCC, 2021). Sandeel species are discussed further as a feature of conservation interest within Volume 2, Chapter 10 (Fish and Shellfish Ecology) and therefore will not be discussed further in this Chapter.

9.5.101. The offshore ECC passes through the Southern NC MPA, which is designated for its burrowed mud feature, a PMF and an OSPAR ‘Threatened’ and/or ‘Declining’ habitat. The site is also designated for marine mammal and geological features. Burrowed mud is mainly found in deep water or sheltered conditions where there is very little water movement and provides habitat for burrowing marine animals such as Norway lobster (*Nephrops norvegicus*), fireworks anemone (*Pachycerianthus multiplicatus*) and sea pens including *Virgularia mirabilis*, *Pennatula. phosphorea* and *Funiculina quadrangularis*. Soft sands also cover much of the seabed which provides a habitat for sand eels. Conservation advice for this NC MPA includes minimising the LSE of renewable energy development on burrowed mud habitats via the existing licensing process.

INTERTIDAL

9.5.102. A number of SSSIs are located in the vicinity of the landfall although these are not designated specifically for benthic qualifying features (Figure 9-7). The Bullers of Buchan Coast SSSI is within the 15 km ZoI area and is 6.8 km south of the offshore ECC. It is protected for its important nesting sites for colonies of seabirds, including guillemots, razorbills, puffins, fulmars, and kittiwakes. The Collieston to Whinnyfold Coast SSSI is just outside the 15 km ZoI, at approximately 15.3 km south of the offshore ECC and is 69 km from the Array Area. Although just outside the 15 km ZoI area, it is also considered as part of the assessment as, along with Bullers of Buchan SSSI, it makes up part of the overlapping Buchan Ness to Collieston Coast SPA. It is designated for nationally important colonies of cliff nesting seabirds, including kittiwake, guillemot, razorbill, fulmar and shag. The Loch of Strathbeg SSSI is located within the 15 km ZoI and is 7.6 km north of the offshore ECC. This site is designated for shallow nutrient-rich loch constituting the largest dune slack pool in Britain. This site provides wintering habitat for numerous important wetland bird species. Whilst these sites are not designated for benthic ecology features, they can provide supporting habitats for birds, so impacts to any supporting features have been considered within the EIAR.

Table 9-10 Designated sites and qualifying features considered within the benthic subtidal and intertidal ecology study areas

Designated Site	Qualifying Feature	Distance to Array Area	Distance to offshore ECC
Turbot Bank NC MPA	Sandeels (sand eel species have been discussed further as a feature of conservation interest within Volume 2, Chapter 10 (Fish and Shellfish Ecology).	Adjacent, touching Array Area boundary on the west (0 km)	0.2 km
Southern Trench NC MPA	Burrowed mud.	40.3 km	Offshore ECC overlaps with the NC MPA (0 km)
Bullers of Buchan SSSI	No benthic features. Included to consider LSE on supporting habitat and bird food resource.	64 km	6.8 km
The Collieston to Whinnyfold Coast SSSI	No benthic features. Included to consider LSE on supporting habitat and bird food resource.	71 km	15.3 km
Loch of Strathbeg SSSI	No benthic features. Included to consider LSE on supporting habitat and bird food resource.	68 km	7.6 km

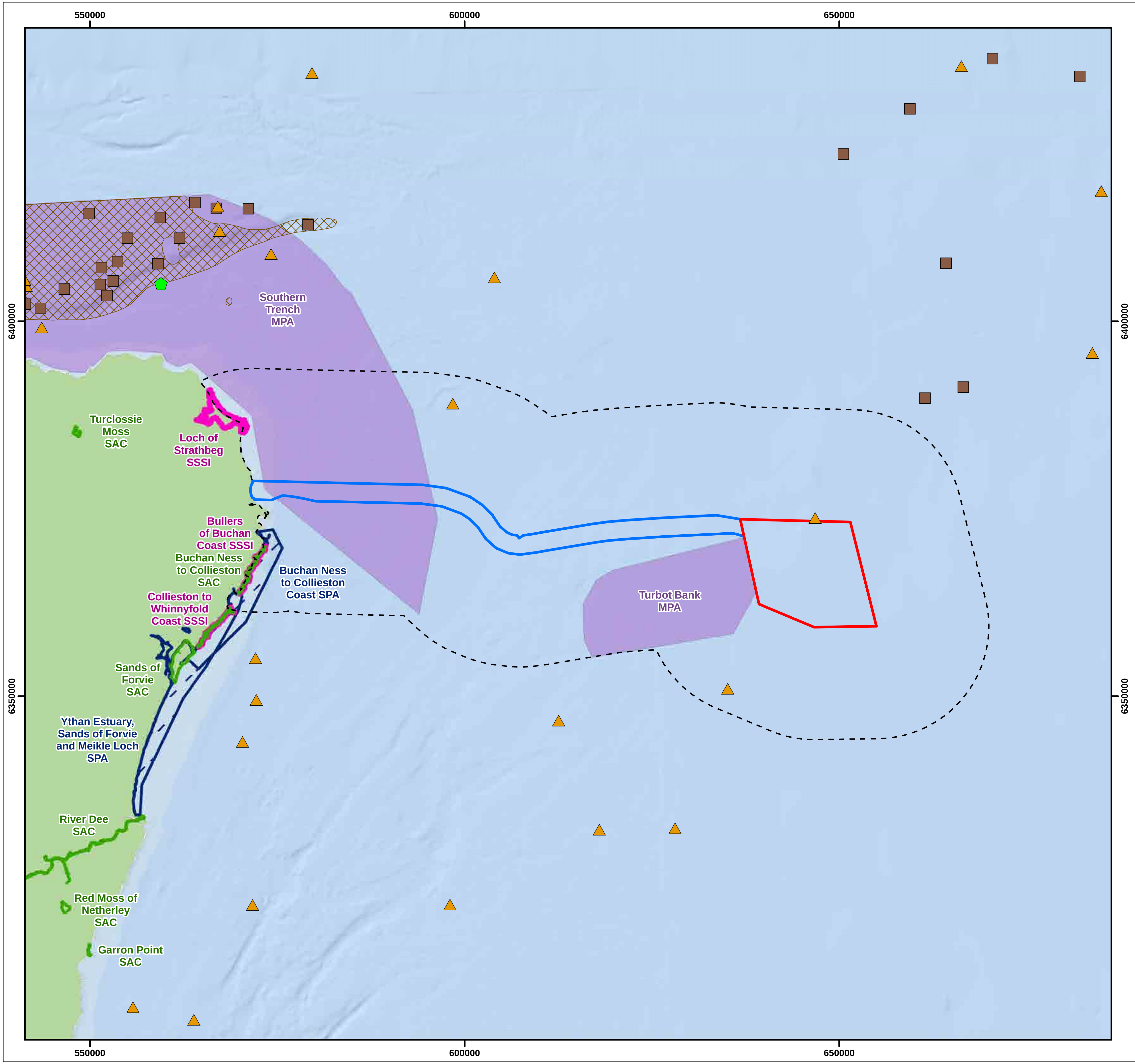
PROTECTED SPECIES/HABITATS

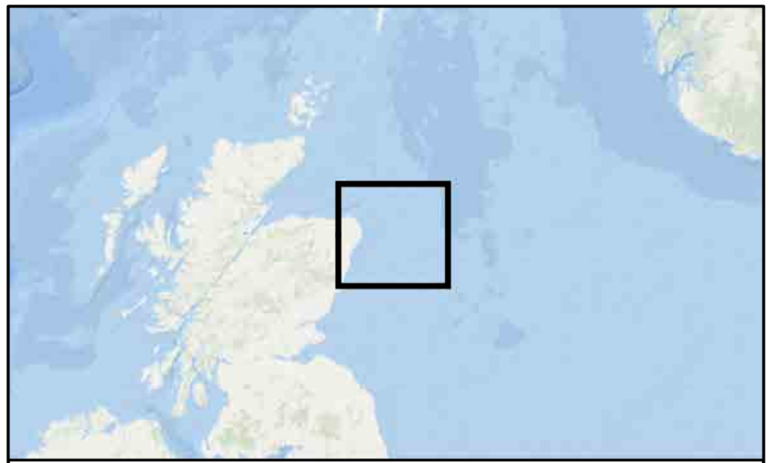
REGIONAL CONTEXT

9.5.103. A number of potential sensitive benthic habitats and species are known to occur in the CNS which are shown in Figure 9-7, to show the locations of conservation interest near the Proposed Development, including potential Annex I of the EC Habitats Directive, the OSPAR List of 'Threatened' and/ or 'Declining' species and habitats, Scottish PMF, Scottish Biodiversity List and UK Post-2010 Biodiversity Framework. Baseline data from site-specific surveys was used to characterise the marine communities and identify the location of any sensitive marine features present. Sensitive marine features include Annex I and II features of Habitat Regulations, PMFs and Scottish Biodiversity List habitats.

9.5.104. Based on the features that were granted protection in nearby protected areas, the main habitats and species of conservation importance of relevance to this region of the CNS are:

- Seapen and burrowing megafauna communities and mud habitats in deep water (Habitat FOCI, OSPAR 'Threatened' and/or 'Declining' habitat, PMF);
- Subtidal sands and gravels (Scottish Biodiversity List);
- Stony reef (EC Habitats Directive Annex I);
- Ross worm (*S. spinulosa*) biogenic reef (EC Habitats Directive Annex I, Habitats listed as Features of Conservation Interest (FOCI), OSPAR 'Threatened' and/or 'Declining' habitat, Scottish Biodiversity List); and
- Ocean quahog (*A. islandica*) (Species FOCI, OSPAR 'Threatened' and/or 'Declining' species).





Legend:

- Array Area
- Offshore Export Cable Corridor
- 15km Zone of Influence
- Special Protection Areas
- Special Areas of Conservation
- Sites of Special Scientific Interest
- Marine Protected Areas
- Burrowed Mud (Area)
- Burrowed Mud
- Annex I Desmophyllum Pertusum Reefs
- OSPAR Arctica Islandica Records

Project:	Report:
Muir Mhòr	Environmental Impact Assessment Report

Designated Sites and Protected Habitats and Species in Relation to the Proposed Development

Figure: 9-7	Drawing No: GoBe-0131		
Revision:	Date:	Drawn:	Checked:
01	03/09/24	EV	BPHB

Map scale 1:500,000 @ A3 — 0 10 20 km

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

MUIR MHÒR OFFSHORE WIND FARM

A joint venture between Fred. Olsen Seawind & Vattenfall

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

9.5.105. The ocean quahog (*A. islandica*) was recorded during surveys undertaken in relation to the Hywind OWF which is located 36 km away from the Array Area and directly south of the offshore ECC. *A. islandica*, which is a PMF, is a large, slow growing and long-lived species which is found subtidally around the UK, with 70% of records being from Scottish waters seas, including within the offshore ECC. This species is also an OSPAR 'Threatened' and/or 'Declining' species.

9.5.106. The Hywind OWF environmental survey also observed a scattered aggregations of *S. spinulosa* which were classified as 'low graded reef' according to criteria detailed by Hendrick Foster-Smith (2006).

9.5.107. It is considered that kelp beds, also a PMF, are likely to be present in the nearshore portion of the offshore ECC. Kelp beds form a key part of marine ecosystems throughout Scottish seas, providing food and shelter for fish, invertebrates, and marine mammal species. Coralline algae often form on the rocks below the kelp canopy, and this supports fauna such as sponges, sea squirts and sea anemones. Crustaceans and worms will often live on the holdfasts and sea urchins and snails will graze on the kelp itself, whilst fish species will use the kelp to hide from predators.

ARRAY AREA

9.5.108. During site-specific surveys, grab samples identified the presence of *S. spinulosa* at eight stations within the Array Area, however high-definition video analysis observed no reef aggregations of *S. spinulosa* within the Array Area. Consequently, it is considered that these records do not represent Annex I reef habitat as noted in Volume 3, Appendix 9.1 (Environmental Baseline Report: OWF (LOT 1)).

9.5.109. A stony reef assessment was undertaken using the criteria proposed by Irving (2009) with images from 22 transects analysed within the Array Area where hard substrate such as cobbles and boulders were observed as reported in Section 8.1, Volume 3, Appendix 9.1 (Environmental Baseline Report: OWF (LOT 1)). Analysis of the images indicated that the transects were characterised primarily by intermittent, variable distributions of cobbles and boulder with some areas of stonier substrate. The overall results of the stony reef assessment, considering reef structure, epifaunal cover and patch extent, identified 19 occurrences of 'Low reef' and no occurrences of 'Medium reef'.

9.5.110. It is worth noting that Irving (2009) considered that strong justification would be needed for areas of 'Low reef' to be considered Annex I habitats. Accordingly, areas of 'Low reef' were further assessed using the Golding *et al*. (2020) assessment method to see if any such strong justification exists for the patches identified within the benthic subtidal ecology study area, but no valid justification was seen for these areas in the Array Area to warrant Annex I protection.

9.5.111. A single ocean quahog (*A. islandica*) was identified a grab sample taken from the Array Area, while a siphon was also recorded during the DDV survey. The abundance of *A. islandica* varies appreciably with a density as low as 7 adults per 100m^2 being recorded in parts of the North Sea (Tyler-Walters and Sabatini, 2017). Consequently, the low numbers seen in the site-specific surveys for the Proposed Development are likely to be indicative of a sparse population across the Array Area.

9.5.112. During the DDV survey, small burrows were observed in low numbers with low numbers of the phosphorescent sea pen (*P. phosphorea*) also observed. However, detailed assessment of images indicated that due to the sparse nature of these features that they did not represent the OSPAR 'Threatened' and/or 'Declining' habitat 'Sea pen and burrowing megafauna communities'.

OFFSHORE ECC

9.5.113. A stony reef assessment was undertaken using criteria proposed by Irving (2009) with images from 15 transects in the offshore ECC analysed where hard substrate such as cobbles and boulders observed, as reported in Section 8.1, Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & 3). While most of these potential reef features were deemed to be 'not a reef' with some patches being considered to be 'Low reef', on one transect patches of 'medium reef' extending to an overall area of approximately of 30m^2 was observed characterised by cobbles and boulders encrusted with barnacles with common starfish (*A. rubens*), the hornwrack (*F. foliacea*) and anemones present. 'Medium reef' is considered as an Annex I habitat.

9.5.114. Possible aggregations of *S. spinulosa* on cobbles were observed in transects along the eastern extent of the ECC. Following assessment for 'reefiness' as described by Gubbay (2007) it was considered that these features were unlikely to constitute Annex I reef habitat due to low elevation and coverage, as reported in Section 8.6, Volume 3, Appendix 9.1 (Environmental Baseline Report: ECC and Intertidal (LOT 2 & 3)).

9.5.115. No ocean quahog (*A. islandica*) siphons were recorded during the DDV survey. Similarly, adults were identified from grab samples although single juvenile specimens were recorded at two grab sites.

9.5.116. Small burrows were observed in low numbers along with phosphorescent sea pens (*P. phosphorea*) in the easterly portion of the offshore ECC. Here sediment consisted primarily of 'fine sand'. As the abundance of these burrows was only found to be 'Occasional' on the SACFOR scale, it was considered that they were unlikely to constitute the OSPAR 'Threatened' and/or 'Declining' habitat 'Seapen and burrowing megafauna communities'.

INTERTIDAL

9.5.117. The infralittoral zonation along the rocky shore consisted primarily of the biotope '*A. esculenta* and *L. digitata* on exposed Atlantic sublittoral fringe bedrock' (EUNIS code: MB12112), with *L. digitata* generally more abundant than *A. esculenta*. Although not an exact fit '*L. hyperborea* on tide-swept, infralittoral rock' is a PMF and the kelp communities within the cable landing area could potentially represent a PMF.

INVASIVE NON-NATIVE SPECIES (INNS)

REGIONAL CONTEXT

9.5.118. Approximately 80 marine INNS are recorded from the North Sea, introduced mainly through shipping and aquaculture. Most invertebrates come from America's Atlantic coast, while most algae come from the Pacific with oyster imports. Marine INNS dominate some habitats, especially estuaries. Current research on their impact is inadequate, and reducing new invaders is essential (Reise *et al*. 2002).

9.5.119. Most exotic species in the North Sea are invertebrates (47), predominantly crustaceans, molluscs, polychaetes, and hydroids (Reise *et al*. 2002).

ARRAY AREA

9.5.120. No INNS were observed in DDV footage or identified from grab or eDNA samples collected during site-specific surveys of the Array Area.

OFFSHORE ECC

9.5.121. Although no marine INNS species were found when eDNA samples analysed at the species level, the family Styelidae was detected at higher taxonomic levels. One species within this family the non-native *Styela clava,* is classified as invasive. It is a non-native species of sea squirt first discovered in Plymouth in 1953, possibly introduced via the hulls of warships after the Korean War ended in 1951 (Millar, 1960). No INNS were identified from grab samples or in DDV images collected from the offshore ECC.

VALUED ECOLOGICAL RECEPTORS

9.5.122. The value of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM, 2016). The most straightforward context for assessing ecological value is to identify those species and habitats that have a specific biodiversity importance recognised through international or national legislation or through local, regional or national conservation plans (e.g., OSPAR 'Threatened' and/or 'Declining' habitats/species on the Scottish Biodiversity List and PMFs). However, only a very small proportion of marine habitats and species are afforded protection under the existing legislative or policy framework and therefore evaluation must also assess value according to the functional role of the habitat or species. For example, some features may not have a specific conservation value in themselves but may be functionally linked to a feature of high conservation value.

9.5.123. Table 9-11 presents the Valued Ecological Receptors (VERs), their conservation status and importance within the benthic subtidal and intertidal ecology study areas for the Proposed Development and the justification and regional importance of each receptor. Where VERs were found within the Array Area and offshore ECC, they have been assessed within this Chapter for direct and indirect impacts (Section 9.6; Figure 9-7). VERs located within the secondary ZoI have been assessed for indirect impacts only (Section 9.6; Figure 9-7).

Table 9-11 VERs within the benthic subtidal and intertidal ecology study areas and the secondary ZoI.

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within the benthic subtidal and intertidal ecology study areas	Importance within benthic subtidal and intertidal ecology study areas and justification
Subtidal					
Coarse and mixed sediments with moderate to high infaunal diversity and epibenthic communities	MD4211 MC3212	None	Habitat of Principal Importance Habitat of Conservation Interest UK Biodiversity Action Plan (BAP) habitat	Located in the Array Area and offshore ECC.	Regional – Habitats of Principal Importance with regional distribution across the North Sea.
Sandy sediments with low infaunal diversity and sparse epibenthic communities	MB5233	None	Habitat of Principal Importance Habitat of Conservation Interest UK BAP habitat	Located in the offshore ECC.	Regional – Habitats of Principal Importance with regional distribution across the North Sea.
Mixed sediments with polychaete and epifaunal communities	MC4214	None	None	Located in the offshore ECC.	Regional – although this habitat is representative of a nationally important marine habitat, the North Sea is not a single key geographical area.
Impoverished mixed gravelly sands	MC3211	None	Habitat of Principal Importance Habitat of Conservation Interest UK BAP habitat	Located in the offshore ECC.	Regional – Habitats of Principal Importance with regional distribution across the North Sea.
Circalittoral rock and coarse substrate with diverse epifaunal communities	MC1216 MC12243	EC Habitats Directive Annex I	None	Located in the secondary ZoI.	International – part of European designated sites.
S.spinulosa reef	MC2211 MC12811	EC Habitats	Habitat of Principal Importance	Potential to be present in the Array Area and	*S. spinulosa* habitat was not recorded in reef form, therefore no national or international

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within the benthic subtidal and intertidal ecology study areas	Importance within benthic subtidal and intertidal ecology study areas and justification
		Directive Annex I	Habitat of Conservation Interest UK BAP habitat OSPAR List of 'Threatened' and/or 'Declining' Species and Habitats	offshore ECC. Located in the secondary ZoI.	importance is applied to this habitat within the Array Area or offshore ECC. Indirect impacts to this habitat within the wider study have been considered in the assessment. To add an element of precaution as a result of the geophysical data interpretation, the assessment will assume *S. spinulosa* reef might occur is some form across the Proposed Development and therefore direct impacts to this habitat have also been considered.
Stony reef	N/A	EC Habitats Directive Annex I	None	Potential to be present in the Array Area and present in offshore ECC. Cobbles and boulders dispersed in Array Area but unlikely to constitute stony reef. 'Medium Reef and 'Low Reef' observed in the offshore ECC.	International – part of European designated sites. 'Medium Reef' in ECC determined to be Annex I habitat.
Intertidal					
Mussel and/or barnacle communities	MA122 MA12231	EC Habitats Directive Annex I	UK BAP Species	Located in the benthic intertidal ecology study area.	International – part of European designated sites.

VER	Representative biotope (EUNIS, 2022)	Protection status	Conservation interest	Distribution within the benthic subtidal and intertidal ecology study areas	Importance within benthic subtidal and intertidal ecology study areas and justification
Brachiopod and ascidian communities	MC123	None	None	Located in the benthic intertidal ecology study area.	N/A
Barnacles and fucoids on moderately exposed shores	MA1243 MA1244	EC Habitats Directive Annex I	OSPAR List of 'Threatened' and/or 'Declining' Species and Habitats	Located in the benthic intertidal ecology study area.	International – part of European designated sites.
Rockpool communities	MA126 MA1264	EC Habitats Directive Annex I	None	Located in the benthic intertidal ecology study area.	International – part of European designated sites.
Ephemeral green or red seaweed communities	MA4211	EC Habitats Directive Annex I	None	Located in the benthic intertidal ecology study area.	International – part of European designated sites.
Strandline communities	MA521	None	None	Located in the benthic intertidal ecology study area.	N/A
Barren or amphipod-dominated mobile sand shores	MA5233 MA52333	EC Habitats Directive Annex I	None	Located in the benthic intertidal ecology study area.	International – part of European designated sites.
Kelp and red seaweeds	MB121 MB12112 MB12211	EC Habitats Directive Annex I	None	Located in the benthic intertidal ecology study area and the secondary ZoI.	International – part of European designated sites.
Priority Marine Features					
Kelp beds	MB1215	EC Habitats Directive Annex I	Scottish Biodiversity List	Located in the secondary ZoI.	International – part of European designated sites.

VER	**Representative biotope (EUNIS, 2022)**	**Protection status**	**Conservation interest**	**Distribution within the benthic subtidal and intertidal ecology study areas**	**Importance within benthic subtidal and intertidal ecology study areas and justification**
Burrowed mud	MC6216	None	Scottish Biodiversity List OSPAR List of 'Threatened' and/or 'Declining' Species and Habitats Habitat of Principal Importance Habitat of Conservation Interest UK BAP habitat	Potential to be present in the Array Area. *P. phosphorea* SACFOR 'rare' in Array Area.	National – protected feature of Southern Trench NC MPA. However, it should be noted that this habitat is widespread across the North Sea.
Offshore subtidal sands and gravel	MC5211 MC5212 MD3211	None	Habitat of Principal Importance Habitat of Conservation Interest	Located in the Array Area and offshore ECC.	Regional – however, it should be noted that this species is found across the North Sea.
Ocean quahog *Arctica islandica*	N/A	None	OSPAR List of 'Threatened' and/or 'Declining' Species and habitats	Located in the Array Area and offshore ECC as well as in the secondary ZoI.	Regional – however, it should be noted that this species is found across the North Sea.
Horse mussel beds *Modiolus modiolus*	N/A	EC Habitats Directive Annex I	Scottish Biodiversity List OSPAR List of 'Threatened' and/or 'Declining' Species and Habitats Habitat of Principal Importance Habitat of Conservation Interest UK BAP habitat	Potential to be present in the Array Area and offshore ECC. Sediment eDNA revealed the presence of horse mussel, but there was no evidence of horse mussel beds.	None (as there is no evidence of reef habitat).

FUTURE BASELINE CONDITIONS

9.5.124. In line with the EIA Regulations, this EIAR requires a "description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge". This reflects how the baseline relevant to benthic subtidal and intertidal ecology is expected to evolve without the Proposed Development.

9.5.125. From the point of assessment, over the course of the development and operational lifetime of the Proposed Development (operational lifetime anticipated to be approximately 35 years from final commissioning), long-term trends mean that the condition of the baseline environment is expected to evolve. This Section provides a qualitative description of the evolution of the baseline environment, on the assumption that the Proposed Development is not constructed, using available information and scientific knowledge of marine water quality.

9.5.126. Further to potential change associated with existing cycles and processes, it is necessary to take account of the potential impacts of climate change on the marine environment.

9.5.127. Variability and long-term changes on physical influences may bring direct and indirect changes to benthic subtidal and intertidal habitats and communities in the mid to long term future (UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3), 2016). A strong base of evidence indicates that long-term changes in the benthic subtidal and intertidal ecology may be related to long-term changes in the climate or in nutrients (OESEA3, 2016), with climatic process driving shifts in abundances and species composition of benthic communities (Marine Climate Change Impacts Partnership (MCCIP), 2015). Studies of the benthic subtidal and intertidal ecology over the last three decades have shown that biomass has increased by at least 250% to 400%; opportunistic and short-lived species have increased; and the abundance of long-living sessile animals has decreased (Krönke, 1995; Krönke, 2011). Modelling sea surface temperature in relation to climate change in the UK has shown that the rate of temperature increase over the previous 50 years has been greater in waters off the east coast of the UK compared to the west and this is predicted to continue for the next 50 years (MCCIP, 2013).

9.5.128. Furthermore, most literature to date focuses on temperature, with regards to the effects of climate change on marine habitats. Climatic warming can also cause deoxygenation within the water column. Over decadal timescales, there has been a measurable decline in dissolved oxygen content in the global ocean in response to ocean warming (Mahaffey *et al*., 2020), with a further 7% decrease predicted for the year 2100 (Intergovernmental Panel on Climate Change (IPCC), 2013). It was concluded from 26 years of monitoring a benthic community within the Firth of Clyde that benthic communities had been affected by the decreasing levels of oxygen. This finding agreed with other short-term studies (Breitburg *et al*., 2018, Levin *et al*., 2009). Specific changes included changes in morphology, burrow depth, bioturbation and feeding mode of invertebrates (Caswell *et al*., 2018).

9.5.129. Evidence also suggests there will be a decrease of 0.4 parts per thousand (ppt) salinity between 2000 and 2040 and a decrease of 0.8 ppt between 2000 and 2060 globally (CMIP6 projections of changes in Sea Surface Temperature).(Climate Change Web Portal CMIP6 _ Timeseries: National Oceanic and Atmospheric Administration (NOAA) Physical Sciences Laboratory, n.d.). For example, a study examined salinity's impact on the functional composition, diversity, and redundancy of soft-bottom communities in the Baltic Sea. It finds that decreasing salinity shifts species from long-lived specialists to short-lived generalists, increasing functional redundancy and ecosystem robustness to environmental changes (Darr *et al*., 2014).

9.5.130. The MCCIP report on ocean acidification (Findlay *et al*., 2022) states that global pH levels are projected to decrease at a mean rate of -0.003 per year under Representative Concentration Pathways (RCP) 8.5 from present until 2050. On the shelf (water depth <200 m), the bottom waters around the UK are projected to experience faster rates of decline in pH because of the seasonal processes that influence the carbonate chemistry at depth that can exacerbate the global ocean acidification signal. For example, the average trends of pH in bottom waters in the Greater North Sea are -0.0040 per year (RCP 8.5) which is 15% more rapid than at surface. This difference is particularly evident in the central and northern part of the North Sea where stratification is more important. A mesocosm experiment in Plymouth, UK showed that marine benthic communities (molluscs, annelids, arthropods, and nematodes) showed that reduced pH and elevated temperature significantly alter marine invertebrate community structure and diversity. Lower pH decreased diversity, while temperature effects varied. Molluscs were most affected, annelids least, and nematodes thrived due to reduced competition and predation (Hale *et al*., 2011).

9.5.131. There is also potential for changes in the severity of future storm surge events, however, the Met Office indicates no evidence for significant changes in future storm surges using the UK Climate Projection (UKCP) 18 model. Sea level rise will significantly affect tidal characteristics but not the atmospheric contribution to storm surges. Extreme sea levels will increase due to higher mean sea levels, with no additional change expected from the atmospheric contribution to extreme sea level (Lowe *et al*., 2009; Lowe *et al*., 2018).

9.5.132. Under the RCP 8.5 emission scenario, Coupled Model Intercomparison Project Phase 5 (CMIP5) simulations project a 10-20% decrease in mean significant wave height along most of the UK coastline by the end of the 21st century. This could impact intertidal habitats in various ways. Reduced wave energy may lessen coastal erosion, stabilise habitats, and alter sediment distribution. However, changes in wave patterns could also affect species distribution and decrease shoreline protection against extreme events. It's important to note that the potential of change in annual maximum significant wave height varies among models and locations, and the confidence in these projections is limited due to the subset of CMIP5 models used. Thus, while these forecasts provide insights, local conditions and model accuracy will ultimately determine actual impacts (Lowe *et al*. 2009; Lowe *et al*. 2018).

9.5.133. The current baseline description above provides an accurate reflection of the current state of the existing environment. The earliest possible date for the start of construction is 2029 with an expected operational life of approximately 35 years, and therefore there exists the potential for the baseline to evolve between the time of assessment and point of impact. Outside of short-term or seasonal fluctuations, changes to the baseline in relation to benthic subtidal and intertidal ecology usually occurs over an extended period of time. Based on current information regarding reasonably foreseeable events, the baseline is not anticipated to have fundamentally changed from its current state at the point in time when impacts occur. The baseline environment for operational/decommissioning impacts is expected to evolve as described in the next Section, with the additional consideration that any changes during the construction phase will have altered the baseline environment to a degree as set out in this Chapter.

9.5.134. As such, the baseline in the benthic subtidal and intertidal ecology study areas described in Section 9.5 is a 'snapshot' of the present benthic ecosystem within a gradually yet continuously changing environment. Any changes that may occur during the design life span of the Proposed Development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

CLIMATE CHANGE EFFECTS

9.5.135. The key ecological receptors that may be affected by a combination of the Proposed Development and future climate change impacts include sub-tidal and inter-tidal habitats, sediment characteristics, designated site features, and protected species.

9.5.136. As indicated in the future baseline conditions Section above, potential climate change effects include elevated temperatures coupled with pH reduction, as well as alterations in sea levels and wave patterns. These changes could lead to habitat loss, adverse effects on native species, and increased stress on intertidal environments due to shifts in habitat structure and morphology.

9.5.137. Subtidal and intertidal receptors in the benthic subtidal and intertidal ecology study areas which could be affected include those listed in Table 9-11 e.g. seapen and burrowing megafauna communities, burrowed mud, circalittoral sediments, various faunal communities, and seaweed/kelp habitats. Designated site features like burrowed mud, sand and gravels and offshore deep-sea mud.

9.5.138. Protected sites that could be affected include the Turbot Bank NC MPA and Southern Trench NC MPA, and the benthic features and/or supporting habitats of these sites include burrowed mud, sand and gravels, and S. spinulosa reefs. However, the level of significance of these in-combination impacts is expected to be low, as the habitat cycles are shorter than the long-term climate change effects.

9.5.139. Volume 2, Chapter 18 (Climate) further discusses changes in the baseline environment due to climate change during construction, O&M, and decommissioning. Volume 3, Appendix 18.1 (GHG Technical Report) presents the LSE from the Proposed Development on climate.

DATA LIMITATIONS AND ASSUMPTIONS

9.5.140. Grab sampling and video surveys offer detailed insights into the infauna and epifauna populations within the benthic subtidal and intertidal ecology study areas, yet they are limited in their coverage of large seabed areas, Consequently, they represent point samples that must be interpreted in combination with the geophysical datasets to produce benthic maps that provide comprehensive cover.

9.5.141. Classification of survey data into benthic habitats and the production of benthic habitat maps from the survey data, while highly useful for assessment purposes, has two main limitations:

- Difficulties in defining the precise extents of each habitat/biotope, even when using site-specific geophysical survey data to characterise the seabed; and
- There is generally a transition from one habitat/biotope to another, rather than fixed limits and therefore, the boundaries of where one habitat/biotope ends, and another starts often cannot be precisely defined.

9.5.142. Consequently, the benthic habitats and biotopes presented in the baseline environment and this Chapter should not be considered as definitive, nor should the habitat boundaries be considered to be fixed, they do however represent a robust characterisation of the receiving environment.

9.5.143. However, despite the above uncertainties, it should be noted that there is robust data available on the benthic communities present in the benthic subtidal and intertidal ecology study areas. The seabed in the area is well studied and surveyed, therefore, the sensitivities of the habitats present are understood, and the post construction surveys undertaken for the Proposed Development can be used to validate the assessments of the likely impacts within this chapter. As such, the available evidence base is sufficiently robust to underpin the assessment presented here.

9.5.144. As eDNA is a relatively new way of supplementing baseline characterisation in offshore wind projects, there is not a wealth of literature or protocols available to understand the implications of the data provided. Although eDNA shows great promise in identifying receptors and aiding EIA monitoring, there are potentially some challenges when applied within the context of a more generic EIA framework within marine environments. As a result of these challenges, the use of eDNA is recommended as a proxy for the presence of a receptor and not a direct measure of presence (Hinz *et al*., 2022). For example, one of the challenges is defining a sampling unit and sampling strategy with respect to the survey area which can create challenges in drawing comparisons between different areas, across spatial and temporal scales (Hinz *et al*., 2022). The transport of eDNA fragments in marine environments is also generally unknown and influencing factors such as shedding dynamics, biogeochemical and physical processes need to be well understood to link a fragment of eDNA with a potential receptor's presence (Hinz *et al*., 2022).

9.6. BENTHIC SUBTIDAL AND INTERTIDAL ASSESSMENT METHODOLOGY

9.6.1. Assessment of effects in this Chapter will follow the general approach outlined in Volume 1, Chapter 6 (Environmental Impact Assessment Methodology) of the EIAR.

9.6.2. Specific assessment criteria and recognised guidance on assessing LSE on benthic subtidal and intertidal ecology due to the construction, O&M and decommissioning phases of the Proposed Development are provided below.

CRITERIA FOR ASSESSMENT

9.6.3. In addition to the general approach and guidance outlined in Volume 1, Chapter 6 (Environmental Impact Assessment Methodology), the benthic subtidal and intertidal ecology assessment also considers the following guidance documents:

- Chartered Institute of Ecology and Environmental Management (CIEEM) guidance (CIEEM, 2018).
  - The CIEEM guidance considers the importance of ecological features. Ecological features can be important for a variety of reasons and may relate, for example, to the quality, rarity or extent of habitats/species, and/or the extent to which they are threatened throughout their range, or to their rate of decline.
- MarLIN on the MarESA four-point scale (high – medium – low – not sensitive) (MarLIN, 2019).
  - The scale takes account of the resistance and recoverability (resilience) of a species or biotope in response to a stressor. Specific benchmarks (duration and intensity) are defined for the different impacts for which sensitivity has been assessed (e.g., smothering, abrasion, habitat alteration etc.). Detailed information on the benchmarks used and for further information on the definition of resistance and resilience can be found on the MarLIN website.

MAGNITUDE

9.6.4. The magnitude of LSE is defined by a series of factors, including the spatial extent of any interaction, the likelihood, frequency, duration of a potential impact and reversibility of impact.

9.6.5. The definitions of magnitude used as the criteria for the benthic subtidal and intertidal ecology assessment are defined in Table 9-12. Potential impacts have been considered in terms of permanent or temporary, and adverse or beneficial effects. Where an effect could reasonably be assigned more than one level of magnitude, professional judgement has been used to determine which rating is applicable.

Table 9-12 Receptor magnitude criteria for Benthic Subtidal and Intertidal Ecology

Magnitude Value	Description
Negligible	Discernible, temporary change, or barely discernible change for any length of time, over a small area of the receptor, and/or slight alteration to key characteristics or features of the particular receptors character or distinctiveness.
Low	Discernible, temporary change, over a minority of the receptor, and/or limited but discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
Medium	Considerable, permanent/irreversible changes, over the majority of the receptor, and/or discernible alteration to key characteristics or features of the particular receptors character or distinctiveness.
High	Fundamental, permanent/irreversible changes, over the whole receptor, and/or fundamental alteration to key characteristics or features of the particular receptors character or distinctiveness.

SENSITIVITY

9.6.6. The sensitivities of different biotopes have been classed as ‘High’, ‘Medium’, ‘Low’ or ‘Negligible’. These are based on the MarESA four-point scale (MarLIN, 2019). The scale of sensitivity for a receptor is dependent on the specific environmental topic and receptor in question and considers the value of a receptors in the context of its resistance and ability to recover from impacts (resilience). Specific benchmarks (duration and intensity) are defined for the different impacts for which sensitivity has been assessed (e.g., smothering, abrasion, habitat alteration etc.). Detailed information on the benchmarks used and further information on the definition of resistance and resilience can be found on the MarLIN website.

9.6.7. For the purposes of this assessment, four sensitivity categories have been defined, each drawing on the four MarLIN MarESA categories and the importance of the receptor. Sensitivity/importance of the environment is defined in Table 9-13.

Table 9-13 Receptor sensitivity criteria for Benthic Subtidal and Intertidal Ecology

Sensitivity Value	Description
Negligible	Equivalent to MarLIN MarESA sensitivity category ‘Not Sensitive’, whereby: • The habitat or species is noted as exhibiting ‘High’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over short timescales, i.e., <2 years (resilience is ‘High’).
Low	Equivalent to MarLIN MarESA sensitivity category ‘Low’, whereby: • The habitat or species is noted as exhibiting ‘Low’ or ‘Medium’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over < 2 years (resilience is ‘High’); or • The habitat or species is noted as exhibiting ‘High’ resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium to very long timescales, i.e. >2 years or up to 25 years or not at all (resilience is ‘Medium’, ‘Low’ or ‘Very Low’).

Sensitivity Value	Description
Medium	Equivalent to MarLIN MarESA sensitivity category 'Medium', whereby: • The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium timescales, i.e., > 2 or up to ten years (resilience is 'Medium'); or • The habitat or species is noted as exhibiting 'None' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over <2 years (resilience is 'High'); or • The habitat or species is noted as exhibiting 'Medium' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover over medium to very long timescales, i.e., >2 years or up to 25 years or not at all (resilience is 'Medium', 'Low' or 'Very Low').
High	Equivalent to MarLIN MarESA sensitivity category 'High', whereby: • The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e., >25 years or not at all (resilience is 'Very Low'); or • The habitat or species is noted as exhibiting 'None' or 'Low' resistance (tolerance) to an external factor, whether that arises from natural events or human activities, and is expected to recover only over very extended timescales i.e., >10 or up to 25 years (resilience is 'Low').

9.6.8. The matrix used for the assessment of significance is shown in Table 9-14. The combination of the magnitude of the impact with the sensitivity of the receptor determines the assessment of significance of effect. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIAR terms, whether this be adverse or beneficial. Any effect that has a significance of minor or negligible is not considered to be significant in EIAR terms. An assessment of the likely significance of effects is described in Section 9.7.

Table 9-14 Matrix used for the assessment of significance of the effect

MUIR MHÒR OFFSHORE WIND FARM – A joint venture between Fred. Olsen Seawind & Vattenfall		Magnitude of Impact			
		Negligible	**Low**	**Medium**	**High**
Sensitivity of Receptor	**Negligible**	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Minor	Minor
	Medium	Negligible	Minor	Moderate	Moderate
	High	Negligible	Minor	Moderate	Major

ASSESSMENT OUTCOME

9.6.9. To enable the likely significance of effects of the Proposed Development to be assessed, a description of the existing benthic communities has first been provided above, focusing particularly on any areas of conservation interest. Potential impact pathways that could affect the subtidal and intertidal physical, chemical, and biological environment as a result of the planned construction, O&M and decommissioning have been identified. The sensitivities of the communities present to the types of impact expected from wind farm construction, O&M and decommissioning activities has then been assessed. Following impact assessment, where necessary, measures have been proposed to mitigate the LSE of the impact.

9.6.10. Where European sites (i.e., nature conservation sites in Europe designated under the Habitats or Birds Directives; or sites in the UK that comprise the National Site Network (collectively termed 'European sites')) are considered, this Chapter assesses the LSE in EIA terms on the qualifying interest feature(s) of these sites as described within Section 9.5.108 of this Chapter. The assessment of the LSE on the site itself is deferred to the RIAA for the Proposed Development (Muir Mhòr Offshore Wind Farm Limited, 2024).

9.6.11. With respect to assessment of effects to protected features in a Nature Conservation (nc) MPA (hereafter termed as an MPA), a dedicated MPA assessment has been conducted for the Proposed Development, see Volume 4, Appendix 9.2 (Marine Protected Area Assessment Report). Specific consideration of MPAs is required for consent under Section 83 of the Marine (Scotland) Act 2010. The objective of the MPA assessment is to determine if the Proposed Development may result in significant effects on an MPA, and/or any ecological or geomorphological process on which the conservation of any protected feature in an MPA relies.

IMPACTS SCOPED INTO THE ASSESSMENT

9.6.12. The following impacts have been scoped into the assessment:

- Construction:
  - **Impact 1:** Increases in SSCs and changed to seabed levels;
  - **Impact 2:** Temporary habitat disturbance; and
  - **Impact 3:** Direct and indirect seabed disturbance leading to release of sediment contaminants.
- O&M:
  - **Impact 4:** Permanent and/ or long-term habitat loss/alteration due to the addition of infrastructure to the area;
  - **Impact 5:** Temporary habitat disturbance;
  - **Impact 6:** Colonisation of hard substrates;
  - **Impact 7:** Risk of introduction and/ or spreading of INNS particularly due to presence of infrastructure and vessel movement (e.g., ballast water) which may affect benthic ecology;
  - **Impact 8:** Indirect effects on benthic ecology EMF effects generated by dynamic cables; and
  - **Impact 9:** Changes in physical processes resulting from the presence of the subsea infrastructure associated with the Proposed Development e.g., scour effects, changes in wave/ tidal current regimes and resulting effects on sediment transport.
- Decommissioning:
  - **Impact 10:** Increases in SSCs and changes to seabed levels;
  - **Impact 11:** Temporary habitat disturbance;

- **Impact 12:** Direct and indirect seabed disturbance leading to release of sediment contaminants; and
- **Impact 13:** Removal of hard substrate during decommissioning**.**

IMPACTS SCOPED OUT OF THE ASSESSMENT

9.6.13. Table 9-15 describes the impacts that have been scoped out of the benthic subtidal and intertidal ecology assessment.

9.6.14. The decision to scope out impacts out from further consideration in the EIA for benthic subtidal and intertidal ecology is informed by the following:

- Relevant stakeholder consultation (see Section 9.4);
- Volume 3, Appendix 5.1 (Offshore Scoping Report);
- Volume 3, Appendix 5.2 (Offshore Scoping Opinion); and
- Understanding of worst-case design scenarios (Table 9-17) and environmental baseline conditions

Table 9-15 Impacts scoped out of the benthic subtidal and intertidal ecology assessment.

Impact Scoped Out	Justification
Construction and Decommissioning	
Accidental pollution events during construction and decommissioning activities	Chemical and oil inventories on vessels working during construction and decommissioning stages will be small in size. In the event of an accidental chemical or oil spill, hydrocarbons would rapidly be dispersed or diluted. As well as this, all vessels on the Proposed Development will be required to comply with strict environmental controls set out in the EMP will be produced post-consent and followed to cover the construction and decommissioning phases of the Project. The EMP (Volume 4, Appendix 2) will include planning for accidental spills, address all potential contaminant releases and include key emergency contact details, which will minimise the risk and set out provisions for responding to spills during construction or decommissioning. Due to the implementation of control measures and small quantities of hydrocarbons and chemicals it is proposed to scope this impact out of further consideration within the EIA. Scoping out of this impact was agreed with NatureScot and Scottish Ministers.
Operation and Maintenance	
Accidental pollution events during O&M activities	See justification described for accidental pollution events during construction and decommissioning activity above. Scoping out of this impact was agreed with NatureScot and Scottish Ministers.

EMBEDDED COMMITMENTS

9.6.15. As part of the project design process, several designed-in measures have been proposed to reduce the LSE on environmental receptors. As there is a commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development and have therefore been considered in the assessment (i.e., the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development. The embedded commitments relevant to benthic subtidal and intertidal ecology are presented in Table 9-16, see Volume 3, Appendix 6.1 (Commitments Register), provides additional information on how these commitments are secured.

9.6.16. The embedded commitments (C-01, C-02, C-08, C-09, C-10, C-29 and C-34) collectively aim to mitigate the impact of the Proposed Development and benthic subtidal and intertidal receptors. Commitments such as the use of scour protection (C-01) and cable burial (C-29) safeguard seabed integrity, preventing scour and erosion of the seabed avoiding, where possible, sensitive habits which may be of importance to benthic receptors. Adherence to plans like the Cable Plan (CaP) (C-02) and micrositing (C-34) will ensure that installation, routing, and construction are optimised to minimise disruption to sensitive habitats. Environmental management (C-08) further prevents pollution, while a Decommissioning Programme (DP) (C-09) ensures long-term prevention of the environment, including benthic subtidal and intertidal habitats post-project.

Table 9-16 Embedded commitment measures for Benthic Subtidal and Intertidal Ecology

Code	Commitment	Type (Primary, Secondary or Tertiary)	How Commitment Secured
C-01	Scour protection to be installed around seabed infrastructure where there is the potential for scour to develop.	Tertiary	CaP Construction Method Statement (CMS)
C-02	Development of and adherence to a CaP. The CaP will confirm planned cable routing, installation methods, cable specifications and any additional protection and any post-installation monitoring.	Tertiary	CaP
C-04	The infrastructure will be designed in such a way to minimise the impacts and will be within the key parameters set out in the EIA Project Description and EIAR.	Primary	Development Specification and Layout Plan (DSLP)
C-08	Development of and adherence to an EMP. This will set out mitigation measures and procedures relevant to environmental management, including but not limited to chemical usage, invasive and non-native species (including production of, and adherence to, an INNS plan), pollution prevention and waste management.	Tertiary	EMP
C-09	Development of and adherence to a DP. The DP will outline measures for the decommissioning of the Proposed Development.	Tertiary	DP
C-10	Development of and adherence to a Vessel Management Plan (VMP) (part of the Vessel Management and Navigational Safety Plan (VMNSP)). The VMP will confirm the types and numbers of vessels that will be engaged on the Proposed Development and consider vessel	Tertiary	VMP (part of VMNSP)

Code	Commitment	Type (Primary, Secondary or Tertiary)	How Commitment Secured
	coordination including indicative transit route planning.		
C-29	Where practicable, cable burial will be the preferred means of cable protection. Cable burial will be informed by the cable burial risk assessment (CBRA) and detailed within the CaP. In areas where the CBRA deems burial not feasible, suitable implementation and monitoring of cable protection will be employed.	Primary	CaP
C-34	Offshore infrastructure will be microsited and the cable will be microrouted, where reasonably practicable and where required (to an extent not resulting in a hazard for marine traffic and Search & Rescue capability), around any sensitive seabed habitats including Annex I habitat (if present). The location of potential Annex I habitat has been determined from site characterisation surveys and will be informed further via pre-construction surveys.	Primary	DSLP EMP

WORST CASE DESIGN SCENARIO

9.6.17. The Developer has adopted a design envelope approach to impact assessment (also known as a 'Rochdale Envelope'). In line with guidance from Section 36 of the Electricity Act 1989 (Scottish Government, 2022), the design envelope approach offers flexibility in the EIA process by enabling impact assessment to be carried out against several potential design options.

9.6.18. The assessment of benthic subtidal and intertidal ecology impacts has been undertaken with respect to the details provided in Volume 1, Chapter 3 (Project Description). A 'worst case' design scenario has been selected for each impact which would lead to the greatest impact for all receptors or receptor groups, when selected from a range of values. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within Volume 1, Chapter 3 (Project Description) (e.g., different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

9.6.19. Table 9-17 presents the worst-case design scenario for each impact associated with LSE assessment on benthic subtidal and intertidal ecology, along with justification.

Table 9-17 Worst Case Design Scenarios with respect to the benthic subtidal and intertidal ecology assessment.

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
Construction			
Impact 1: Increases in Suspended Sediment Concentrations (SSCs) and changes to seabed levels.	C-01, C-02, C-09, C-29	**Total SSC released because of construction activities = 12,718,023 m^3** **Foundation installation (without drilling) = 6,030,000 m^3** *WTGs:* • Maximum sediment disturbance volume from 67 WTGs using drag embedded anchors with nine anchors per foundation (603 anchors total x 200 m drag x 50 m target box = 6,030,000 m^3 **Foundation with drilling = 478,782 m^3** *WTGs:* • Anchor piles with a maximum diameter of 4 m to be drilled to a depth of 60 m below the seabed = 754 m^3 of drill arisings per pile • Maximum volume of drill arisings from 67 floating WTGs using piled anchors with nine anchors per foundation (603 anchors total) = 454,662 m^3 *OEP(s):* • Piled foundations for two jacket foundation OEP(s) with a maximum pile diameter of 4 m to be drilled to a depth of 80 m below the seabed = 1,005 m^3 of drill arisings per pile • Maximum volume of drill arisings from two OEP(s) with piled foundations for each OEP having 2 piles per jacket leg and 6 jacket legs 12 piles total per OEP = 24,120 m^3 **Cable Installation = 1,432,800 m^3** *Inter-array cables* • Inter-array cable installation method = Jetting • Total IAC length = 250 km • IAC cable seabed width = 3 m • IAC cable burial depth = 2 m • IAC trench cross Sectional area = 6 m^2 • Assuming 30% of material is forced into suspension in the water column • Maximum sediment disturbance volume = 250,000 x 6 m^2 = 1,500,000 m^2 x 0.3 (spill factor) = 450,000 m^3 • Assumed maximum installation rate of up to 700 m/hr *OEP Interconnector Cable* • Interconnector cable installation method = Jetting • Total length of Interconnector cable = 3 km • Interconnector cable seabed width = 3 m • Interconnector cable burial depth = 4 m (excludes burial in sandwaves of up to 20 m) • Interconnector cable trench cross Sectional area = 12 m^2 • Assuming 30% of material is forced into suspension in the water column • Maximum sediment disturbance volume = 3,000 m x 12 m^2 = 36,000 m^2 x 0.3 (spill factor) = 10,800 m^3 • Assumed maximum installation rate of up to 700 m/hr *Export cables*	Defining the Worst-Case Design Scenario for sediment disturbance activities is highly complex as the disturbance will be temporally and spatially variable (depending upon the metocean conditions at the time). For sediment plumes, the Worst-Case Design Scenario is intended to be representative in terms of peak concentration, plume extent and plume duration but will not correspond to a single sediment disturbance activity. The same applies for sediment deposition at the seabed, where the Worst-Case Design Scenario is a representation of maximum deposit thickness, maximum footprint extent or likely duration. **Seabed preparation prior to foundation installation** Seabed preparation works, including boulder clearance, would be required prior to installation of certain foundation types. The use of a Pre-Lay Grapnel Run (PLGR) is considered to be the realistic worst-case option for sediment disturbance. PLGR will be used prior to any trenching activity, and should any debris be brought to the surface it will be disposed of in line with relevant regulatory requirements. **Foundation installation (without drilling)** The installation of certain anchoring options will result in the release of disturbed sediments. The greatest sediment release is anticipated to be from the installation of drag-embedded anchors, although the impact of potential sediment plumes is expected to be of relatively short duration and in close proximity to the seabed. Drag-embedded anchors derive their holding capacity from being buried, or embedded in the sea floor and are installed by means of dragging, using a mooring chain. **Drilling as part of foundation installation** Of the anchoring options under consideration, the greatest sediment release is anticipated to be from the drilling of anchor piles. While some of the other options could result in the release of large sediment volumes (for example drag embedded anchors), the impact of these is expected to be of relatively short duration and in close proximity to the bed. Drilling has the potential to release larger volumes of relatively finer sediment as a result of the site geology. The worst-case assumption of the drill arisings being released at the surface of the water column has been adopted. **Cable Installation** Cable installation may require some combination of jetting, ploughing, trenching and/or cutting type installation techniques. The realistic worst-case option is represented by the use of jetting, having the greatest potential to fluidise and suspend fine sediments and therefore resulting in the largest amount of displaced sediment in the water column, with a realistic trenching rate of 500 m/hr and maximum trenching rate of 700 m/hr representing the highest release rate of sediments, and operating in locations with the largest contribution of fine sediments. **HDD Operations** Although other trenchless installation technologies are available, HDD is the established solution and has therefore been identified as the realistic worst-case

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
		• Export cable installation method = Jetting • Total length of three export cables = 270 km, each up to 90 km in length from array area to landfall • Export cable seabed width = 3 m • Export cable burial depth = 4 m (excludes burial in sandwaves of up to 20 m) • Export cable trench cross Sectional area = 12 m^2 • Assuming 30% of material is forced into suspension in the water column • Maximum sediment disturbance volume = 270,000 m x 12 m^2 = 3,240,000 m^2 x 0.3 (spill factor) = 972,000 m^3 • Assumed maximum installation rate of up to 700 m/hr **Seabed preparation for cable installation = 4,776,000 m^3** *Inter-array cables* • Seabed preparation method = Pre-Lay Grapnel Runs (PLGR) • Total length inter-array cables = 250 km, up to 100% of which require seabed preparation • Maximum area of seabed affected = 250,000 m (100% of total inter-array cable length) x 3 m (maximum width of disturbance) = 750,000 m^2 • Maximum sediment disturbance volume = 750,000 m^2 (area affected) x 2 m depth = 1,500,000 m^3 *OEP Interconnector Cable* • Seabed preparation method = PLGR • Total length of up to three export cables = 3 km, up to 100 % of which require seabed preparation • Maximum area of seabed affected = 3,000 m (100 % of total interconnector cable length) x 3 m (maximum width of disturbance) = 9,000 m^2 • Maximum sediment disturbance volume = 9,000 m^2 (area affected) x 4 m depth = 36,000 m^3 *Export cables* • Seabed preparation method = PLGR • Total length of up to three export cables = 270 m, up to 100% of which require seabed preparation • Maximum area of seabed affected = 270,000 m (100% of total export cable length) x 3 m (maximum width of disturbance) = 810,000 m^2 • Maximum sediment disturbance volume = 810,000 m^2 (area affected) x 4 m depth = 3,240,000 m^3 **Horizontal Directional Drilling (HDD) drilling fluid release = 441 m^3** • Three offshore HDD conduits and exit pits • Maximum volume of drilling fluid loss per conduit = 25 m^3 • Total drilling fluid loss = 75 m^3 • 20% of the cut volume would be released per conduit • Max 122 m^3 per conduit • Total other sediment lost = 366 m^3	option. HDD operations are expected to have localised and short-term effects on SSC concentrations due to the potential release of bentonite (or drilling mud) during the punch-out in the nearshore exit pit. Accordingly, the total drilling fluid loss = 75 m^3 (three conduits, 25 m^3 per conduit).

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
Impact 2: Temporary habitat disturbance	C-02, C-09, C-34	**Total area of habitat disturbance = 7,731,870 m²** **Foundation seabed preparation area = 6,066,000 m²** *OEP(s):* • Seabed preparation method = Boulder clearance grabs • Maximum sediment disturbance area for two OEP(s) = 36,000 m² *WTG anchoring operations:* • Deployment of nine drag-embedment anchors, per WTG (total 603 anchors x 200 m drag distance x 50 m drag box) = 6,030,000 m² **Wave buoy anchoring operations = 2,000 m²** • Seabed preparation for four wave rider buoys with one anchor point each = 2,000 m² **Jack-Up Vessels (JUV) and anchoring operations = 83,620 m²** • Anchor deployment area of disturbance for installation of OEP jacket foundations = 35,000 m² • Anchor deployment area of disturbance for installation of OEP topside = 35,000 m² • OEP JUV footprint = six legs per JUV, 227 m² per leg = 1,362 m² • Five jack-up operations x two OEP construction = 5 x 2 x 1,362 m² = 13,620 m² • JUV operations for WTGs are not applicable for the offshore array, applies to nearshore port location only **IAC Junction Box Installation = 1,800 m²** • Max Dimensions (L x W x H) = 15 x 6 x 4 m • Seabed Footprint per unit = 90 m² • Max Number of Units = 20 • Total Seabed Footprint within Array = 90 x 20 = 1,800 m² • Anchoring method = ballast/weight of the unit itself, no additional anchoring planned **Cable seabed preparation and installation = 1,569,000 m²** • Burial of export cables by jetting (270 km length x 3 m disturbance width) = 810,000 m² • Burial of interconnector cable by jetting (3 km length x 3 m disturbance width = 9,000 m² • Burial of inter-array cables (tether wave) by jetting (250 km x 3 m disturbance width) = 750,000 m² • Export cable jointing - largest cable diameter = 310 mm, therefore cross-Sectional area = 0.0755 m² per cable. Joints every 25 km, 90 km length per cable = 4 joints • 4 joints x 0.0755 m² per joint x 3 cables = 0.906 m² (no additional boulder and sandwave clearance planned for jointing) **HDD installation = 9,450 m²** • Total installation area: cofferdam area = 450 m² • HDD bores x 3 = 3000 mL x 1mD x 3 = 9,000 m²	Temporary habitat disturbance relates to the maximum total area of habitat disturbance during the construction phase. Temporary disturbance relates to seabed preparations for foundations and cables, JUV and vessel anchors, as well as the creation of cofferdams for the HDD process. The footprint of infrastructure is less than the seabed preparation areas for foundations and this footprint of infrastructure is assessed as a permanent impact during O&M. It should be noted that where boulder clearance overlaps with sandwave clearance, the boulder clearance footprint will be within the sandwave clearance footprint. It also should be noted that for gravity anchors, the seabed preparation area is less than the footprint of the foundation scour protection. The Worst-Case Design Scenario presents a precautionary approach to temporary habitat disturbance because it counts both the total footprint of seabed clearance as well as cable burial across both the array area and offshore ECC. This approach effectively counts the footprint of seabed habitat to be impacted by construction in the same area twice. However, this precautionary approach has been taken because there is some potential for recovery of habitats between the activities due to timescales for the construction of the Proposed Development.
Impact 3: Direct and indirect seabed disturbance leading to release of sediment contaminants	C-08, C-09	The Worst-Case Design Scenario for the maximum volumes of seabed sediment disturbance are presented in Impact 1 (Increases in SSCs and changes to seabed levels).	This Worst-Case Design Scenario represents the maximum total seabed disturbance and therefore the maximum amount of contaminated sediment that may be released into the water column during construction activities.
Operation and Maintenance			

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
Impact 4: Permanent and/or long-term habitat loss/alteration due to the addition of infrastructure to the area	C-02, C-08, C-34	**Maximum area of permanent and/or long-term habitat loss/alternation = 2,757,400 m^2** **WTG anchor footprints, and scour protection = 1,038,500 m^2** • Up to nine anchors per WTG (nine gravity anchors per WTG = [(9 x 500 m^2) x 67 WTGs] = 301,500 m^2 • Gravity anchor scour protection area (excluding anchor footprint) = 737,000 m^2 **Mooring line movement (strimming effect) = 874,350 m^2** • Any movement (strimming effect) will be at the transition where the mooring line touches down on the seabed, rather than the full chain length along the seabed. • Assuming a 1 m movement corridor along the full chain length along the seabed. Potential moorings seabed movement area = 67 x 9 x 1450 x 1 = 874,350 m^2 **OEP foundation footprints = 36,000 m^2** • Two OEP(s) disturbance = 36,000 m^2 **IAC Junction Box footprint = 1,800 m^2** • Max Dimensions (L x W x H) = 15 x 6 x 4 m • Seabed Footprint per unit = 90 m^2 • Max Number of Units = 20 • Total Seabed Footprint within Array = 90 x 20 = 1,800 m^2 **Lidar and wave buoy anchor footprints = 4000 m^2** • Two Lidar buoys with two anchor point each (gravity anchors) = 2,000 m^2 • Four Wave rider buoys with one anchor point each = 2,000 m^2 **Dynamic inter-array cable (strimming effect) = 6,700 m^2** • 50 m^2 per each tether wave cable x 2 cables x 67 WTGs = 6,700 m^2 **Dynamic inter-array cable anchor footprints = 10,050 m^2** • Tether wave cable, with up to 3 anchor points on seabed = 25 m^2 x 3 anchors x 2 cables x 67 WTGs = 10,050 m^2 **Inter-array cable protection = 375,000 m^2** • Up to 50% of IAC cables protected (total length 250 km) = 125 km at 3 m width • Maximum area of cable protection for IAC = 375,000 m^2 to a maximum height of 2 m above the seabed. **Interconnector cable protection = 4,500 m^2** • Up to 50% of interconnector cables protected (total length 3 km) = 1.5 km at 3 m width • Maximum area of cable protection for interconnector cables = 4,500 m^2 to a maximum height of 2 m above the seabed. **Export cable protection = 405,000 m^2** • Up to 50% of export cables protected (total length 270 km) = 135 km at 3 m width • Maximum area of cable protection for export cables = 405,000 m^2 to a maximum height of 2 m above the seabed	The Worst-Case Design Scenario is defined by the maximum area of seabed lost by the footprint of anchors on the seabed, OEP foundations, scour and cable protection, and cable crossings. Habitat loss from drilling and drill arisings is of a smaller magnitude than presence of infrastructure. There is the potential for the introduction of localised seabed abrasion associated with wind farm infrastructure that moves, for example anchor or mooring chains and dynamic inter-array cables, under the influence of waves, currents, and movement of the turbines ('strimmer effects'). This impact is considered to be permanent over the operational period.

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
		Export cable crossings = 1,500 m² • 3 crossings with existing infrastructure (based on the centreline of the offshore export cable route) • Maximum total footprint = 500 m² (footprint) x 3 (number of crossings) = 1,500 m² to a maximum height of 5 m above the seabed	
Impact 5: Temporary habitat disturbance	C-02, C-08, C-34	**Total direct disturbance to seabed from maintenance activities= 1,930,600 m²** **WTGs and OEP(s) = 635,600 m²** • JUV footprint for WTG and OEP(s) = 8 x 227 x 2 = 3,632 m² • 5 JUV trips per year = 175 trips over 35 year project lifetime • Total = 3,632 m² x 175 = 635,600 m² • JUV Operations for WTGs are N/A for the offshore array, applies to nearshore port location only. **Inter-array cables = 245,000 m²** • Up to seven inter-array cable failures assumed throughout the lifetime of the wind farm, with 7,000 m km (length) x 5 m (width) (35,000 m²) disrupted per repair, placement for a total impacted area of 245,000 m² over the lifetime of the Proposed Development (35 years). **Export Cables = 1,050,000 m²** • 1 repair per cable every 5 years, 7 repairs per cable over lifetime of the windfarm (35 years) x 3 export cables = 21 repairs in total. • Area per repair = 1,000 m x 50 m = 50,000 m² per repair • Total = 21 x 50,000 m² = 1,050,000 m²	The Worst-Case Design Scenario is defined by the maximum area of habitat disturbance arising from maintenance activities during the approximately 35-year O&M phase. The worst-case scenario is defined by the maximum number of jack-up and anchoring operations and the total cable replacement and repairs through maintenance activities that could have an interaction with the seabed during operation.
Impact 6: Colonisation of hard substrates	C-08, C-29	**Total hard substrates introduced = 5,530,120 m²** • Calculated for maximum envelope sizes & maximum no. of WTGs (67), 10% coverage included. **Hard substrates on seabed = 2,737,100 m²** • Moorings = 874,350 m² • IAC Cable Protection - max length (50% of 250 km = 125 km) x 3 m at seabed = 375,000 m² to a maximum height of 2 m above the seabed • IAC Cable Tether Clump Weights - 67 WTGs, 2 cables, up to 3 clump weights each 25 m² (conservative assumption) = 10,050 m² • IAC Junction Boxes scour protection – max area of scour protection for 20 units = 9,000 m² to a maximum height of 2 m above the seabed • Interconnector Cable Protection – max length (50% of 3 m = 1.5 km) x 3 m at seabed = 4,500 m² to a maximum height of 2 m above the seabed • Export Cable Protection - max length (50% of 270 km = 135 km) x 3 m at seabed = 405,000 m² to a maximum height of 2 m above the seabed • OEP Scour Protection 2 OEP(s) = 12,800 m² • WTG Anchor Scour Protection = 737,000 m² • Landfall/Intertidal/HDD - assume 20% coverage of export cable protection = 162,000 m² • Additional items such as wave buoy / floating lidar moorings/anchors/scour - 147,400 m² **Hard Substrates in Water Column = 2,793,020 m²** • WTG Floating Foundations = 1,072,000 m²	The Worst- Case Design Scenario is defined by the maximum area of structures, introduced into the water column, including mooring lines, floating platforms, and dynamic cables. Man-made substructures such as WTG and OEP foundations and any associated scour/cable protection on the seabed are expected to be colonised by marine organisms. This colonisation is expected to then result in an increase in local biodiversity and alterations to the near field benthic ecology of the area.

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
		• Moorings within water column - Using max mooring material diameter, total surface area in water column with full radius = 1,278,899 m^2 • Anchors = Consider max pile diameter (15m) & max stickup above seabed (5m) = 355,196 m^2 • OEP Jacket = 46,560 m^2 • OEP Piles Maximum 2x OEP(s), each with max 12 piles. Consider max pile diameter (4m) & max stickup above seabed (10m) = 3,619 m^2 • IAC within water column - Using max diameter, total surface area assuming 300 m IAC in water column = 31,586 m^2 • IAC Junction boxes = 20 units x (15 m x 4 m) x 2 + (6 m x 4 m) x 2 + (15 m x 6 m) = 5,160 m^2	
Impact 7: Risk of introductions and/ or spreading of INNS particularly due to presence of infrastructure and vessel movements (e.g., ballast water) which may affect benthic ecology and biodiversity.	C-08	**Total surface area of introduced hard substrates (Impact 6) = 5,530,120 m^2** Increased risk of introduction or spread of INNS by operation and maintenance vessel movements: • 259 total round trips per year • 9065 total round trips throughout whole operational phase (approximately 35 years)	Maximum surface area created by offshore infrastructure in the water column and maximum number of vessel movements during the operation and maintenance phase.
Impact 8: Indirect effects on benthic ecology from EMF) effects generated by dynamic cables and buried cables.	C02, C-08, C-29	**Total length of cables: 523 km** **Inter-array cables = 250 km** • Maximum of 250 km of inter-array cables, operating at up to 132 kV • Minimum cable burial depth = 1 m **Interconnector cable = 3 km** • Up to 3 km of interconnector, operating at up to 275 kV • Minimum cable burial depth = 1 m **Export cables = 270 km** • Up to 270 km of export cables, operating at up to 275 kV • Minimum cable burial depth = 1 m The operational lifetime of the Proposed Development is 35 years.	The maximum length and operating current of inter-array and offshore export cables will result in the greatest potential for EMF effects. The minimum target burial depth represents the worst case scenario as EMF exposure will be reduced with greater burial.
Impact 9: Changes in marine and coastal processes resulting from the presence of subsea infrastructure e.g., scour effects, changes in wave/ tidal current regimes and resulting effects on sediment transport	C-08	The Worst Case Design Scenario will be identical (or less) to that of the construction phase (Impact 2)	This impact is defined by any anticipated changes to marine and coastal processes as defined in Volume 1, Chapter 7 (Marine and Coastal Processes).

Impact	Embedded Commitment	Worst Case Design Scenario	Justification
Decommissioning			
Impact 10: Increases in Suspended Sediment Concentrations (SSCs) and changes to seabed levels.	C-02, C-09, C-29	Cutting of piles associated with the jacket OEP foundations at 1-2 m below seabed level and removal of jacket. Recovery and removal of anchors Decommissioning of inter-array and offshore export cables: • Inter-array cable length up to 250 km; • Export cables length up to 270 km; • Decommissioning using jetting; and • Recovery and removal of tethers/clump weights. Decommissioning activities lasting approximately three years.	The Worst Case Design Scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left in situ this will result in reduced levels of suspended sediment and associated deposition during decommissioning.
Impact 11: Temporary habitat disturbance	C-02, C-08, C-34	The Worst Case Design Scenario will be identical (or less) to that of the construction phase (Impact 2).	The Worst Case Design Scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left in situ this will result in reduced areas of temporary habitat disturbance during decommissioning.
Impact 12: Direct and indirect seabed disturbance leading to release of sediment contaminants	C-08, C-09	The Worst Case Design Scenario will be identical (or less) to that of the construction phase (Impact 3).	The Worst Case Design Scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left in situ this will result in reduced levels of sediment disturbance during decommissioning.
Impact 13: Removal of hard substrate during decommissioning		The Worst Case Design Scenario will be the removal of the area of introduced hard substrate outlined in Impact 7 (5,530,120 m^2).	The Worst Case Design Scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left in situ this will result in a reduced area of hard substrate being removed during decommissioning.

9.7. ASSESSMENT OF LIKELY SIGNIFICANT EFFECTS

9.7.1. Assessment of LSE on benthic subtidal and intertidal ecology has been undertaken for all phases of the Proposed Development. A detailed description of each impact, informed by Volume 1, Chapter 3 (Project Description), baseline information and various analytical methods including modelling is provided below.

CONSTRUCTION PHASE

9.7.2. This Section presents the assessment of impacts arising from the construction phase of the Proposed Development on benthic subtidal and intertidal ecology receptors .

9.7.3. A description of the significance of effect upon benthic subtidal and intertidal receptors caused by each identified impact is also provided below.

IMPACT 1: INCREASES IN SUSPENDED SEDIMENT CONCENTRATIONS (SSCS) AND CHANGES TO SEABED LEVELS

9.7.4. Temporary localised increases in SSC and associated sediment deposition and smothering are expected from foundation and cable installation works (including HDD installation) and seabed preparation works (including PLGR). This assessment should be read in conjunction with:

- Volume 2, Chapter 7 (Marine and Coastal Processes); and
- Volume 3, Appendix 7.2 (Marine Processes Modelling Report), which provides the detailed offshore physical environment assessment (including project specific modelling of sediment plumes).

SUBTIDAL

MAGNITUDE OF IMPACT

9.7.5. During the construction of the Proposed Development sediment will be disturbed and released into the water column. This will give rise to plumes of suspended sediment and localised changed in seabed levels as material settles out of suspension. The activities associated with the Proposed Development which will result in the greatest disturbance of seabed sediments are:

- Pre-lay cable trenching using a jetting tool at the seabed;
- Seabed preparation (including PLGR and boulder clearance) including spoil disposal via a jetting tool;
- Foundation installation using drilling techniques; and
- Drilling fluid release during HDD operations.

9.7.6. Suspended Particulate Matter (SPM) concentrations are typically low in the Array Area, with surface concentrations of up to 5 mg/l recorded between the period 1998 to 2015 (Cefas, 2016) although near-bed SPM levels may be significantly elevated during storm events. Higher values will occur during spring tides and storm conditions, with the greatest concentrations encountered close to the seabed (Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report)). SPM concentrations in the offshore ECC are generally low, with surface levels reaching up to 5 mg/l between 1998 and 2015 (Cefas, 2016). However, near-bed SPM levels can rise significantly during storm events, and elevated concentrations are observed near the coast due to wave-bed interaction and riverine sediment inputs.

9.7.7. The Worst Case Design Scenario used for each of these activities is provided in Table 9-17, and each has been considered within the Array Area and along the offshore ECC, for both spring and neap tides. Boulder/debris clearance using PLGR operations, pre-lay cable trenching using jetting tools at the seabed, OEP foundation and WTG anchor installation using drilling techniques, and drilling fluid release during HDD operations are all predicted to result in sediment plumes and localised increases in SSC. Site-specific modelling of sediment plumes and deposition (Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report), Volume 3, Appendix 7.2 (Marine Processes Modelling Report)) from seabed preparation and installation activities along the offshore ECC and within the Array Area has been undertaken. One objective is to quantify the potential footprint of the plumes, their longevity and the concentration of SSC as well as the subsequent deposition of plume material on the seabed.

HDD OPERATIONS

9.7.8. As identified in Table 9-17, the subsea export cable ducts will be installed underneath the beach using HDD. The drilling activity utilises a viscous drilling fluid which consists of a mixture of water and bentonite, a non-toxic, naturally occurring clay mineral. The release of drilling fluid and drill cuttings from HDD operations will result in a plume of elevated SSC. The drilling fluid has an overall density and viscosity similar to seawater and so is expected to behave in a similar manner.

9.7.9. The modelling results detailed in Volume 3, Appendix 7.2 (Marine Processes Modelling Report) indicate an increase in SSC of more than 0.5 mg/l is confined to an area extending roughly 6 km north and south of the release point. During the flood tide release, the highest SSC is found south of the release point, while during the ebb tide release, it is found to the north due to plume advection. However, the flood tide plume extends further north, and the ebb tide plume extends further south, showing that the plume remains in suspension after the slack water period and the flow direction change. Plume concentrations do not exceed 10 mg/l. All measurable increases in SSC are short lived, persisting for less than 3.6 hours on the ebb tide and only persisting for more than 3.6 hours over a small area on the flood tide.

9.7.10. The modelling indicates deposition of up to 0.2 mm thick and is predicted within several hundreds of metres of the exit pit. This deposition is small-scale and highly localised and is likely to be rapidly redistributed by wave action and currents.

FOUNDATION AND ANCHOR INSTALLATION USING DRILLING TECHNIQUES

9.7.11. Piled anchors will be installed into the seabed using standard piling techniques. In some locations, the particular geology may present some obstacle to piling, in which case, some or all of the seabed material might be drilled within the pile footprint to assist in the piling process.

9.7.12. The impact of drilling operations mainly relates to the release of drilling spoil at or above the water surface which will put sediment into suspension and the subsequent redeposition of that material to the seabed. The nature of the disturbance will be determined by the rate and total volume of material to be drilled, the seabed and sub-bottom material type, and the drilling method (affecting the texture and grain size distribution of the drill spoil). While some of the other options could result in the release of large sediment volumes (for example drag embedded anchors), the impact of these is expected to be of relatively short duration and in close proximity to the bed.

9.7.13. The impact is predicted to be of local spatial extent limited to the secondary ZoI of the benthic subtidal ecology study area, short term duration, likely to be negligible after several tidal cycles. The predicted impact to SSC will be temporary with a low magnitude.

9.7.14. Associated deposition from sediment plumes is generally in the order of tens to low hundreds of mm within several hundreds of metres from the point of disturbance, reducing to low tens of mm beyond this. Sediment deposition is generally small-scale and restricted to the near field. This deposition is likely to become integrated into the local sediment transport regime and will be redistributed by tidal currents.

EXPORT CABLE INSTALLATION

9.7.15. Modelling indicates that increase in SSC from the cable installation is typically less than 5 mg/l except for small patches within the Array Area, or near the coastline. Increases in SSC from the cable installation above 0.5 mg/l are constrained within 8 km to the north of the offshore ECC and within 20 km south of the offshore ECC, reflecting the southward flow dominance, although these levels are comparable to background variations with surface concentrations of up to 5 mg/l recorded (Cefas, 2016).

9.7.16. Overall, the modelling results have predicted that the construction impacts are relatively small and are predominantly constrained to occur within the Array Area and along the ECC and with SSC quickly returning to background levels after the activity is ceased.

9.7.17. Modelling indicates that directly along the path of the jet trencher, sedimentation thickness is typically around 4 to 6 mm, with some small areas where thickness is more than 10 mm. Outside of the offshore ECC, the sediment thickness is less than 2 mm, with a more extensive area of deposits to the south of the offshore ECC.

SUMMARY

9.7.18. Overall, the magnitude of change from increases in SSC is noticeable but temporary, with the majority of effects limited to the near-field and of short-term duration. The magnitude of impact has therefore been assessed as low.

SENSITIVITY OF RECEPTORS

9.7.19. The sensitivity of the subtidal biotopes within the benthic subtidal ecology study area and the secondary ZoI reference to both the MarESA benchmarks for deposition and SSC, and for elevated SSCs and turbidity are summarised in Table 9-18 below.

Table 9-18 MarESA for the benthic subtidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smothering, and siltation rate)

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
Benthic subtidal biotopes identified within the boundary of the benthic subtidal ecology study area			
Polychaete-rich deep *Venus* community in circalittoral mixed sediments	MD4211	• Low sensitivity to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is high for all assessments as they are based on peer-reviewed papers.
Mediomastus fragilis, Lumbrineris spp., and venerid bivalves in Atlantic circalittoral coarse sand or gravel.	MC3212	• Low sensitivity to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is high for all assessments as they are based on peer-reviewed papers.
Nephtys. cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand	MB5233	• Low sensitivity to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	MC4214	• Not sensitive to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is medium for all assessments as they are based on some peer reviewed papers but rely heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features.
Spirobranchus triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	MC3211	• Not sensitive to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is high for all assessments as they are based on peer-reviewed papers.
Sabellaria spinulosa on stable circalittoral mixed sediment	MC2211	• Not sensitive to changes in SSC and turbidity	Confidence is high for the SSC and turbidity and light smothering assessments

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
		• Not sensitive to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	as they are based on peer-reviewed papers. Confidence is low for the heavy smothering assessment as it is based on expert judgement (as opposed to peer-reviewed papers).
Seapens and burrowing megafauna in circalittoral fine mud	MC6216	• Not sensitive to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Not sensitive to heavy smothering (5-30 cm)	Confidence is medium for the SSC and turbidity assessment as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is low for the light and heavy smothering assessments as they are based on expert judgement (as opposed to peer-reviewed papers).
Echinocymus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC5211	• Low sensitivity to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity and heavy smothering assessments as they are based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Owenia fusiformis and *Amphiura filiformis* in deep circalittoral sand or muddy sand	MD5212	• Not sensitive to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is medium for the SSC and turbidity assessment as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
Glycera lapidum, *Thyasira* spp. and *Amythasides macrogossus* in offshore gravelly sand	MD3211	• Not sensitive to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity and heavy smothering assessments as they are based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Ocean quahog *Arctica islandica*	N/A	• Not sensitive to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Not sensitive to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
M. modiolus beds	N/A	• Not sensitive to changes in SSC and turbidity • High sensitivity to light smothering (<5 cm) • High sensitivity to heavy smothering (5-30 cm)	Confidence is medium for the SSC and turbidity assessment as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Additional benthic subtidal biotopes identified across the secondary ZoI			
Flustra foliacea and colonial ascidians on tide-swept moderately wave-exposed Atlantic circalittoral rock	MC1216	• Not sensitive to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is medium for the SSC and turbidity assessment as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is low for the light and heavy smothering assessments as they are

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
			based on expert judgement (as opposed to peer-reviewed papers).
Alcyonium digitatum with *Securiflustra securifrons* on tide-swept moderately wave-exposed Atlantic circalittoral rock	MC12243	• Not sensitive to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is high for the SSC and turbidity assessment as it is based on peer-reviewed papers. Confidence is low for the light and heavy smothering assessments as they are based on expert judgement (as opposed to peer-reviewed papers).
Sabellaria spinulosa with a bryozoan turf and barnacles on silty turbid Atlantic circalittoral rock	MC12811	• Not sensitive to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is high for the SSC and turbidity and light smothering assessments as they are based on peer-reviewed papers. Confidence is low for the heavy smothering assessment as it is based on expert judgement (as opposed to peer reviewed papers).
Laminaria hyperborea with dense foliose red seaweeds on exposed Atlantic infralittoral rock	MB1215	• Medium sensitivity to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is high for the SSC and turbidity assessment as it is based on peer reviewed papers. Confidence is low for the light and heavy smothering assessments as they are based on expert judgement (as opposed to peer-reviewed papers).

COARSE AND MIXED SEDIMENTS WITH MODERATE TO HIGH INFAUNAL DIVERSITY AND EPIBENTHIC COMMUNITIES

9.7.20. The biotope 'Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment' (MD4211) accounted for a significant proportion of the offshore ECC, and several points in the offshore area (>9 km from shore) and smaller patches in the Array Area. The venerid bivalves in MD4211 are shallow burrowing infauna and active suspension feeders and therefore require their siphons to be above the sediment surface to maintain a feeding and respiration current. Shallow burying siphonate suspension feeders are typically able to escape smothering of 10-50 cm of their native sediment and relocate to their preferred depth by burrowing. Smothering will result in temporary cessation of feeding and respiration. The energetic cost may impair growth and reproduction but is unlikely to cause mortality. The sensitivity of MD4211 to increases in SSC and turbidity, and light smothering (0-5 cm) is assessed to be low (based on medium resistance and a high resilience). The sensitivity of MD4211 to heavy smothering (5-30 cm) is assessed as medium (based on medium resistance and resilience).

9.7.21. *Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel' (MC3212) was recorded in the offshore ECC and is characterised by venerid bivalves which live close to the surface (Morton, 2009) and burrowing species such as *G. lapidum* which are likely to be able to survive increased SSC and short periods under sediment (0-5 cm). However, the pressure benchmark refers to fine material and species characteristic of sandy habitats may be less adapted to move through this type of substrate than sands. Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type. The MarESA determined MC3212 as having low sensitivity to increased SSC and turbidity, and light smothering (0-5 cm) (based on medium resistance and high resilience). Whilst characterising bivalves are likely to survive short periods under light sediment, it is suggested that the maximum overburden of sediment through which small bivalves can migrate is 20 cm (Bijkerk, 1988). The MarESA therefore classified MC3212 as having medium sensitivity to heavy smothering (5-30 cm).

SANDY SEDIMENTS WITH LOW INFAUNAL DIVERSITY AND SPARSE EPIBENTHIC COMMUNITIES

9.7.22. The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) was recorded in stations in the nearshore areas of the offshore ECC. This biotope group is present in mobile sands with the associated species generally present in low abundances and adapted to frequent disturbance. Within areas of MB5233, increased SSC may increase abrasion, but it is likely that the infaunal species would be unaffected. Characterising species such as *Bathyporeia* spp. feed on diatoms within the sand grains (Nicolaisen & Kanneworff, 1969) and an increase in suspended solids which reduced light penetration could alter food supply. However, diatoms are able to photosynthesise while the tide is out and therefore a reduction in light during tidal inundation may not affect this food source, thus the MarESA determined MB5233 to have low sensitivity to increased SSC and turbidity. As the biotope is associated with wave exposed habitats or those with strong currents, some sediment removal will occur, mitigating the effect of deposition. The mobile polychaete *N. cirrosa* and amphipods are likely to be able to burrow through a 5 cm layer of fine sediments, therefore MB5233 is considered to be not sensitive to light smothering (0-5 cm). In terms of heavy smothering (5-30 cm), sediment removal by wave action could mitigate the level of effect but overall smothering by fine sediments is likely to result in mortality of characterising amphipods and isopods and possibly *N. cirrosa.* Biotope resistance is therefore assessed as low, but resilience is high (based on Leewis *et al*., 2012) and overall, the sensitivity of MB5233 to heavy smothering is assessed as low.

MIXED SEDIMENTS WITH POLYCHAETE AND EPIFAUNAL COMMUNITIES

9.7.23. The biotope '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (MC4214) was recorded in the offshore area of the offshore ECC. This biotope is dominated by a bryozoan and hydroid turf on hard substrata. An increased in SSC may have a negative effect on the suspension feeding community and is likely to cause a decrease in growth rate (Jackson, 2004). However, it has been reported that *F. foliacea* is tolerant to increased SSC based on its occurrence in areas of high suspended sediment (Tyler-Walters and Ballerstedt, 2007). Whilst an increase in SSC may result in extra energetic expenditure through cleaning, it is unlikely to increase mortality. Further, sediment is likely to be removed rapidly. Therefore, MC4214 has been assessed to be not sensitive to SSC and turbidity and light smothering (based on high resistance and resilience). However, heavy smothering would bury almost all characterising species of this biotope and would result in some mortality and overall, the sensitivity of MC4214 to heavy smothering is assessed as low.

IMPOVERISHED MIXED GRAVELLY SANDS

9.7.24. The biotope *'Spribranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' (MC3211) was observed in areas of the offshore ECC. This biotope occurs in scoured habitats, and it is likely that the biotope is exposed to high levels of suspended solids as local sediments and re-mobilised and transported. Evidence suggests that *P. triqueter* is tolerant of a wide range of SSCs (Riley and Ballerstedt, 2005). Overall, the resistance and resilience of MC3211 to increased SSC and turbidity, and light smothering is assessed as high. The biotope is therefore considered to be not sensitive to these pressures. Heavy smothering represents a considerable thickness of deposit and complete burial of the characterising species would occur. However, as the biotopes is exposed to frequent abrasion and scouring, resistance of MC3211 to heavy smothering is assessed as medium. Resilience is assessed as high based on re-growth from the surviving based of the encrusting corallines and larval recolonisation by barnacles and *P. triqueter*. Biotope sensitivity to this pressure is therefore assessed as low.

CIRCALITTORAL ROCK AND COARSE SUBSTRATE WITH DIVERSE EPIFAUNAL COMMUNITIES

9.7.25. The biotope '*Flustra foliacea* and colonial ascidians on tide-swept moderately wave-exposed Atlantic circalittoral rock' (MC1216) was recorded in the Hywind OWF ECC. This biotope occurs on bedrock or boulders in moderately tide swept, wave-exposed conditions and is characteristically dominated by dense beds of the bryozoan *F. foliacea*. Bryozoans are suspension feeders which may be adversely affected by increases in SSC due to clogging of their feeding apparatus. However, Tyler-Walters and Ballerstedt (2007) reported *F. foliacea* as tolerant to suspended sediment based on its occurrence is areas of high suspended sediment. Therefore, resistance and resilience to an increase in SSC and turbidity is assessed as high and MC1216 is not sensitive to this pressure. A light smothering of 5 cm could smother and damage many of the smaller individual of the faunal community. However, as the biotope occurs in a high energy environment, sediment would probably be removed quickly. Therefore, sensitivity of MC1216 to light smothering is assessed as low (based on medium resistance and high resilience). Heavy smothering is likely to prevent feeding, growth, reproduction and respiration so resistance is assessed as low, resilience as medium and biotope sensitivity to heavy smothering is, therefore, medium.

9.7.26. '*Alcyonium digitatum* with *Securiflustra securifrons* on tide-swept moderately wave-exposed Atlantic circalittoral rock' (MC12243) are not thought to be highly susceptible to changes in SSC and turbidity as they are suspension feeders which are not directly dependent on sunlight for nutrition. *A. digitatum* has also been shown to be tolerant of high levels of suspended sediment. *A. digitatum* and *S. securifrons* colonies can grow up to a height of 20 cm and 10 cm, respectively (Edwards, 2008; Porter, 2012) so would still be able to feed in the event of light smothering. Therefore, MC12243 has been assessed as not sensitive to these two pressures (based on high resistance and resilience). However, if heavy smothering occurs up to 30 cm of sediment, respiration and larval settlement are likely to be blocked until the deposited sediment is removed. As a result, the sensitivity of MC12243 to heavy smothering has been assessed as low (based on medium resistance and high resilience).

S. SPINULOSA REEF

9.7.27. *'Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment' (MC2211) has the potential to be present within the benthic subtidal ecology study area. *S. spinulosa* do not rely on light penetration for photosynthesis and are often found in areas with high levels of turbidity as they rely on a supply of SSC and organic matter in order to filter feed and build protective tubes. Further, the depth of burial from light smothering is likely to be similar or less than that experienced from natural storm events. Therefore, MC2211 has been assessed as not sensitive to SSC and turbidity and light smothering (based on high resistance and resilience). No direct evidence was found for the length of time that *S. spinulosa* can survive beneath 30 cm of sediment. As a precautionary assessment, the biotope was assessed to have no resistance to this pressure. Resilience was assessed as medium and sensitivity of MC2211 to high smothering was therefore categorised as medium.

9.7.28. The biotope '*S. spinulosa* with a bryozoan turf and barnacles on silty turbid Atlantic circalittoral rock' (MC12811) which was recorded in the wider secondary ZoI follows the same assessment as for MC2211 above.

KELP BEDS

9.7.29. '*Laminaria hyperborea* with dense foliose red seaweeds on exposed Atlantic infralittoral rock' (MB1215) was recorded in the wider secondary ZoI. An increase in SSC results in a decreased in sub-surface light attenuation, which can result in a decrease of 50% photosynthetic activity of *Laminaria* spp. when turbidity increased by 0.1/m. This will likely decrease the abundance and density of *L. hyperborea*. Therefore, resistance to this pressure is defined as low, resilience is defined as medium, and the biotope is regarded as having a sensitivity of medium to SSC and turbidity. Smothering by 5 cm of sediment is unlikely to damage *L. hyperborea* sporophytes and gametophytes would probably survive smothering by a discrete event. Therefore, sensitivity of MB1215 to light smothering is assessed as not sensitive (based on high resistance and resilience). High smothering, however, is likely to affect gametophyte survival, holdfast communities and interfere with zoospore settlement. Therefore, resistance to this pressure is considered medium and resilience as high, leading to a sensitivity of MB1215 to heavy smothering of low.

BURROWED MUD

9.7.30. The biotope 'Seapens and burrowing megafauna in circalittoral fine mud' has the potential to be present within the Array Area. The characterising sea pen species for this biotope live in sheltered areas, in fine sediments, and are subject to high SSC. *Virgularia mirabilis* has been observed to quickly seize and reject inert particles (Hoare and Wilson, 1977) and *V. mirabilis* has been observed to secrete copious amounts of mucus which could keep polyps clear of silt (Hiscock, 1983). Due to high resistance and high resilience, it is considered that MC6216 is not sensitive to increased SSC and turbidity (Hill *et al*., 2023). Both *P. phosphorea* and *V. mirabilis* can burrow and move into and out of their own burrows, it is therefore probable that deposition of 30 cm of fine sediment will have little effect other than to temporarily suspend feeding and the energetic cost of burrowing. *Funiculina quadrangularis* cannot withdraw into a burrow but can stand up to two metres above the substratum, and so will probably not be affected adversely. Due to the high resilience of characterising sea pen species, the MarESA considers that MC6216 is not sensitive to both light smothering (0-5 cm) and heavy smothering (5-30 cm), (Hill *et al*., 2023).

OFFSHORE SUBTIDAL SANDS AND GRAVEL

9.7.31. The biotope '*Echynocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) (a PMF in Scottish waters) was recorded in the deeper water in the northern third of the Array Area and in the adjacent part of the offshore ECC; this biotope was also recorded from the middle Section of the offshore ECC located within the Buchan Deep. Increased SSC has the potential to affect primary production in the water column and indirectly alter the availability of food accessible to filter-feeding species, however phytoplankton will also be transported from distant areas and so the effect of increased SSC may be mitigated to some extent. Bivalves, polychaetes and other infaunal species are likely to be able to survive short periods under sediments and to reposition, however it is suggested that the maximum overburden of sediment through which small bivalves can migrate is 20 cm (Bijkerk, 1988). As a result, the MarESA determined MC5211 to have low sensitivity to increased SSC and turbidity, and light smothering (0-5 cm), but a medium sensitivity to heavy smothering (5-30 cm) (Tillin and Watson, 2024).

9.7.32. The biotope '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand' (MD5212) (a PMF in Scottish waters) was recorded at multiple stations in offshore and nearshore areas (>20 m deep) in the offshore ECC. Species present within MD5212 are reported to have adapted feeding strategies (between suspension feeding and deposit feeding) depending on flow conditions, also an increase in suspended matter settling out from the water column to the substratum may increase food availability, the MarESA therefore concluded that MD5212 was not sensitive to changes in SSC and turbidity. The characterising species in this biotope are burrowers and they are therefore likely to be able to move within the sediment deposited as a result of 5 cm of deposited sediment. It is suggested, however, that *Astropecten irregularis* can migrate through a maximum increase in sediment of 4 cm (Christensen, 1970) and resistance is therefore assessed as medium (<25 % loss) and resilience as high. Overall, MD5212 is considered to have low sensitivity to light smothering (0-5 cm). Whilst the characterising species in MD5212 are burrowers, a deposition of 30 cm of fine sediment is likely to result in a significant overburden of the infaunal species and, as a result, there may be some mortality of the characterising species. The MarESA has therefore determined this biotope as having medium sensitivity to heavy smothering (5-30 cm).

9.7.33. The biotope '*Glycera lapidum, Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand' (MD3211) was found across the south of the Array Area and located between MC521 and MD421 biotopes in the offshore ECC. An increase in suspended sediment can hinder feeding and respiration in active suspension feeders like venerid bivalves, potentially clogging their gill filaments. *Timoclea ovata*, adapted to low suspended solids, might struggle with particle sorting in high levels of sediment. *Thyasira flexuosa*, buried and symbiotic, remains insensitive. *Glycera* spp. and *Lumbrineris gracilis*, dwelling in sediments, are unaffected by turbidity. *Aphelochaeta marioni* benefits from increased food availability due to siltation but may suffer reduced growth and reproduction if sediment decreases. Overall, the biotope shows high resistance and resilience and has been assessed as 'not sensitive' to suspended solids. Addition of fine sediment alters habitat characteristics, reducing suitability for associated species. Recovery depends on sediment mixing or removal, often influenced by hydrodynamics. Restoration rate varies, but long-term siltation can lead to habitat reclassification. Bivalves and polychaetes can survive brief sediment coverage and reposition, though fine, cohesive material poses challenges, potentially causing mortality. Biotope resistance to light smothering is assessed as medium, resilience is assessed as high, and sensitivity is assessed as low. Resistance to heavy smothering has been assessed as low as few individuals are likely to reposition within fine sediments at the pressure benchmark of up to 30 cm. Resilience is assessed as medium, therefore the sensitivity of MD3211 to high smothering is assessed as medium.

OCEAN QUAHOG (ARCTICA ISLANDICA)

9.7.34. One *A. islandica* siphon was spotted on one transect within the Array Area, and one single adult was identified in a grab sample at one station in the Array Area. Two juvenile specimens were found in two grab samples, and no adult or siphons were spotted in transects of the offshore ECC. *A. islandica* is a PMF and occurs in silty sediments in sheltered to wave exposed conditions, where the surface of the sediment is probably regularly mobilised and is therefore unlikely to be impacted by increased SSC. *A. islandica* have a high resilience to sediment deposition. Powilleit *et al*. (2006) examined the effects of experimental spoil disposal in which up to 1.5m of till and sand/till was deposited on existing sediment and the resident *A. islandica* population structure was similar two years later with no apparent change in growth rates. Powilleit *et al*. (2009), also exposed *A. islandica* to smothering in the laboratory, in which *Arctica islandica* was able to burrow to the surface of 32-41 cm of sediment and regained contact with the surface. The MarESA determined that *A. islandica* is not sensitive to increased SSC and turbidity, light smothering (0-5 cm) and heavy smothering (5-30 cm) (Tyler-Walters and Sabatini, 2017).

MODIOLUS BEDS

9.7.35. *M. modiolus* were found in both the Array Area and offshore ECC. No directly relevant empirical evidence was found to assess the pressure of an increase in SSC. Resistance to this pressure is assessed as high as an increase in turbidity may impact feeding and growth rates but not result in mortality of adults. Resilience is assessed as high (by default), and the biotope is assessed as not sensitive to changes in turbidity at the benchmark level. Experiments by Hutchison *et al*. (2016) show that duration light smothering is a key factor determining survival, burial under even small amounts of fine sediment (2 cm) for longer than 8 days could lead to significant mortality. Resistance to light smothering is assessed as low as some mussels may be smothered for longer than a week and begin to die before the overburden is removed. Resilience is assessed as low and sensitivity is, therefore, categorised as high. The same conclusion has been drawn for the impact of heavy smothering (Tillin *et al*., 2024).

SIGNIFICANCE OF EFFECT

9.7.36. The sensitivity of benthic subtidal features within the benthic subtidal ecology study area is considered to be high as a worst-case, with the sensitivity of the majority of receptors considered to be medium or less reflecting that the receptors have some ability to tolerate the temporary increased SSC and increases to seabed levels and are likely to recover to an acceptable status over a ten-year period.

9.7.37. The impact of temporary increased SSC and increases to seabed levels on the subtidal benthic ecology is considered to be of low magnitude and the sensitivity of the majority of receptors affected is considered to be high in the worst-case. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-19 Significance of impact of increases in SSCs and changes to seabed levels on benthic subtidal ecology receptors

Receptor/Location	Magnitude	Sensitivity	Significance
Coarse and mixed sediments with moderate to high infaunal diversity and epibenthic communities	Low	Medium	**Minor**
Sandy sediments with low infaunal diversity and sparse epibenthic communities	Low	Low	**Negligible**
Mixed sediments with polychaete and epifaunal communities	Low	Low	**Negligible**
Impoverished mixed gravelly sands	Low	Low	**Negligible**
Circalittoral rock and coarse substrate with diverse epifaunal communities	Low	Medium	**Minor**
S. spinulosa reef	Low	Medium	**Minor**
Kelp beds	Low	Medium	**Minor**
Burrowed mud	Low	Not sensitive	**Negligible**

Receptor/Location	Magnitude	Sensitivity	Significance
Offshore subtidal sands and gravel	Low	Medium	**Minor**
Ocean Quahog (*Arctica islandica*)	Low	Not sensitive	**Negligible**
M. modiolus beds	Low	High	**Minor**

INTERTIDAL

MAGNITUDE OF IMPACT

9.7.38. Temporary increases in SSC and associated sediment deposition in the benthic intertidal ecology study area are expected from the cable installation works and the release of drill cuttings and drilling mud from the trenchless technique, during high water (noting that no works are planned to occur directly within the intertidal zone, with HDD below the intertidal zone for cable installation). Volume 2, Chapter 7 (Marine and Coastal Processes) provides a full description of the physical assessment, with a summary of the Worst-Case Design Scenario given in Table 9-17 above.

9.7.39. Those Proposed Development activities in the intertidal which have the potential to result in the greatest disturbance of seabed sediments are:

- Drilling fluid release during HDD operations.

9.7.40. The scenario that results in the greatest impact in the benthic intertidal ecology study area is cable installation using HDD techniques, whilst the HDD punch out will be located within the nearshore (subtidal) environment, it is expected that suspended solids released due to the punch out have the potential to reach the intertidal to some extent. Drilling activities utilise a viscous drilling fluid which consists of a mixture of water and bentonite, a non-toxic, naturally occurring clay mineral. The release of drilling fluid and drill cuttings from HDD operations will result in a plume of elevated SSC. However, site-specific bentonite release modelling demonstrates that these activities are considered to be restricted to the near-field, temporary, and indiscernible from background conditions. The magnitude of impact is therefore considered to be low.

SENSITIVITY OF RECEPTORS

9.7.41. As detailed within the VER table (Table 9-11) none of the biotopes that characterise the landfall location across the intertidal zone are rare or geographically restricted. The sensitivity of the intertidal biotopes with reference to both the MarESA benchmarks for deposition and SSC, and for elevated SSCs and turbidity is summarised in Table 9-18 below.

Table 9-20 MarESA for the intertidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smother, and siltation rate).

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
Intertidal biotopes identified within the benthic intertidal ecology study area			
Mytilus edulis and/or barnacle communities on wave-exposed Atlantic littoral rock	MA122	• Not sensitive to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is high for all assessments as they are based on peer-reviewed papers.
Semibalanus balanoides, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock	MA12231	• Low sensitivity to changes in SSC and turbidity • Medium sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock	MA1243	• Medium sensitivity to changes in SSC and turbidity • Medium sensitivity to light smothering (<5 cm) • Medium sensitivity to heavy smothering (5-30 cm)	Confidence is medium for the SSC and turbidity and high smothering assessments as they are based on some peer reviewed papers but rely heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features. Confidence is high for the light smothering assessment as it is based on peer-reviewed papers.
Fucus serratus on moderately exposed lower eulittoral rock	MA1244	• Low sensitivity to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • High sensitivity to heavy smothering (5-30 cm)	Confidence is medium all assessments as they are based on some peer reviewed papers but rely heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features.
Seaweeds in sediment-floored eulittoral rockpools	MA1264	• Low sensitivity to changes in SSC and turbidity • Low sensitivity light smothering (<5 cm)	Confidence is high for the SSC and turbidity assessment as it is based on peer-reviewed papers. Confidence is medium for the light smothering assessment as it is based on some peer reviewed papers but relies heavily

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
		• No evidence of sensitivity to heavy smothering (5-30 cm)	on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features.
Ephemeral green and red seaweeds (freshwater influenced, or disturbed or organically enriched) on Atlantic littoral mixed substrata	MA4211	• Low sensitivity to changes in SSC and turbidity • Low sensitivity to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Amphipods and *Scolelepis* spp. in Atlantic littoral medium-fine sand	MA5233	• Low sensitivity to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Pontocrates arenarius in Atlantic littoral mobile sand	MA52333	• Low sensitivity to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is high for the light and heavy smothering assessments as they are based on peer-reviewed papers.
Alaria esculenta and *Laminaria* digitata on exposed Atlantic sublittoral fringe bedrock	MB12112	• Low sensitivity to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Not sensitive to heavy smothering (5-30 cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement (as opposed to peer-reviewed papers). Confidence is medium for the light and heavy smothering assessments as they are based on some peer reviewed papers but rely heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features.

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
Additional intertidal biotopes identified within the secondary ZoI			
Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock	MB12211	• Medium sensitivity to changes in SSC and turbidity • Not sensitive to light smothering (<5 cm) • Low sensitivity to heavy smothering (5-30 cm)	Confidence is high for the SSC and turbidity assessment as it is based on peer-reviewed papers. Confidence is low for the light and heavy smothering assessments as they are based on expert judgement (as opposed to peer-reviewed papers).

MUSSEL AND/OR BARNACLE COMMUNITIES

9.7.42. The biotope '*Mytilus edulis* and/or barnacle communities on wave-exposed Atlantic littoral rock' (MA122) was recorded in the benthic intertidal ecology study area. *M. edulis* are often found in areas with high levels or turbidity. In general, increased suspended particles may enhance food supply or decrease feeding efficiency. Very high levels of silt may clog respiratory and feeding organs of *M. edulis* and *S. balanoides*. Resistance to increases in SSC and turbidity is therefore assessed as high. Recovery is assessed as high (no impact to recover from) and sensitivity is therefore not sensitive. Barnacle feeding may be affected by light smothering however, wave action on rocky shores is likely to remove deposits rapidly. Essink (1999) suggested that deposition of sediment on shallow mussel beds should be avoided. However, Widdows *et al*. (2002) noted that mussels buried by 6 cm of sand sediment were able to move to the surface within one day. Some mussels may die if smothering is prolonged, so resistance is assessed as medium. Resilience is assessed as high (recovery within two years), therefore sensitivity of MA122 to light smothering is assessed as low. Heavy smothering may cause significant mortality of mussels where sediments persist. Resistance to heavy smothering is therefore assessed as low and resilience is assessed as medium. Therefore, sensitivity of MA122 to heavy smothering is assessed as medium.

9.7.43. '*Semibalanus balanoides, Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock' (MA12231) dominated the southern rocky outcrop of the benthic intertidal ecology study area. Increased suspended organic particles can enhance food supply, while inorganic particles decrease feeding efficiency and may clog respiratory organs. High turbidity also reduces macroalgal photosynthesis (Gyory *et al*., 2013; Gyory & Pineda, 2011). An increase in inorganic suspended sediments may negatively affect the feeding of *S. balanoides* with some impacts on growth and survival. Resistance is therefore assessed as medium and resilience is high, so sensitivity to this pressure is assessed as low. *S. balanoides* is permanently attached to hard substrates and has no ability to escape from silty sediments. Even small deposits of sediments are likely to result in local removal of limpets. Small patches subject to a single impact may recover quickly via adult migration. Therefore, resilience is assessed as medium and resistance to siltation is assessed as low. Sensitivity of MA122 to light smothering is therefore assessed as medium. Resistance to heavy smothering is classified as none, with resilience assessed as medium. Sensitivity of MA122 to heavy smothering is therefore assessed as medium.

BARNACLES AND FUCOIDS ON MODERATELY EXPOSED SHORES

9.7.44. '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' (MA1243) was found in both the northern and southern extent of the benthic intertidal ecology study area. Light is crucial for *F. vesiculosus*, which is affected by water clarity changes from suspended solids. Reduced light compromises photosynthesis and growth. Sediment deposition impacts recruitment and survival of germlings. Suspended particles hinder filter feeders like *S. balanoides*. Resistance and resilience are medium, with overall biotope sensitivity classified as medium (Eriksson & Bergstrom, 2005). *S. balanoides* can be entirely smothered by 5 cm sediment, leading to mortality if not removed. Resistance and resilience to light smothering is medium, with overall biotope sensitivity of medium (Eriksson & Bergstrom, 2005). Resistance to heavy smothering is assessed as low, with resilience assessed as medium, therefore overall MA1243 is assessed to have a medium sensitivity to heavy smothering.

9.7.45. '*Fucus serratus* on moderately exposed lower eulittoral rock' (MA1244) formed a distinct band along the rocky shore under the barnacle and limpet layer. Intertidal biotopes experience limited exposure to suspended solids during immersion. Increased suspended solids reduce light penetration, affect photosynthesis in *F. serratus*, and increase scour. Turf-forming algae, like *Osmundea pinnatifida*, thrive in higher turbidity, while *F. serratus* may suffer sub-lethal damage. Sensitivity of the biotope is considered low with high resilience. Macroalgae and germlings are vulnerable to sedimentation (light and heavy), with germlings suffering high mortality (Atalah & Crowe, 2010). Turf-forming algae may increase, while grazers and encrusting corallines decrease with sedimentation. Overall, resistance is medium, resilience is high, and sensitivity is low. Sensitivity to siltation (heavy) depends on hydrodynamic conditions and boulder size. Smothering likely causes mortality in *Fucus serratus*, algae, and invertebrates. Resistance is low, resilience medium, and overall sensitivity medium (Airoldi, 2003; Huff & Jarett, 2007; Atalah & Crowe, 2010).

ROCKPOOL COMMUNITIES

9.7.46. 'Seaweeds in sediment-floored eulittoral rockpools' (MA1264) was recorded on the northern and southern extremities of the bay. The presence of sediment in the rockpool environment is a defining feature of this biotope therefore it is potentially sensitive to changes in suspended solids. *Furcellaria lumbricalis* often occurs in relatively turbid waters, increases in turbidity may provide the species with a competitive advantage over other macroalgae. *L. littorea* is found in turbid estuaries where suspended sediment levels are high. As the species present are tolerant of turbidity, biotope resistance is assessed as medium and resilience as high (as crustose bases are expected to remain to support recovery). The sensitivity of MA1264 to increases SSC and turbidity is therefore assessed as low. The same is true for light smothering. No evidence was found to assess heavy smothering on this biotope. Sensitivity to this pressure will be mediated by site-specific hydrodynamic conditions and the footprint of the impact.

EPHEMERAL GREEN OR RED SEAWEED COMMUNITIES

9.7.47. 'Ephemeral green and red seaweeds (freshwater influenced, or disturbed or organically enriched) on Atlantic littoral mixed substrata' (MA4211) was identified on the northern border of the intertidal survey extent. *Ulva* spp. benefit from reduced turbidity but may suffer from sediment abrasion. *Ulva* spp. show high tolerance to burial stressors like darkness, anoxia, and sulphides, with evidence from experiments (Vermaat & Sand-Jensen, 1987). However, attached individuals from rocky shores may have lower resistance (Daly & Mathieson, 1977). An increase in suspended solids may increase the level of scour and deposition in this sheltered biotope and this may negatively affect growth and recruitment of the characterizing *Ulva* spp. and *Porphya* spp. Resistance to an increase in SSC and turbidity is assessed as medium and resilience as high (following habitat recovery) so that the biotope is considered to have low sensitivity. Associated species, like *P. vulgata*, may suffer from sedimentation (Airoldi & Hawkins, 2007). Siltation by 5 cm of fine sediments is considered to remove a proportion of the population through scour effects and resistance is assessed as medium, resilience is assessed as high (following habitat recovery), so MA4211 is considered to have a low sensitivity to light smothering. Siltation may be a factor in allowing this biotope to develop where it removes grazers and creates space for colonisation by *Porphyra* sp. and *Ulva* sp. (Robles, 1982). Siltation by 30 cm of fine sediments is considered to remove a large proportion of the population through scour effects and resistance is assessed as low, recovery is assessed as high and sensitivity of MA4211 to heavy smothering is assessed as low.

BARREN OR AMPHIPOD-DOMINATED MOBILE SAND SHORES

9.7.48. 'Amphipods and *Scolelepsis* spp. in Atlantic littoral medium-fine sand' (MA5233) was found in the northern and southern extent of the benthic intertidal ecology study area. The characterising species are adapted to varying levels of suspended solids. *Scolelepis squamata*, a suspension feeder, may benefit from increased organic particles (Dauer, 1983). *Bathyporeia* spp. feed on diatoms within sand grains, potentially unaffected by light reduction (Nicolaisen & Kanneworff, 1969). Mobile amphipods and the isopod *E. pulchra* can likely burrow through a 5 cm layer, *S. squamata* may also survive burial and reposition. Despite some recovery observed, smothering by fine sediments leads to low biotope resistance (Peterson *et al*., 2000). Resistance is assessed as medium, and resilience is assessed as high (following a return to normal conditions). Therefore, the sensitivity of MA5233 to increases in SSC and turbidity is assessed as low. The mobile amphipods and the isopod *E. pulchra* are likely to be able to burrow through a 5 cm layer of fine sediments (light smothering). *S. squamata* is also likely to be able to survive some burial. Biotope resistance is therefore assessed as high and resilience as high (by default). Therefore, the biotope is considered to be not sensitive to this light smothering. Heavy smothering, however, is likely to result in the mortality of characterising amphipods, isopods and possibly *S. squamata*. Resistance is, therefore, assessed as low and resilience as high. Therefore, the sensitivity of MA5233 to heavy smothering is low.

9.7.49. '*Pontocrates areanarius* in Atlantic littoral mobile sand' (MA52333) was found across the benthic intertidal ecology study area. The characterising species in mobile sands habitats, such as *Pontocrates* spp., are adapted to varying levels of suspended solids. While increased organic particles may benefit *P. squamata,* changes in food supply could indirectly affect *P. pulchra*. Biotope resistance to increase in SSC and turbidity is assessed as medium, resilience is assessed as high (following a return to normal conditions) and sensitivity is assessed as low. The biotope, primarily associated with wave-exposed beaches, shows high resistance to light smothering from sediment deposition. Mobile amphipods and isopods are likely to burrow through a 5 cm layer, and *S. squamata* can survive burial (Lewis *et al*., 2012). Overall, the biotope is assessed as not sensitive to this pressure due to its high resilience and resistance (Peterson *et al*., 2006; Leewis *et al*., 2012). Heavy smothering, however, is likely to result in the mortality of characterising amphipods, isopods and possibly *S. squamata*. Biotope resistance is, therefore, assessed as low and resilience as high. Therefore, the sensitivity of MA52333 to heavy smothering is assessed as low.

KELP AND RED SEAWEEDS

9.7.50. '*Alaria esculenta* and *Laminaria digitata* on exposed Atlantic sublittoral fringe bedrock' (MB12112) was found in the infralittoral zone of the rocky shore. Increased turbidity correlates with sub-surface light attenuation (Kd), influencing kelp growth depth (Devlin *et al*., 2008). *A. esculenta* avoids siltation areas, hindering photosynthesis and larval recruitment (Birkett *et al*., 1998b; Fletcher, 1996). While wave exposure aids sediment clearance, persistent low clarity may favour silted kelp biotopes. Overall, sensitivity to increased SSC and turbidity is low, with medium resistance and high resilience. Juvenile kelp stages may be inundated by 5 cm sediment, but high wave exposure in MB12112 swiftly removes deposits (Birkett *et al*., 1998b). Therefore, resistance and resilience to light smothering has been assessed as high, and sensitivity has been assessed as not sensitive. Juvenile kelp stages, including sporophytes, germlings, gametophytes, and spores, may face inundation by 30 cm sediment during discrete events. However, high wave exposure swiftly removes deposits, likely resulting in only temporary effects (Birkett *et al*., 1998b).

9.7.51. The biotope 'Foliose red seaweeds with dense *Dictyota dichotoma* and/or *Dictyopteris membranacea* on exposed lower infralittoral rock' (MB12211) was recorded across the wider secondary ZoI. In this biotope, red and brown seaweeds are the key characterising species that define and structure the biotope. Beneath the foliose seaweeds, the rock surface may be covered with coralline crusts which are tolerant of abrasion. In areas of high turbidity, the biotope may revert to red algae only biotope which would lead to a less diverse and abundant faunal community. Resistance to an increase in SSC and turbidity is assessed as low, and resilience (following a return to previous habitat conditions) is assessed as medium, as red algal turfs may prevent brown algae from recolonising. Therefore, the sensitivity of MB12211 to this pressure is assessed as medium. Based on the exposure of the biotope to wave and water flow, which will remobilise and remove sediments, biotope resistance and resilience to light smothering is assessed as high and MB12211 is considered to be not sensitive to this pressure. Heavy smothering represents a considerable thickness of sediment deposits (up to 30 cm) so complete burial or algal turf, encrusting corallines and associated fauna would occur, with removal of the sediments by wave action resulting in considerable scour. Resistance to this pressure is assessed as low as the impact on the characterising red algal species could be significant but may be mitigated by rapid removal. Resilience is assessed as high based on vegetative re-growth. The sensitivity of MB12211 to heavy smothering is therefore assessed as low.

SIGNIFICANCE OF EFFECT

9.7.52. Overall, it is predicted that the sensitivity of the intertidal receptors located across the benthic intertidal ecology study area is worst-case medium, with the sensitivity of the majority of the receptors considered to be medium or less reflecting that the receptors have some ability to tolerate the temporary increased SSC and increases to seabed levels. As it is not anticipated that heavy smothering will be recorded across intertidal biotopes due to HDD works, and the only high sensitivity recorded was that of MA1244 to heavy smothering, it is considered that the sensitivity of intertidal receptors to increases in SSCs and changes to seabed levels is worst-case medium.

9.7.53. The impact of increased SSCs and deposition on the intertidal biotopes is considered to be of low magnitude as intertidal biotopes are not expected to be directly affected by trenching operations or bedform clearances due to the use of HDD, and the sensitivity of receptors affected is predicted to be worst-case medium. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-21 Significance of impact of increases in SSCs and changes to seabed levels on benthic intertidal ecology receptors

Receptor/Location	Magnitude	Sensitivity	Significance
Mussel and/or barnacle communities	Low	Medium	**Minor**
Barnacles and fucoids on moderately exposed shores	Low	Medium	**Minor**
Rockpool communities	Low	Low	**Negligible**
Ephemeral green or red seaweed communities	Low	Low	**Negligible**
Barren or amphipod-dominated mobile sand shores	Low	Medium	**Minor**
Kelp and red seaweeds	Low	Medium	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.54. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 2: TEMPORARY HABITAT DISTURBANCE

9.7.55. Temporary habitat loss and disturbance in the benthic subtidal and intertidal ecology study areas will be a likely occurrence from anchor and OEP foundation seabed preparation works, the use of jack-ups and anchored vessels and cable seabed preparation and installation works during the construction phase of the Proposed Development. These construction activities have the potential to impact on benthic subtidal and intertidal ecology by the removal of essential habitats for survival.

MAGNITUDE OF IMPACT

9.7.56. The total maximum area of temporary loss/disturbance of subtidal habitat due to construction activities is described in Table 9-17. This equates to approximately 2% of the total seabed area within the Array Area and offshore ECC. It should be noted that the worst-case design scenario presents a precautionary approach to temporary habitat disturbance because it counts both the total footprint of seabed clearance as well as cable burial across both the Array Area and offshore ECC. This approach effectively counts the footprint of seabed habitat to be impacted by construction in the same area twice. However, this precautionary approach has been taken because there is some potential for recovery of habitats between the activities due to construction timescales.

9.7.57. Of the total area of temporary habitat loss described a maximum of approximately 6.9 km^2 is predicted to be temporarily disturbed within the Array Area as a result of seabed preparations for foundations, anchoring operations, jack-up barge operations and the installation and burial of the export cable (including associated anchor placements). This equates to approximately 3.4% of the total seabed area within the Array Area.

9.7.58. Of the total area of temporary habitat loss described in Table 9-17, a maximum of approximately 819,000 m^2 will be temporarily disturbed within the subtidal areas of the offshore ECC as a result of seabed preparation, OEP installation, export cable installation, burial and jointing. This equates to approximately 0.4% of the total seabed area within the offshore ECC.

9.7.59. As described in Section 9.5 and in Volume 3, Appendix 9.1 (Offshore Baseline Survey Reports) the benthic habitats comprise macrofaunal assemblages associated with the predominantly gravel, sand and mixed sediment habitats that characterise the Array Area and offshore ECC. Whilst these are considered VERs (see Table 9-11) the majority of benthic habitats that are predicted to receive a direct temporary habitat disturbance of this nature, are common and widespread throughout the wider region and CNS (as previously detailed in Section 9.5). The temporary habitat disturbance during construction activities would therefore have an impact on a very limited footprint, particularly when compared to the overall extent of such habitats and this loss is not expected to undermine regional ecosystem functions or diminish biodiversity.

9.7.60. The total area of habitat disturbance is considered to represent a very small percentage loss of the total area of the OSPAR Region II (Greater North Sea) within which ocean quahog is listed as under threat and/or in decline. Therefore, the magnitude of the impact on ocean quahog is negligible. The impact on benthic habitats is predicted to be of local spatial extent (i.e., restricted to discrete areas within the boundaries of the Proposed Development), of a short-term duration (as it is limited to the duration of construction activities of four years), intermittent and with high reversibility. It is predicted that the impact will affect the receptor directly. The magnitude is therefore, considered to be low.

SENSITIVITY OF RECEPTORS

9.7.61. The sensitivity of all biotopes that are known to characterise the Array Area and offshore ECC (see Section 9.5) have been assessed according to the detailed MarESA sensitivity assessments (Table 9-22).

Table 9-22 MarESA for the benthic subtidal habitats for habitat disturbance.

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
Polychaete-rich deep *Venus* community in offshore mixed sediments	MD4211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	MC3212	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand	MB5233	Low (based on low resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	MC4214	Medium (based on low resistance and medium resilience)	Confidence is medium as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
			species of interest) or similar features
Spirobranchus triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	MC3211	Low (based on low resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Sabellaria spinulosa on stable Atlantic circalittoral mixed sediment	MC2211	Medium (based on low resistance and medium resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Seapens and burrowing megafauna in circalittoral fine mud	MC6216	Medium (based on medium resistance and low resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Echinocymus pusillus, *Ophelia borealis* and *Abria prismatica* in circalittoral fine sand	MC5211	Low (based on medium resistance and high resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Owenia fusiformis and *Amphiura filiformis in* deep circalittoral sand or muddy sand	MD5212	Medium (based on low resistance and medium resilience)	Confidence is high as the assessment is based on peer reviewed papers
Glycera lapidum, Thyasira spp. and *Amythasides macroglossus* in offshore gravelly sand	MD3211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
M. modiolus beds	N/A	High (based on low resistance and low resilience)	Confidence is medium as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features
Ocean Quahog *Arctica islandica*	N/A	High (based on low resistance and very low resilience)	Based on peer-reviewed papers (observational or experimental) or grey literature reports by established agencies on the feature (habitat, its component species, or species of interest).

COARSE AND MIXED SEDIMENTS WITH MODERATE TO HIGH INFAUNAL DIVERSITY AND EPIBENTHIC COMMUNITIES

9.7.62. The biotope ‘Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment’ (MD4211) accounted for a significant proportion of the offshore ECC, and several points in the offshore area (>9 km from shore), with smaller patches in the Array Area. The burrowing species associated with this biotope (such as *G. lapidum* and *Lumbrineris latreilli*) may be unaffected by surface abrasion. However, biotope resistance is assessed as medium as abrasion is likely to damage a proportion of the characterising species. Resilience is assessed as high as opportunistic species are likely to recruit rapidly, and some damaged characterising species may recover or recolonise. Therefore, the sensitivity of MD4211 has been assessed as low for abrasion and disturbance (Tillin and Watson, 2023a).

9.7.63. '*M. fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel' (MC3212) was recorded in the Array Area and is characterised by venerid bivalves which live close to the surface (Morton, 2009) and burrowing species such as *G. lapidum* which may be unaffected by surface abrasion. As abrasion may damage a proportion of the characterising species, biotope resistance is assessed as medium. Resilience is assessed as high as opportunistic species are likely to recruit rapidly, and some damaged characterising species may recover or recolonise. As a result, biotope sensitivity to abrasion and disturbance is assessed as low (Tillin and Watson, 2024a).

SANDY SEDIMENTS WITH LOW INFAUNAL DIVERSITY AND SPARSE EPIBENTHIC COMMUNITIES

9.7.64. The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) was recorded at two stations in the south of the offshore ECC. This biotope group is present in mobile sands with the associated species generally present in low abundances and adapted to frequent disturbance. This suggests that resistance to surface abrasion is high. The amphipod and isopod species present are agile swimmers and are characterised by their ability to withstand sediment disturbance (Elliot *et al*., 1998). Similarly, the polychaete *N. cirrosa* is adapted to life in unstable sediments and lives within the sediment which is likely to protect this species from surface abrasion. The resilience of this biotope is therefore assessed as high and the sensitivity is assessed as low for abrasion and disturbance (Tillin *et al*., 2023).

MIXED SEDIMENTS WITH POLYCHAETE AND EPIFAUNAL COMMUNITIES

9.7.65. The biotope *'Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (MC4214) was found close to the shore in the offshore ECC. The species that define this biotope reside on the rock surface, leaving them vulnerable to surface abrasion. Significant abrasion from the scouring action of moving sands and gravels is a crucial factor in shaping this biotope (Connor *et al*., 2004) and can hinder ecological succession. When organisms attach to mobile pebbles, cobbles, and boulders instead of stable bedrock, these surfaces can be displaced and overturned, which disrupts feeding and causes smothering. Due to the sessile, erect nature of hydroids and bryozoans, physical disturbances can cause significant damage and mortality. However, some studies question the extent of this damage. Abrasion from sand, mobile cobbles, and pebbles is a crucial factor in this biotope's structure (Connor *et al*., 2004). The persistence of these assemblages may rely on rapid recovery and scour resistance. The resistance of this biotope is therefore assessed as low, resilience as medium, and the sensitivity of MC4214 to this pressure is assessed as medium (Readman and Watson, 2024).

IMPOVERISHED MIXED GRAVELLY SANDS

9.7.66. The biotope *'Spirobrachus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' (MC3211) was observed in areas of the offshore ECC. The species defining this biotope inhabit the rock surface, leaving them unprotected from surface abrasion. High levels of abrasion caused by scouring from mobile sands and gravels are crucial in shaping this biotope (Connor *et al*., 2004; JNCC, 2022), preventing the establishment of less scour-tolerant species, such as red algae. When individuals attach to mobile pebbles, cobbles, and boulders instead of bedrock, these surfaces can be displaced and overturned. This displacement leads to the smothering of attached algae and animals, or at least reduces photosynthesis, respiration, feeding efficiency, and fertilization of gametes in the water column. The impact of surface abrasion depends on its footprint, duration, and magnitude. High levels of abrasion from scouring by mobile cobbles and pebbles are key in shaping this biotope (Connor *et al*., 2004; JNCC, 2022), but the persistence of the assemblage may rely on rapid recovery rather than high resistance (Gorzula, 1977). The resistance of this biotope is assessed as low and resilience as high, resulting in an overall sensitivity assessment of low.

SABELLARIA REEF

9.7.67. There were patchy occurrences of the biotope '*Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment' (MC2211) across the Array Area and offshore ECC and are known to occur throughout the wider region in reef form (see Section 9.5). *S. spinulosa* is fixed to the substratum, so substratum abrasion and disturbance is likely to lead to mortality. However, *S. spinulosa* is most frequently found in disturbed sediment conditions and is a r-strategist (a life strategy which allows a species to deal with the vicissitudes of climate and food supply by responding to suitable conditions with a high rate of reproduction). R-strategists are continually colonising habitats of a temporary nature. *S. spinulosa* occurs in high densities on subtidal gravels that would be expected to be disturbed every year or perhaps once every few years due to storms. Areas where *S. spinulosa* had been lost due to winter storms appeared to recolonise up to a maximum thickness of 2.4 cm during the following summer (R. Holt, pers. Comm. In Jones *et al*., 2000). Abrasion at the surface of *S. spinulosa* reefs is likely to damage the tubes and result in damage to the worms. Therefore, resistance is assessed as low. The recovery in thick reefs is likely to occur through tube repair and may be relatively rapid, therefore resilience is assessed as medium. The overall sensitivity of the biotope to temporary habitat disturbance is assessed as medium (Tillin *et al*., 2023).

BURROWED MUD

9.7.68. An occurrence of the biotope 'Seapens and burrowing megafauna in Atlantic circalittoral fine mud' (MC6216) was found in the Array Area (one burrow of *P. phosphorea* was observed on one transect, which was further assessed, and categorised on the SCAFOR scale as 'rare'). Experimental studies (Kinnear *et al*., 1996; Eno *et al*., 2001) show that seapens like *P. phosphorea* are resilient to smothering and uprooting by pots and creels, often recovering within 24-72 hours. However, trawling causes significant damage, with many specimens not surviving long-term (Malecha and Stone, 2009). Most seapens can avoid abrasion by withdrawing into the sediment, but frequent disturbance will probably reduce feeding time and viability. Therefore, resistance is assessed as medium. As the resilience is likely to be low, the sensitivity of this biotope to this pressure is assessed as medium (Hill *et al*., 2023).

OFFSHORE SUBTIDAL SANDS AND GRAVEL

9.7.69. The biotope '*Echinocyamus pusillus, Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) was recorded in the deeper stations closest to the Array Area and in the area of the Buchan Deep in the offshore ECC. Abrasion is likely to damage a proportion of the characterising species associated with this biotope. Therefore, biotope resistance is assessed as medium. Resilience is assessed as high as opportunistic species are likely to recruit rapidly, and some damaged characterising species may recover or recolonise. Biotope sensitivity to this pressure is assessed to be low (Tillin and Watson, 2024b).

9.7.70. The biotope '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand' (MD5212) was recorded in the offshore ECC. Although burrowing taxa may be provided some protection from damage by abrasion at the surface, a proportion of the population is likely to be damaged or removed. Furthermore, as this biotope is generally in soft sediment it means that objects causing abrasion are likely to penetrate the surface and cause damage to the characterising species. Resistance is therefore assessed as low and resilience as medium, so sensitivity of MD5212 is assessed as medium (De-Bastos, 2023).

9.7.71. The biotope '*Glycera lapidum, Thyasira* spp. and *Amythasides macroglossus* in offshore circalittoral gravelly sand' (MD3211) was found across the south of the Array Area and offshore ECC. This biotope is distinguished by the presence of the rarely recorded ampharetid polychaete *A. macroglossus* and, in some instances, the common small ear file clam *Limatula subauriculata.* De Biasi and Pacciardi (2008) compared macrobenthic communities in a commercially fished area, subject to otter trawling, with a region closed to fishing for over ten years in the Adriatic Sea. They found that polychaetes, including *Aphelochaeta* spp., dominated the disturbed areas. This dominance likely reflects their ability to quickly recolonise disturbed areas rather than indicating resistance to seabed surface disturbance. Abrasion may damage some characterizing species, so biotope resistance is rated as medium. With opportunistic species likely to recruit quickly and some damaged species recovering or recolonizing, resilience is rated as high. Overall, biotope sensitivity is assessed as low.

M. MODIOLUS BEDS

9.7.72. *M. modiolus* were found in both the Array Area and offshore ECC. This species is large, sessile and present on the sediment surface. This leads to individuals being exposed to abrasion on the surface of the seabed so clumps may be flattened, and individual mussels damaged (Holt *et al*., 1998). Older mussels, made brittle by boring sponge infestations, are particularly susceptible (Comely, 1978). Abrasion also harms associated biota. Resistance and resilience are both assessed as low; therefore, sensitivity is assessed as high.

OCEAN QUAHOG

9.7.73. The Ocean Quahog (*A. islandica*) lives at the surface of the sediment while feeding but burrows to relatively shallow depths. This species is therefore exposed to both surface abrasion and penetration of the sediment and is known to be damaged by abrasion due to mobile fishing gear resulting in direct mortality with an observed decline in the population in the southern North Sea reportedly correspond ing to trawling activity. Resistance to an impact of this kind is considered to be low and resilience very low. Consequently, the sensitivity of *A. islandica* to temporary habitat disturbance is assessed as high.

SIGNIFICANCE OF EFFECT

9.7.74. The sensitivity of the benthic subtidal features within the boundary of the Proposed Development is therefore considered to be worst case high,, with the majority of receptors having medium or low seinsitivity, reflecting that the receptors have some ability to tolerate the LSE of temporary habitat disturbance and are likely to recover to an acceptable status over a ten-year period.

9.7.75. The impact of temporary habitat disturbance on the subtidal benthic biotopes present is considered to be of low magnitude, and the sensitivity of the majority of receptors affected is considered to be worse-case high sensitivity. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-23 Significance of impact of temporary habitat disturbance on benthic subtidal ecology receptors

Receptor/Location	Magnitude	Sensitivity	Significance
Coarse and mixed sediments with moderate to high infaunal diversity and epibenthic communities	Low	Low	**Negligible**
Sandy sediments with low infaunal diversity and sparse epibenthic communities	Low	Low	**Negligible**
Mixed sediments with polychaete and epifaunal communities	Low	Medium	**Minor**
Impoverished mixed gravelly sands	Low	Low	**Negligible**
S. spinulosa reef	Low	Medium	**Minor**

Receptor/Location	Magnitude	Sensitivity	Significance
Burrowed mud	Low	Medium	**Minor**
Offshore subtidal sands and gravel	Low	Low	**Negligible**
M. modiolus beds	Low	High	**Minor**
Ocean quahog	Negligible	High	**Negligible**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.76. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 3: DIRECT AND INDIRECT SEABED DISTURBANCES LEADING TO THE RELEASE OF SEDIMENT CONTAMINANTS

9.7.77. As discussed under Impact 1, construction activities will re-suspend sediments. While in suspension, there is the potential for sediment-bound contaminants, such as metals, hydrocarbons and organic pollutants, to be released into the water column and lead to an effect on benthic subtidal receptors.

MAGNITUDE OF IMPACT

9.7.78. The results of the sediment chemistry survey that has been undertaken within the boundaries of the Proposed Development revealed that across the Array Area the contaminants were predominantly recorded as below Cefas AL1. PAHs were generally low (below the UKOOA (2001) 50th percentile reference threshold for the background stations in the CNS), apart from two stations in the benthic intertidal ecology study area feature recorded PAHs that exceeded the UKOOA threshold (although did not exceed the UKOOA (2001) 95th percentile), which was hypothesised to be localised atmospheric fallout of PAHs along isolated parts of the beach. However, this is not a concern as the intertidal sediments will not be disturbed during construction. Pyrene was also slightly higher than the OSPAR Background Assessment Concentrations (BAC) at one offshore ECC subtidal station.

9.7.79. THC and *n*-alkane concentrations of sediments were low across the Proposed Development, and no stations exceeded UKOOA (2001) 50th percentile threshold for the North Sea. Carbon Preference Index (CPI) did indicate a dominance in biogenic, odd carbon numbered alkanes across the benthic subtidal ecology study area. This shows typical North Sea run-off and non-drilling related hydrocarbons from shipping traffic. The North Sea is a region where both oil and gas are produced (Cefas, 2001). Hydrocarbon signatures were indicative of those typically seen for background sediments on the UK Continental Shelf (UKCS).

9.7.80. Ten stations in the Array Area recorded metal concentrations exceeding OSPAR (2014) BAC including arsenic and nickel at six stations, and mercury and lead at three stations. The arsenic concentrations recorded in this study were within the range of that reported for the CNS (Cefas, 2001). Twenty stations in the offshore ECC and in the benthic intertidal ecology study area recorded metal concentrations exceeding OSPAR (2014) BAC, and within these stations eight metals were above thresholds. Arsenic had the highest occurrence at five stations, and nickel was elevated at three stations and zinc at four stations. These recorded concentrations are consistent with those within marine sediments in the wider North Sea.

9.7.81. Following disturbance as a result of construction activities, the majority of re-suspended sediments are expected to be deposited in the immediate vicinity of the works. The release of contaminants from the small proportion of fine sediments is likely to be rapidly dispersed with the tide and/or currents and therefore increased bioavailability resulting in adverse eco-toxicological effects are not expected.

9.7.82. The impact is predicted cause very slight or no change to the baseline conditions as it is of local spatial extent, short term duration, intermittent and high reversibility. The magnitude is therefore, considered to be negligible.

SENSITIVITY OF RECEPTORS

9.7.83. Sensitivity of the receptors to a pressure of this type is not assessed within the Marlin MarESA sensitivity assessment for the majority of due to the lack of research. Biotopes that are known to characterise the Array Area and offshore ECC for which relevant information is available have been assessed according to the detailed the MarESA sensitivity assessments and are detailed in Table 9-24.

Table 9-24 MarESA for the benthic subtidal habitats to toxic pollutants that may be released by construction activities

Biotope name	Biotope code (EUNIS 2022)	Sensitivity assessment	Assessment confidence
Seapens and burrowing megafauna in circalittoral fine mud	MC6216	1. High (based on low resistance and low resilience) to transition elements and organo-metal contamination; 2. High (based on low resistance and low resilience) to hydrocarbon and PAH contamination; and 3. High (based on no resistance and low resilience) to synthetic compound contamination.	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
M. modiolus beds	N/A	1. High (based on low resistance and low resilience) to transition elements and organo-metal contamination; 2. High (based on low resistance and low resilience) to hydrocarbon and PAH contamination; and 3. High (based on no resistance and low resilience) to synthetic compound contamination.	Confidence is medium as it is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature (habitat, its component species, or species of interest) or similar features

SEAPENS AND BURROWING MEGAFAUNA IN CIRCALITTORAL FINE MUD

9.7.84. There is no direct evidence of the effects of 'transitional metals and organometals' on sea pens, although evidence for Anthozoa as a group suggests that the worst-case resistance of sea pen species is ‘low’. Similarly, evidence suggests that Anthozoa and, hence, possibly sea pens, are sensitive to petroleum hydrocarbons, oils, dispersed oils and dispersants It is precautionary to assume that sea pens may be affected adversely by some pesticides, or PCPs in the same way as some Anthozoa. Similarly, sea pens are likely to be affected adversely by some pesticides, or PCPs in the same way as some Anthozoa (Hill *et al*., 2023). Overall, as resistance and resilience are both assessed as low, sensitivity is assessed as high.

MODIOLUS BEDS

9.7.85. It has been demonstrated that *Modiolus* has some tolerance to heavy metal contamination (Richardson *et al*., 2001) and they can accumulate metals in contaminated conditions while exhibiting no adverse effects (Julshamn and Andersen, 1983; Holt *et al*., 1998; Klumpp & Burdon-Jones, 1982).

Similarly, *Modiolus* has been shown to accumulate oil residues (Scarratt & Zitko, 1972), although mortality has been observed with increased exposure to hydrocarbons (Al-Sabagh *et al*., 2013) However, results of toxicity testing has shown a lethal response in *Modiolus* to a number of metals with mortality positively correlated both with the increasing concentration of metals and period of exposure (Hilmy *et al*., 1981). It is considered that a *Modiolus* population that is reduced in extent or abundance will take many years to recover while a population destroyed by an impact will require a very long time to re-establish and recover (Tillin *et al*., 2024). Resistance and resilience are both assessed as low; therefore, sensitivity is assessed as high.

9.7.86. The sensitivity of other benthic receptors to toxic pollutants that may be released because of construction activities is therefore deemed to be High, which is considered precautionary and reflects the lack of evidence on individual receptors and biotopes. A sensitivity of high describes the habitat or species as exhibiting 'none' or 'low' resistance (tolerance) to an external factor and is expected to recover only over very extended timescales, e.g. greater than 25 years or not at all.

SIGNIFICANCE OF EFFECT

9.7.87. The sensitivity of benthic subtidal features within the ZoI is therefore considered to be high as a worst-case A sensitivity of high describes the habitat or species as exhibiting 'none' or 'low' resistance (tolerance) to an external factor and is expected to recover only over very extended timescales, e.g. greater than 25 years or not at all.

9.7.88. The impact of direct and indirect seabed disturbances leading to the release of sediment contaminants benthic ecology is considered to be of negligible magnitude and the sensitivity of the receptors with sensitivity assessments available are considered to be high in the worst-case. The effect will therefore be of negligible significance, which is not significant in EIA terms.

Table 9-25 Significance of impact of direct and indire3ct seabed disturbances leading to the release of sediment contaminants

Receptor/Location	Magnitude	Sensitivity	Significance
Seapens and burrowing megafauna in circalittoral fine mud	Negligible	High	**Negligible**
M. modiolus beds	Negligible	High	**Negligible**
All other subtidal benthic receptors	Negligible	High	**Negligible**
All intertidal benthic receptors	Negligible	High	**Negligible**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.89. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

OPERATION AND MAINTENANCE

9.7.90. This Section presents the assessment of impacts arising from the O&M phase of the Proposed Development. The effects of O&M on benthic subtidal and intertidal ecology have been assessed for the benthic subtidal and intertidal ecology study areas.

IMPACT 4: PERMANENT AND/OR LONG-TERM HABITAT LOSS/ALTERATION DUE TO THE ADDITION OF INFRASTRUCTURE TO THE AREA

MAGNITUDE OF IMPACT

9.7.91. The presence of the WTG anchors and OEP foundations and the associated scour protection, along with the cable protection measures used at cable crossings and areas where cable burial is not possible, will lead to a change from a sedimentary habitat to one characterised by hard substrate. Dynamic inter-array cable mooring lines are also predicted to have a strimming effect on the seabed which will also lead to seabed change. This will be either a long-term habitat loss (for the approximate 35-year design life duration of the Proposed Development) or a permanent change and is therefore considered an impact of the O&M phase of the Proposed Development and potentially beyond. It is assessed here as habitat loss and a LSE due to the potential shift in the baseline condition).

9.7.92. Table 9-17 identifies the worst-case design scenario for foundation, scour, anchor and cable protection footprint. The total habitat loss arising from these components would be 2,757,400 m^2, which equates to approximately 0.75% of the subtidal habitat within the Proposed Development area.

9.7.93. Dynamic inter-array cable mooring lines are predicted to have a strimming effect on the seabed which would lead to seabed change. This will either be a long-term habitat loss (for the 35-year lifetime of the Proposed Development) or a permanent change and is therefore considered an impact of the O&M phase of the Proposed Development and potentially beyond. The maximum mooring line strimming effect would be 6,700 m^2, which represents 0.003% of the total Proposed Development Array Area.

9.7.94. While the impact will be locally significant and comprise a permanent change in seabed habitat within the footprint of the anchors, structures and scour and cable protection, the footprint of the area affected is highly localised. A change of subtidal sediment biotopes to rock or artificial hard substratum would alter the character of the biotope leading to reclassification and the loss of the sedimentary community. As the habitats and characterising biotopes are common and widespread throughout the wider region, the loss of these habitats represents a minor loss/divergence from baseline conditions. The magnitude is therefore assessed as to be low for undesignated seabed.

9.7.95. Permanent loss of habitat might occur within the MPA where the offshore ECC overlaps, where cable protection might be required. If cable protection is required in the offshore ECC, it will occur in an area representing less than <0.01% of the whole MPA. This disturbance, therefore, will only occur at a highly localised scale and transport processes are not expected to be affected. Therefore, the magnitude of this receptor has also been assessed as low.

SENSITIVITY OF RECEPTORS

9.7.96. All benthic receptors identified within the Proposed Development area have been assessed according to the MarESA criteria as having no resistance to long-term or permanent habitat loss/change, with recovery in all receptors assessed as very low as the change at the pressure benchmark is at worst-case permanent. The sensitivity of subtidal receptors is therefore considered to be at worst-case high according to the EIA assessment values.

SIGNIFICANCE OF EFFECT

9.7.97. A change of subtidal biotopes to artificial rock or hard substrate would alter the character of the biotope leading to reclassification and the loss of the sedimentary community. However, while the impact will be locally significant and comprise a long-term or permanent change in seabed habitat within the footprint of the structure and scour and cable protection, the footprint of the area affected is highly localised. Furthermore, as the habitats and characterising biotopes are common and widespread throughout the wider region, the loss of these habitats is considered to be a minor loss.

9.7.98. The magnitude of the impact is deemed to be low, and the sensitivity of the benthic subtidal receptors is high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-26 Significance of impact of permanent and/or long-term habitat loss/alteration due to the addition of infrastructure to the area

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	High	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.99. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 5: TEMPORARY HABITAT DISTURBANCE

9.7.100. Temporary subtidal habitat disturbance will arise in the subtidal due to repair and replacement activities associated with the approximately 35-year operational phase of the Proposed Development. This will occur from the use of jack-up vessels, vessel mooring and anchoring operations, and cable burial and repair.

MAGNITUDE OF IMPACT

9.7.101. The total worst case design scenario is presented in Table 9-17, which is predicted to arise over the design life of the Proposed Development (equating to approximately 0.53% of the Array Area and offshore ECC combined).

9.7.102. Cable replacement works will require de-burial and re-burial of a cable or cable Sections and along with cable preventative maintenance, including re-burial, will consequently result in increases in SSC and sediment deposition. However, the impacts from these works will be spread over the life span of O&M activities with only a limited number of activities occurring within any one year.

9.7.103. The magnitude of temporary habitat disturbance from jack-up vessels and cable maintenance activities relating to the Proposed Development on benthic subtidal receptors is considered to be low, indicating that the disturbance of habitat does not threaten the long-term viability of the benthic resource within the Array Area and offshore ECC.

SENSITIVITY OF RECEPTORS

9.7.104. Given that the habitats are common and widespread throughout the wider region (as described in Section 9.5 the temporary habitat disturbance occurring during O&M activities would have an impact on a very limited footprint compared to their overall extent. As detailed in paragraph 9.7.1409.7.62 *et* seq., the benthic receptors directly affected by habitat loss/disturbance have a worst-case sensitivity of high to a disturbance of this nature, with the MarESA sensitivity assessment also presented in detail.

SIGNIFICANCE OF EFFECT

9.7.105. The magnitude of the impact is deemed to be low, and the sensitivity of the receptor is worst-case high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-27 Significance of impact of temporary habitat disturbance to benthic subtidal ecology receptors

Receptor/Location	Magnitude	Sensitivity	Significance
Coarse and mixed sediments with moderate to high infaunal diversity and epibenthic communities	Low	Low	**Negligible**
Sandy sediments with low infaunal diversity and sparse epibenthic communities	Low	Low	**Negligible**
Mixed sediments with polychaete and epifaunal communities	Low	Medium	**Minor**
Impoverished mixed gravelly sands	Low	Low	**Negligible**
S. spinulosa reef	Low	Medium	**Minor**
Burrowed mud	Low	Medium	**Minor**
Offshore subtidal sands and gravel	Low	Low	**Negligible**
M. modiolus beds	Low	High	**Minor**
Ocean quahog	Negligible	High	**Negligible**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.1.1 No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 6: COLONISATION OF HARD SUBSTRATES

9.7.106. The introduction of subsea infrastructure from OWFs can provide potential novel hard substrate for colonisation by epifaunal species within the benthic subtidal ecology study area. The introduction of hard infrastructure may alter previously soft sediment habitat areas, attract new species with a preference for hard substrate, and increase the habitat complexity biodiversity of the area.

MAGNITUDE OF IMPACT

9.7.107. The long-term footprint of the Proposed Development is 5.53 km^2, which accounts for approximately 1.51% of the total Proposed Development boundary. This will be present for the duration of the Proposed Development lifetime (approximately 35 years). The presence of up to 67 WTGs and two OEP(s) will introduce new hard structures with the potential for encrusting epifauna to colonise.

9.7.108. To reduce the footprint of the cable protection, where practicable, cable burial will be the preferred means of cable protection. In instances where adequate burial cannot be achieved, an alternative form of cable protection will be deployed.

9.7.109. Hard substrate habitats are comparatively rare within the benthic subtidal ecology study area, which is dominated by predominantly sedimentary habitats, although multiple large boulders were identified across the Array Area and offshore ECC. The introduction of hard substrate, and associated increases in biodiversity, will alter the biotopes that characterise the area. This will be long-term, lasting for the duration of the Proposed Development. Any effects on benthic subtidal and intertidal ecology arising from the introduction of hard substrates will likely be localised to the Array Area and offshore ECC (where cable protection is laid).

9.7.110. The impact is, therefore, predicted to be of local spatial extent, long-term duration but reversable once the infrastructure is removed, although it may be that some hard substrate (i.e. cable and/or scour protection) will remain *in-situ*. The magnitude of the impact is deemed to be low, as the habitats and characterising biotopes are not geographically restricted and are typically common and widespread throughout the wider region.

SENSITIVITY OF RECEPTORS

9.7.111. The introduction of new hard substrate will represent a potential shift in the baseline condition within a small proportion of the Array Area and offshore ECC. Potential beneficial effects that may occur are associated with the likely increase in biodiversity and biomass, as has been observed at the Egmond aan Zee Offshore Windfarm (Lindeboom *et al*., 2011). Individual species with the potential to benefit from the introduction of hard substrate due to increased substrate for attachment are those which are typical of rocky habitats and intertidal environments.

9.7.112. The species potentially introduced may also have indirect and adverse effects through increased predation on, or competition with, neighbouring soft sediment species. However, such effects are difficult to predict. The increased biodiversity associated with the structures could provide benefits at higher trophic levels as the benthic organisms colonising the structures provide an additional food source. Studies at the Horns Rev Offshore Windfarm in Denmark provided evidence that OWF structures are used as successful nursery habitats for *C. pagurus* (BioConsult 2006). However, any direct benefits are only likely to occur on a very localised basis (i.e., near the infrastructure).

9.7.113. Given the presence of epifaunal species and colonising fauna within discrete parts of the Array Area and offshore ECC (i.e., associated with coarser sediment habitats), it is predicted that colonisation of hard substrates by common species such as bryozoans and ascidians will occur.

9.7.114. There is also potential for the introduction of INNS to the area due to the introduction of new hard substrate habitats, however, this is discussed in more detail in Impact 7 (paragraph 9.7.121 *et seq*.).

9.7.115. All the biotopes present are characterised by a muddy or sedimentary habitat. A change of seabed type to an artificial or rock substratum would alter the character of the biotopes leading to loss of the sedimentary community including bivalves, polychaetes and echinoderms living buried within the sediment. Based on the loss of the biotopes, the assessment has concluded no resistance, very low resilience and, therefore, sensitivity has been assessed to be high.

9.7.116. A change to artificial hard substratum would remove the sedimentary habitat required by *A. islandica* and *M. modiolus*. Based on the loss of suitable habitat, there is no resistance of these species to this pressure and resilience is assessed as very low. Therefore, sensitivity is assessed to be high.

SIGNIFICANCE OF EFFECTS

9.7.117. Any beneficial effects associated with an increase in biodiversity will be highly localised in nature and are not regarded as mitigation for the loss of sedimentary habitat associated with the installation of these structures. The introduction of hard structures such as scour protection can lead to an increase in biomass and biodiversity which may be considered beneficial, but it also represents a change from the baseline environment which may be considered adverse.

9.7.118. While the impact will be locally significant and comprise a permanent change in water column and seabed habitat within the footprint of the structures and scour and cable protection, the footprint of the area affected and any associated increases and/or changes in biodiversity will be highly localised. As the habitats and characterising biotopes are common and widespread throughout the wider region, the loss of these habitats is assessed as barely discernible.

9.7.119. The magnitude of the impact is deemed to be low, and the sensitivity of the receptor is worst-case high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-28 Significance of the impact of colonisation of hard substrates

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	High	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.120. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 7: RISK OF INTRODUCTION AND/OR SPREADING OF INNS PARTICULARLY DUE TO THE PRESENCE OF INFRASTRUCTURE AND VESSEL MOVEMENT (E.G., BALLAST WATER) WHICH MAY AFFECT BENTHIC ECOLOGY

9.7.121. There is a risk that the introduction of hard substrate into a sedimentary habitat will enable the colonisation of the introduced substrate by INNS that might otherwise not have had a suitable habitat for colonisation, thereby enabling their spread. This along with the movement of vessels in and out of the Array Area and offshore ECC has the potential to impact upon benthic subtidal and intertidal ecology and biodiversity locally and in the broader region.

9.7.122. Marine INNS can have a detrimental effect on benthic ecology, either by outcompeting existing taxa for habitat and food or due to predation on existing species. This can result in biodiversity changes in the existing habitats present within the benthic subtidal ecology study area. Introduced marine INNS could potentially lead to the complete loss of certain species and may result in new habitats forming (e.g., introduction of reef-forming species).

MAGNITUDE OF IMPACT

9.7.123. Table 9-17 presents the worst case design scenario for new hard substrate habitat that will be introduced into the Array Area and offshore ECC, which has the potential to provide new habitat for colonisation by marine INNS. In addition, Table 9-17 details the round trips to port during the O&M phase which could contribute to the risk of introduction or spread of marine INNS through ballast water discharge.

9.7.124. Table 9-16 presents the embedded mitigation measures which includes the development of a EMP with an INNS plan. This will ensure that the risk of potential introduction and spread of marine INNS from increased vessel activity is minimised.

9.7.125. The main pathways for the transport and introduction of marine INNS have been identified as recreational boating, aquaculture, fisheries, shipping, and offshore energy (Marine Pathways Project, 2014). Pathways of introduction involving vessel movements represent the single highest potential risk route for the introduction of INNS; this could either be from discharge of ballast water at a site or via transportation on vessel hulls (Carlton, 1992; Pearce *et al*., 2012).

9.7.126. It should be noted that there is a widespread presence of marine INNS across the North Sea. Marine INNS that are widespread and well established in Scottish seas include, but are not restricted to, wireweed (*Sargassum muticum)*, green sea-fingers (*Codium fragile)* subsp. *tomentosoides*, red algae *Dasysiphonia japonica*, acorn barnacle (*Austrominius modestus)*, Japanese skeleton shrimp (*Caprella mutica)*, leathery sea squirt *Styela clava*, orange tipped sea squirt (*Corella eumyota)* and orange ripple bryozoan (*Schizoporella japonica)* (NatureScot, 2023). In site-specific surveys, the Styelidae family was recorded in sediment eDNA analysis in the offshore ECC, however not identified to species level.

9.7.127. The impacts on benthic receptors within the Array Area and offshore ECC is predicted to be of low spatial extent. The introduction of hard structures (including mooring lines and dynamic cables) may serve as 'stepping stones' and extend the impact beyond a local scale. However, based on current scientific knowledge it is not possible to predict whether such a spread will occur, to what extent and which species, if any, this may involve. The impact is predicted to be of long-term permanent duration, continuous and irreversible, though it is predicted that the impact will affect the receptors indirectly. With the implementation of an EMP with associated INNS plan to mitigate and manage INNS, the magnitude of this impact is considered to be low.

SENSITIVITY OF RECEPTORS

9.7.128. As described in Table 9-29, benthic biotopes within the benthic subtidal ecology study area range from being not sensitive to having a high sensitivity to the introduction or spread of marine INNS, according to MarESA.

Table 9-29 MarESA for the benthic habitats to introduction on spread of marine INNS

Biotope / species name	**Biotope code (EUNIS, 2022)**	**Sensitivity assessment**	**Assessment confidence**
Polychaete-rich deep *Venus* community in offshore mixed sediments	MD4211	High (based on low resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	MC3212	High (based on low resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand	MB5233	Not sensitive (based on high resistance and high resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment	MC4214	Medium (based on medium resistance and very low resilience	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Spirobranchus triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	MC3211	Not sensitive (based on high resistance and high resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Sabellaria spinulosa on stable Atlantic circalittoral mixed sediment	MC2211	No evidence (there is not enough evidence of the interaction with INNS to make an assessment)	Not relevant (there is no direct interaction between the pressure and his biotope)
Seapens and burrowing megafauna in circalittoral fine mud	MC6216	No evidence (there is no direct evidence on the effect of INNS on this biotope)	Not relevant (there is no direct interaction between the pressure and his biotope)

Biotope / species name	Biotope code (EUNIS, 2022)	Sensitivity assessment	Assessment confidence
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC5211	High (based on no resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Owenia fusiformis and *Amphiura filiformis* in deep circalittoral sand or muddy sand	MD5212	Not relevant (there are no record of the introduction of INNS in this biotope)	Not relevant (there is no direct interaction between the pressure and his biotope)
Glycera lapidum, *Thyasira* spp., and *Amythasides macroglossus* in offshore gravelly sand	MD3211	High (based on low resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)
Ocean quahog	N/A	No evidence (no evidence was found to suggest that populations were adversely affected by INNS)	Not relevant (there is no direct interaction between the pressure and his biotope)
M. modiolus beds	N/A	High (based on low resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement (as opposed to peer-reviewed papers)

9.7.129. The sensitivity of biotopes 'Polychaete-rich deep Venus community in offshore mixed sediments' (MD4211), '*Mediomastus fragilis, Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel' (MC3212), '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) and '*Glycera lapidum, Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand' (MD3211) are deemed to be at worst-case high due to the risk of colonisation by the slipper limpet (*Crepidula fornicata)*. The sediments characterising these biotopes are likely to be too mobile and otherwise unsuitable for most of the marine INNS currently recorded in the UK. However, *C. fornicata* could colonise coarse sediments in the subtidal which are typical of these biotopes due to the presence of gravel or shells embedded in the substratum that can be used for larvae settlement (Tillin *et al*., 2020). *M. modiolus* beds are also deemed to be at worst-case high due to the risk of colonisation by the slipper limpet.

9.7.130. The biotope '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (MC4214) is assessed to have a medium resistance to this pressure as the high levels of scour in this biotope will limit the establishment of all but the most scour-resistant marine INNS. *C. fornicata* has been recorded in this biotope (Hinz *et al*., 2001) but scour from cobbles and pebbles might hinder colonisation. Resilience is assessed as very low as, if *C. fornicata* were to colonise, it would probably require artificial removal. Therefore, the biotope sensitivity is assessed as medium.

9.7.131. The biotopes '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) and '*Spirobranchus triqueter* with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles' (MC3211) have a high resistance to this pressure as the sediments characterising these biotopes are mobile, and frequent disturbance limits the establishment of marine INNS. The habitat conditions are also unsuitable for *C. fornicata* due to the mobility of the sediment. These biotopes also have high resilience in general and are therefore assessed to be not sensitive to the pressure of marine INNS (Tillin *et al*., 2023).

9.7.132. There is not enough evidence found to suggest that the biotope '*Sabellaria spinulosa* on stable Atlantic circalittoral mixed sediment' (MC2211) is currently impacted by marine INNS. However, it should be noted that *C. fornicata* may pose a threat in terms of competition for food or space. The same is true for the biotope 'Seapens and burrowing megafauna in circalittoral fine mud' (MC6216). Furthermore, there are no records of the introduction or spread of marine INNS in the biotope '*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand' (MD5212), and no evidence found that ocean quahog are adversely affected by marine INNS. In order for this assessment to be sufficiently precautionary, it is assumed that the sensitivity of these receptors to the pressure of marine INNS is at worst case high.

SIGNIFICANCE OF EFFECT

9.7.133. The sensitivity of benthic receptors within the benthic subtidal ecology study area to an introduction or spread of marine INNS is deemed to be at worse-case high, with some biotopes having no or very low resistance to an impact of this nature.

9.7.134. The magnitude of the impact is deemed to be low, and the sensitivity of the receptor is worst-case high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-30 Significance of risk of introduction and/or spreading of inns particularly due to the presence of infrastructure and vessel movement (e.g., ballast water) which may affect benthic ecology

Receptor/Location	Magnitude	Sensitivity	Significance
Polychaete-rich deep *Venus* community in offshore mixed sediments	Low	High	**Minor**
Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	Low	Not sensitive	**Negligible**
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand	Low	Not sensitive	**Negligible**
Spirobranchus triqueter with barnacles and bryozoan crusts on unstable circalittoral cobbles and pebbles	Low	Not sensitive	**Negligible**
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	Low	High	**Minor**
Glycera lapidum, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand	Low	High	**Minor**
M. modiolus beds	Low	High	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.135. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 8: INDIRECT EFFECTS ON BENTHIC ECOLOGY FROM ELECTROMAGNETIC FIELD (EMF) EFFECTS GENERATED BY DYNAMIC CABLES)

9.7.136. EMF are generated by the current that passes through an electric cable. It is known that EMF can be detected by fish and elasmobranchs, and it is thought that any benthic invertebrates can also detect EMF. Three types of fields are generated by underwater electric cables: electric fields (E-fields), magnetic fields (B-fields) and induced electric fields (iE-fields). Standard industry practice is for the cables used to have sufficient shielding to contain the E-fields generated and the cable system descriptions for the inter-array and export cables have abided by this. Shielding and/or burial does not reduce the B-fields and it is these fields that allow the formation of iE-fields. As such, further reference here to EMF is limited to B-fields and associated iE-fields.

MAGNITUDE OF IMPACT

9.7.137. Impacts from changes in EMFs arising from cables, are not considered to result in any appreciable effects on benthic subtidal and intertidal ecology receptors. EMFs are likely to be generated by subsea cables and detectable above background levels in close proximity to the cables. Although burial does not mask EMFs it increases the distance between species that may be affected by EMFs and the source. Burial of the cables and protection with cable protection where shallow buried or surface laid (Table 9-16) will not reduce the strength of the fields, however, it moves the cables further from some receptors, and as such the receptors will be subject to reduced field strengths. Any behavioural responses are therefore likely to be mitigated, to some degree.

9.7.138. Floating WTGs use dynamic inter-array cables which are primarily suspended within the water column, instead of along the sea floor unlike inter-array cables associated with traditional fixed foundation WTG. Some portion of the dynamic inter-array cables will be on the seafloor and will be buried but the majority will be in the water column and therefore will not have a direct effect on the benthic environment.

9.7.139. It is considered unlikely that EMFs will result in a behavioural response that will cause a change in benthic communities within the benthic subtidal and intertidal ecology study areas and that any potential negative effects will be confined to a localised area surrounding the cables. Therefore, the magnitude of the impact is considered to be negligible, indicating that any behavioural response of benthic fauna is likely to be discernible or barely discernible over a very small area, that does not threaten benthic subtidal ecology features, undermine regional ecosystem functions or diminish biodiversity.

SENSITIVITY OF RECEPTORS

9.7.140. The MarESA sensitivity assessments do not consider there to be sufficient evidence to support assessments of impacts of EMF on benthic subtidal and intertidal habitats; therefore, a desktop study has been undertaken to describe the typical responses of benthic invertebrates. A detailed assessment on elasmobranch, fish and shellfish species is provided in Volume 2, Chapter 10 (Fish and Shellfish Ecology).

9.7.141. Typically, the impacts of EMF on marine organisms have focused on electrically sensitive fish and elasmobranchs, with little research focusing on benthic invertebrates, with the few studies using invertebrates focusing on crustaceans (e.g., Woodruff *et al*., 2012). Furthermore, many studies contradict each other or provide inconclusive results (Switzer and Meggitt, 2010), further reducing the available evidence.

9.7.142. However, evidence of sensing, responding to, or orienting to natural magnetic field cues has been shown for invertebrates including molluscs and arthropods (Boles and Lohmann, 2003; Lohman and Willows, 1987; Ugolini, 2006; Ugolini and Pezzani, 1995). Scott *et al*. (2021) investigated the effects of EMF (strengths 250 μT, 500 μT and 1000 μT) from submarine power cables on edible crab, showed limited physiological and behavioural effects on the crabs exposed to EMF of 250 μT. EMF of 500 μT or above showed physiological stress in crabs, and changes to behavioural trends, specifically an attraction to EMF. It is to be noted however, that these studies investigated EMF strengths significantly higher than those that receptors will typically be exposed to as a result of offshore wind cables in the marine environment. Specifically, the lowest experimental EMF used in Scott *et al*. (2021) was a factor of 10 higher than that expected for the Proposed Development at 1 m from the cable, with no impacts identified at this EMF strength. Effects were only noted in these studies using EMF strengths which were a factor of 20 – 1,000 higher than those expected from the Proposed Development cables. Therefore, it is considered that it is unlikely that there would be any impacts to crustaceans from EMF. Taking this into consideration, any effects on marine invertebrates are anticipated to only occur in the immediate vicinity of the cable.

9.7.143. A laboratory study assessing the effects of environmentally realistic, low-frequency B-field exposure on the behaviour and physiology of the common ragworm (*Hediste diversicolor)* did not find any evidence of avoidance or attraction behaviours (Jakubowska *et al*., 2019). The polychaetes did, however, exhibit enhanced burrowing activity when exposed to the B-field, with plausible consequences for their metabolism; however, knowledge about the biological relevance of this response is currently absent (Jakubowska *et al*., 2019).

9.7.144. One recent study examined the difference in invertebrate communities along an energised and nearby surface laid cable. The study identified that there were no functional differences between the communities on and around the cables up to three years after installation (Love *et al*., 2016). The same study also identified that EMF levels reduce to background levels generally within one metre of the cable.

9.7.145. For invertebrate receptor species, it is difficult to translate the patchwork of knowledge about individual-level EMF effects into assessments of biologically or ecologically significant impacts on populations (Boehlert and Gill, 2010). However, given the evidence presented, it is predicted that EMFs have no significant impact on mobile or sessile benthic invertebrates, including if the cable is surface laid.

9.7.146. The sensitivity of benthic receptors is therefore considered to be low, reflecting that the receptor has a high resistance and ability to tolerate the impacts of EMF over the approximate 35-year operational lifetime of the Proposed Development.

SIGNIFICANCE OF EFFECT

9.7.147. The Developer has committed to bury or protect cables (Table 9-16) and the use of dynamic inter-array cables (where not buried) will be in the water column and therefore will not have a direct effect on the benthic environment. Any behavioural responses of benthic receptors are therefore likely to be reduced due to an increased distance between the cable and receptor.

9.7.148. The magnitude of the impact is deemed to be negligible, and the sensitivity of the receptor is worst-case low. The effect will therefore be of negligible significance, which is not significant in EIA terms.

Table 9-31 Significance of indirect effects on benthic ecology from EMF effects

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Negligible	Low	**Negligible**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.149. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 9: CHANGES IN PHYSICAL PROCESSES RESULTING FROM THE PRESENCE OF THE PROPOSED DEVELOPMENT SUBSEA INFRASTRUCTURE E.G., SCOUR EFFECTS, CHANGES IN WAVE/TIDAL CURENT REGIMES AND RESULTING EFFECTS ON SEDIMENT TRANSPORT

9.7.150. The presence of anchors, foundations, scour protection and cable protection material may introduce changes to the local hydrodynamic and wave regime, resulting in changes to the sediment transport pathways and associated effects on benthic subtidal and intertidal ecology. Scour and increases in flow rates can change the characteristics of the sediment potentially making the habitat less suitable for some species.

MAGNITUE OF IMPACT

9.7.151. The use of correctly designed scour protection at foundations and sufficiently buried cables (Table 9-16) will prevent scour occurring. Scour will therefore only occur if and where scour protection has not been applied.

9.7.152. The cable protection methods being considered include concrete mattresses, rock placement, grout bags, iron cast and an engineered Cable Protection System (CPS). The exact form of cable protection used will depend on local ground conditions, hydrodynamic processes and the selected cable protection contractor. Where cable protection is used, some scouring is predicted to occur throughout the operational phase at these sites. The extent of this scouring is predicted to be local, occurring around the perimeter of the rock berms.

9.7.153. Volume 2, Chapter 7 (Marine and Coastal Processes) has determined that the impacts on hydrodynamic and wave regimes will be not result in significant impacts to coastal and physical processes and will therefore not result in any significant changes to sediment transport. Consequently, this conclusion will result in there not being any significant changes on the benthic environment and therefore the benthic subtidal and intertidal ecology. The magnitude of this impact is therefore considered to be low.

SENSITIVITY OF RECEPTORS

9.7.154. As detailed within paragraph 9.7.61 *et seq.*, the subtidal benthic habitats directly affected by temporary habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature. Paragraph 9.7.19 *et seq*. detail that the habitats indirectly affected by increased SSC and deposition have a worst-case sensitivity of high to the expected levels of SSC and deposition, with the MarESA also presented in detail.

SIGNIFICANCE OF EFFECT

9.7.155. The magnitude of the impact is deemed to be low, and the sensitivity of the receptor is worst-case high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-32 Significance of changes in physical processes resulting from the presence of the Proposed Development

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	High	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.156. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

DECOMMISSIONING

9.7.157. The effects of the decommissioning of the Proposed Development on benthic subtidal and intertidal ecology have been assessed for the benthic subtidal and intertidal ecology study areas and the secondary ZoI. The environmental impacts arising from the decommissioning of the Proposed Development are listed in Table 9-17 along with the design envelope against which each decommissioning phase impact has been assessed.

9.7.158. A description of the significance of effect upon benthic subtidal and intertidal receptors caused by each identified impact is provided below.

IMPACT 10: INCREASES IN SUSPENDED SEDIMENT CONCENTRATIONS (SSC) AND CHANGES TO SEABED LEVELS

MAGNITUDE OF IMPACT

9.7.159. Increases in SSC and sediment deposition from the decommissioning works will be similar to that for construction and the impacts are considered to be of a similar magnitude. The magnitude of the impact is described in detail in paragraph 9.7.5 *et seq.* for subtidal receptors and paragraph 9.7.38 *et seq*. for intertidal receptors.

9.7.160. The magnitude of change from increases in SSC is expected to be noticeable but temporary, with the majority of effects limited to the near-field and of short-term duration. The magnitude of impact has therefore been assessed as low.

SENSITIVITY OF RECEPTORS

9.7.161. The sensitivities of the species to increases in SSC and sediment deposition are detailed in Table 9-18 and paragraph 9.7.19 *et seq*., for subtidal receptors, and in Table 9-20 and paragraph 9.7.41 *et seq*., for intertidal receptors and summarised below.

9.7.162. The sensitivity of benthic subtidal features within the boundary of the Proposed Development and wider ZoI is considered to be high as a worst-case, with the sensitivity of the majority of receptors considered to be medium or less reflecting that the receptors have some ability to tolerate the temporary increased SSC and increases to seabed levels and are likely to recover to an acceptable status over a ten-year period.

9.7.163. It is predicted that the sensitivity of the intertidal receptors located across the benthic intertidal ecology study area is worst-case high, with the sensitivity of the majority of the receptors considered to be medium or less. As it is not anticipated that heavy smothering will be recorded across intertidal biotopes due to HDD works not occurring during decommissioning, and the only biotope recorded as being of high sensitivity to heavy smothering was MA1244, it is considered that the overall sensitivity of intertidal receptors to increases in SSC and changes to seabed level is worst-case medium.

SIGNIFICANCE OF EFFECT

9.7.164. The magnitude of the impact is deemed to be low, and the sensitivity of the receptor is worst-case high for benthic subtidal receptors and medium for benthic intertidal receptors. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-33 Significance of increases in SSCs and changes to seabed levels

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	High	**Minor**
All benthic intertidal receptors	Low	Medium	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.165. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 11: TEMPORARY HABITAT DISTURBANCE

MAGNITUDE OF IMPACT

9.7.166. Temporary habitat disturbance during decommissioning is assumed (for the purpose of this assessment) to be similar to that described for the equivalent activities during the construction phase in paragraphs 9.7.56 *et seq*.).

9.7.167. Decommissioning has the potential to cause temporary disturbance to benthic habitats within the Proposed Development, similar to those during the construction phase. However, as seabed preparation works would not be required, the magnitude of this impact will be lower than during the construction phase.

9.7.168. The impacts will be temporary and only a single event will occur at each location; therefore, the magnitude of the impact is assessed as low.

SENSITIVITY OF RECEPTORS

9.1.1 The sensitivities of the species to temporary habitat disturbance are described in Table 9-22 and paragraph 9.7.61 *et seq.*

9.1.2 The sensitivity of the benthic subtidal features within the boundary of the Proposed Development is therefore considered to be worst case high, reflecting that the receptors have some ability to tolerate the potential impacts of temporary habitat disturbance and are likely to recover to an acceptable status over a ten-year period.

SIGNIFICANCE OF EFFECT

9.7.169. The magnitude of the impact is deemed to be low and the sensitivity of the subtidal benthic receptors being high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-34 Significance of temporary habitat disturbance

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	Medium	**Minor**
M. modiolus beds	Low	High	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.170. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 12: DIRECT AND INDIRECT SEABED DISTURBANCE LEADING TO RELEASE OF SEDIMENT CONTAMINANTS

MAGNITUDE OF IMPACT

9.7.171. Direct and indirect seabed disturbances leading to the release of sediment contaminants from the decommissioning works will be similar to that for construction and the impacts are considered to be of similar magnitude. The magnitude of the impact is described in detail in paragraph 9.7.78 *et seq.*

9.7.172. The impact is predicted to cause very slight or no change to the baseline conditions as it is of local spatial extent, short term duration, intermittent and with high reversibility. The magnitude is therefore considered to be negligible.

SENSITIVITY OF RECEPTORS

9.7.173. The sensitivities of the species to release of sediment contaminants are described in Table 9-4 and paragraph 9.7.83 *et seq*.

9.7.174. The sensitivity of benthic receptors within the Proposed Development area is therefore considered to be high as a worst-case. A sensitivity of high describes the habitat or species as exhibiting ‘none’ or ‘low’ resistance (tolerance) to an external factor and is expected to recover only over very extended timescales, e.g. greater than 25 years or not at all.

SIGNIFICANCE OF EFFECT

9.7.175. The magnitude of the impact is deemed to be negligible and the sensitivity of the subtidal benthic receptors being high. The effect will therefore be of minor significance, which is not significant in EIA terms.

Table 9-35 Significance of the benthic subtidal habitats to toxic pollutants that may be released by decommissioning activities

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Negligible	High	**Negligible**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.176. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

IMPACT 13: REMOVAL OF HARD SUBSTRATE DURING DECOMMISSIONING

MAGNITUDE OF IMPACT

9.7.177. As detailed in paragraph 9.7.106 *et seq*., hard substrate introduced from the Proposed Development will become colonised by epifauna. If hard substrate such as foundations, cable protection and scour protection are removed during decommissioning, the species and any associated habitats which they create would also be removed.

9.7.178. The removal of the foundations, cable protection and scour protection will result in a permanent loss of 6.9 km^2 of hard substrate. The impact will be permanent (i.e., the colonising species will be permanently lost) and irreversible. It is predicted that the impact will directly affect the receptors, but it will be of highly localised extent. The magnitude of the impact is therefore considered to be low.

SENSITIVITY OF RECEPTORS

9.7.179. While the removal of the hard substrate will result in local declines in biodiversity, area of bare sedimentary habitat which was lost during construction will be exposed and will be open to recolonisation by the original benthic community. It is expected than the baseline benthic communities in these areas will recover to their pre-construction based on the recovery rates for disturbed sediment, which would equate to a maximum sensitivity for the baseline habitats of medium.

SIGNIFICANCE OF EFFECT

9.7.180. The loss of species colonising the hard substrate will be highly localised and there will be a typically high recoverability of the subsequently exposed substrate and communities back to their pre-construction state (see Section 9.5). Overall, the maximum sensitivity of the receptors is considered to be medium, and the magnitude of the impact is assessed as low. Therefore, the significance of the removal of hard substrate during decommissioning is minor, which is not significant in EIA terms.

Table 9-36 Significance of the benthic subtidal habitats to removal of hard substrate during decommissioning

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	Medium	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.7.181. No additional mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

PROPOSED MONITORING

9.7.182. No benthic subtidal and intertidal ecology monitoring is proposed to test the predictions made within the assessment of likely significant effects on benthic subtidal and intertidal ecology receptors as no likely significant effects were predicted during construction, O&M and decommissioning phases of the Proposed Development.

9.7.183. The Developer will engage with MD-LOT, NatureScot, and other relevant key stakeholders to identify and contribute to targeted and proportionate regional or strategic monitoring to better understand the environmental effects of offshore wind taking account of known evidence gaps taking account of Evidence Maps published through the Scottish Marine Energy Research (ScotMER) forum (Scottish Government, 2024) or any successor programme formed to facilitate these research interests, or any developer-led regional groups. This monitoring commitment will be secured in the Section 36 Consent and associated Marine Licences via the requirement for a Project Environmental Monitoring Plan (PEMP).

9.8. WHOLE PROJECT ASSESSMENT

9.8.1. The Proposed Development's infrastructure and activities are the focus of this EIAR. However, where the potential exists for onshore elements of the Project (the onshore infrastructure landward of MLWS) to impact the offshore receptors, these have been identified and assessed below in the Whole Project Assessment (WPA).

9.8.2. A separate onshore EIAR is being prepared which will provide a description of the onshore elements of the Project landward of MLWS, and an assessment of the associated LSE.

CONSTRUCTION

9.8.3. The onshore Proposed Development will undertake HDD operations above MHWS, with an HDD exit point offshore. The impacts from the HDD exit point on benthic subtidal and intertidal ecology receptors have been assessed in full in Section 9.7. It is not anticipated that there will be any additional impacts from the onshore Proposed Development on benthic subtidal and intertidal ecology receptors as all other activities from the onshore Proposed Development are fully terrestrial.

9.8.4. The potential for additive impacts between the onshore and offshore activities associated with the Project on benthic subtidal and intertidal ecology receptors during construction, are expected to be of negligible significance and not significant in EIA terms.

OPERATION AND MAINTENANCE

9.1.1 No continuous deposits or releases from onshore aspects of the Project into the marine environment are anticipated during the O&M phase of the Proposed Development.

9.1.2 The potential for additive impacts between the onshore and offshore activities on benthic subtidal and intertidal receptors during O&M, is expected to be of negligible significance and not significant in EIA terms.

DECOMMISSIONING

9.1.3 The infrastructure associated with the Proposed Development will be decommissioned in accordance with the DP (Commitment C-09). Structures are proposed to be removed in reverse order of the installation procedure however aspects, in particular inter-array and export cables, may be left in situ to minimise disturbance to the seabed.

9.1.4 The potential for additive impacts between the onshore and offshore activities on benthic ecology receptors during decommissioning, is expected to be of negligible significance and not significant in EIA terms.

9.9. CUMULATIVE EFFECTS ASSESSMENT

9.9.1. This cumulative impact assessment for benthic subtidal and intertidal ecology has been undertaken in accordance with the methodology provided in Volume 3, Appendix 6.2 (Offshore Cumulative Effects).

CEA METHODOLOGY

9.9.2. Effects of the Proposed Development alone are generally spatially restricted to being near the Array Area and offshore ECC. However, certain impacts have the potential to be observed over a wider area. These cumulative effects are the effects of the Proposed Development, combined with the effects from other projects, on the same receptor or group of receptors. For benthic subtidal and intertidal ecology, cumulative interactions may occur with other planned OWFs as well as other activities in the benthic subtidal and intertidal ecology study areas.

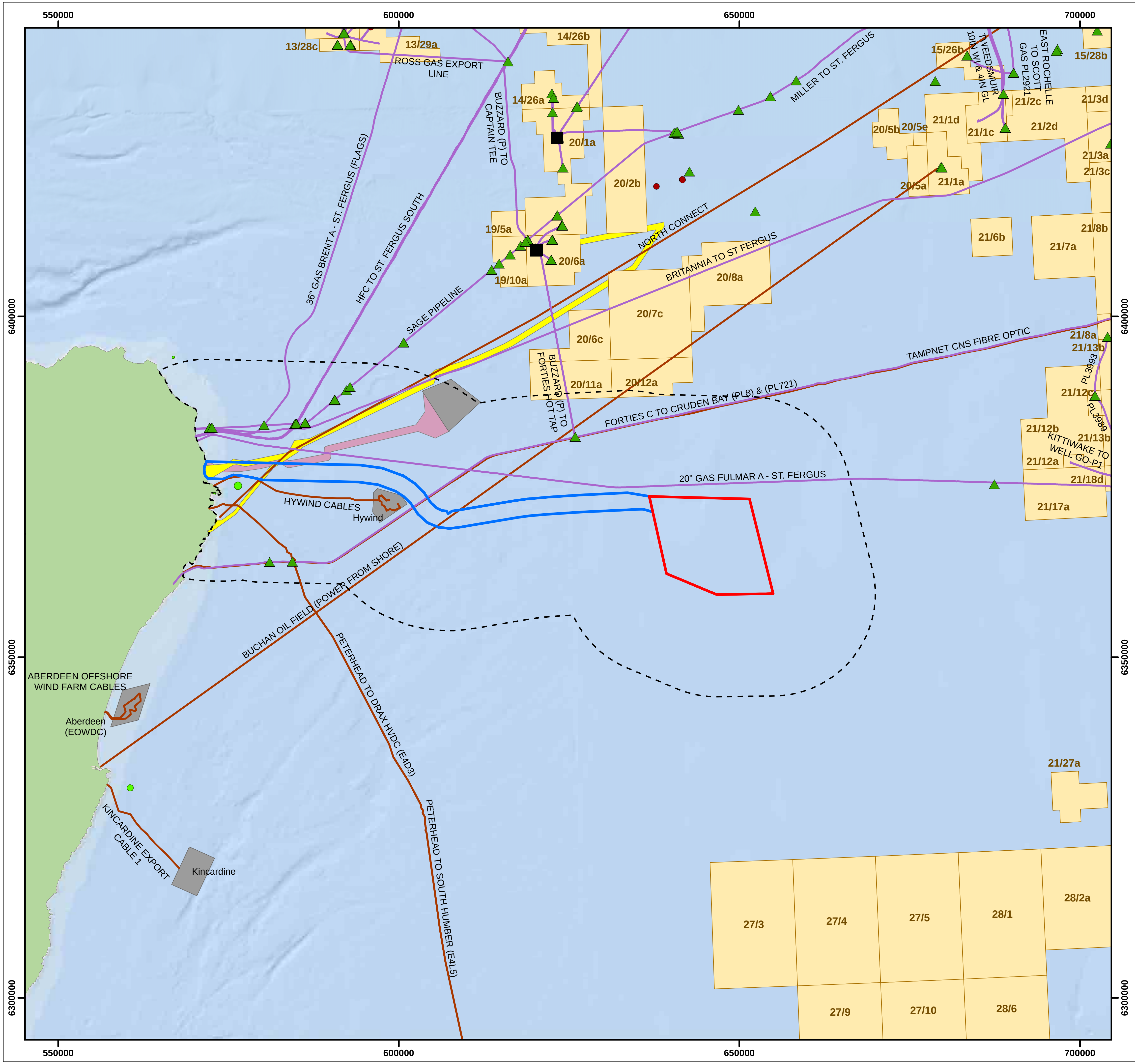
9.9.3. Volume 1, Chapter 6 (EIA Methodology) and Volume 3, Appendix 6.2 (Offshore Cumulative Effects) details how potential cumulative effects will be assessed for the Proposed Development through a CEA. A CEA screening process has identified the relevant other plans, projects, and activities which are to be included in the assessment within a 15 km screening range surrounding both the Array Area and ECC. This area encompasses the combined extent of potential impacts to benthic and intertidal ecology from the Proposed Development and also any regional project likely to contribute in-combination effects. Those plans/projects relevant to the CEA for benthic subtidal and intertidal ecology are indicated in Table 9-37 and shown in Figure 9-8. For each of these relevant plans/projects, the most up-to-date publicly available project parameters have been used to inform the CEA.

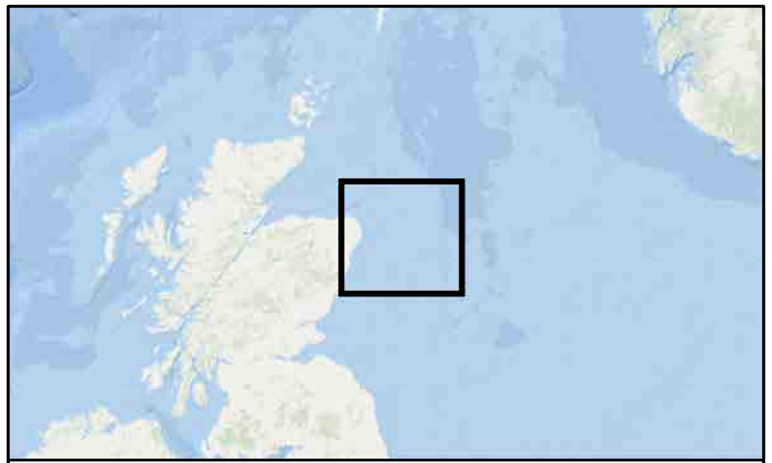
9.9.4. The benthic subtidal and intertidal ecology study areas for the CEA are defined by the wider 15 km buffer surrounding the boundary of the Proposed Development, to incorporate maximum distance suspended sediments will travel in one tidal cycle and therefore the indirect impacts on benthic subtidal ecology arising from the Proposed Development that could interact cumulatively with impacts from other plans or projects (Figure 9-8).

9.9.5. These other plans or projects may present different levels of potential cumulative effect when combined with the Proposed Development, informed by other plan/project's readiness and likelihood for actual operation. A tiered approach to the CEA is therefore applied here, allowing weighted assessment of cumulative effects. The cumulative effects are categorised as follows:

- **Tier 1** – The whole project (both onshore and offshore elements), combined with plans/projects which have become operational since the baseline characterisation of the Project, operational projects that have an ongoing impact, plus those that are consented and are yet to be constructed or under construction;
- **Tier 2** – All plans/projects assessed under Tier 1, plus those projects that have submitted a Scoping Report or those pending determination following a submitted application; and
- **Tier 3** – All plans/projects assessed under Tier 2, plus those projects that are not currently in the planning system but are likely to enter the planning system in the near future (e.g., Agreement for Lease (AfL) or projects at feasibility / early design stages) where information is available to inform the cumulative assessment and there is sufficient data confidence.

9.9.6. This CEA for benthic subtidal and intertidal ecology will consider the worst-case design scenario for each of the project's, plans and activities in line with the methodology outlined in Volume 1, Chapter 6 (EIA Methodology). For LSE on benthic receptors, planned projects were screened into the assessment based on a screening range that encapsulates the benthic subtidal and intertidal ecology study areas and the secondary ZoI, which has been defined based on the expected maximum distance that sediment within the Proposed Development might be transported on a single mean spring tide, in the flood and/or ebb direction (15 km).





Legend:

- Array Area
- Offshore Export Cable Corridor
- 15km Cumulative Study Area
- Offshore Wind Farm Sites
- Green Volt Consented Offshore ECC
- Salamander Application Offshore ECC
- Open Disposal Sites
- Oil and Gas Licensed Blocks
- Active Oil and Gas Platforms
- Active, Proposed and Precommissioned Oil and Gas Pipelines
- Active and Proposed Subsea Cables
- Completed, Drilling and Plugged Wells
- Active, Proposed and Precommissioned Subsea Structures

Project:	Report:
Muir Mhòr	Environmental Impact Assessment Report

Projects Screened into the Cumulative Effects Assessment for Benthic Subtidal and Intertidal Ecology

Figure:	9-8	Drawing No:	GoBe-0135

Revision:	Date:	Drawn:	Checked:
01	14/11/24	EV	BPHB

Map scale 1:550,000 @ A3 — 0 10 20 km

Co-ordinate system: ETRS 1989 UTM Zone 30N **EPSG:** 25830

MUIR MHÒR OFFSHORE WIND FARM

A joint venture between Fred. Olsen Seawind & Vattenfall

Service Layer Credits: Esri, Garmin, GEBCO, NOAA NGDC, and other contributors

Table 9-37 Other plans/projects relevant to the Benthic Subtidal and Intertidal Ecology CEA

Plan/Project	Summary	Status	Distance from Array Area (km)	Distance from ECC (km)	Construction dates (if relevant)	Operational by (if relevant)	Summary of interaction with Proposed Development
Tier 1							
North Buchan Ness	Disposal site	O&M	59.85	0.98	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Peterhead Harbour (CR071)	Disposal site	O&M	63.68	1.13	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Fraserburgh (CR060	Disposal site	O&M	72.62	13.52	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
20” Gas Fulmar A – St. Fergus (PL208)	Pipeline	O&M	1.46	0.45	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
PL2074 FHT Spool	Pipeline	O&M	13.95	7.11	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Buzzard (P) to Forties Hot Tap (PL2074)	Pipeline	O&M	13.96	7.17	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Britannia to St Fergus	Pipeline	O&M	27.69	2.66	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Peterhead to Drax High Voltage Direct Current (HVDC) (E4D3)	Cable	Construction	47.69	0.00	2024	2025	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Peterhead to South Humber (E4L5)	Cable	Construction	47.70	3.70	2024-2028	2029	O&M phase interacts with the construction and O&M phases of the Proposed Development.
32 IN MCP01 Bypass Bundle to St Fergus Gas Plant (PL6S)	Pipeline	O&M	50.03	1.58	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
HFC to St Fergus South (PL7S)	Cable	O&M	50.10	1.60	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
36” Gas Brent A – St Fergus (Flags) (PL002)	Pipeline	O&M	55.14	1.72	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Hywind OWF	Offshore Energy	O&M	35.56	0.06	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Hywind ECC	Power Cables	O&M	36.61	0.00	N/A	N/A	O&M phase interacts with the construction and O&M phases of the Proposed Development.
Green Volt ECC	Power Cables	Consented - Not constructed	29.40	0.00	2025 to 2027	2028	Operational phase interacts with construction phase of Proposed Development.
Tier 2							
Salamander Offshore Windfarm	Offshore Energy	Awaiting determination	28.37	9.10	2028-2030	2031	Construction phase interacts with the construction phase of the Proposed

Plan/Project	Summary	Status	Distance from Array Area (km)	Distance from ECC (km)	Construction dates (if relevant)	Operational by (if relevant)	Summary of interaction with Proposed Development
							Development. O&M phase interacts with the construction and O&M phases of the Proposed Development.
Salamander ECC	Power Cables	Application submitted	30.88	0.00	2026 to 2030	2031	Construction phase interacts with the construction phase of the Proposed Development.
Tier 3 – No projects identified within the 15 km screening range.							

9.9.7. Certain impacts assessed for the Proposed Development alone are not considered in the cumulative assessment due to:

- The highly localised nature of the impacts (i.e., the occur entirely within the Proposed Development boundary only);
- Management measures in place for the Proposed Development will also be in place on other projects reducing the risk of impact occurring; and/or
- Where the LSE from the Proposed Development alone has been assessed as negligible.

9.9.8. Therefore, the CEA has only considered the temporary increase in SSC and sediment deposition during construction and decommissioning. The magnitude of temporary habitat disturbance from jack-up and maintenance activities related to the Proposed Development on benthic subtidal receptors is considered to be low as it is very localised and has therefore not been included in this CEA as an O&M impact. The cumulative worst-case design scenario described in Table 9-38 has selected those that have the potential to result in the greatest cumulative effect on an identified receptor group. The cumulative impacts presented assessed in this Section have been selected from the details provided in Volume 1, Chapter 3 (Project Description) for the Proposed Development, as well as the information available on other projects and plans in order to inform a cumulative worst-case design scenario. Effects of greater adverse significance are not predicted to arise should any other development scenario (based on details within the design envelope to that assessed here), be taken forward in the final design scheme.

WORST CASE DESIGN SCENARIO CEA

9.9.9. The benthic subtidal and intertidal ecology CEA has been undertaken with respect to the details provided in Volume 1, Chapter 3 (Project Description). A 'worst case' design scenario has been selected for each cumulative impact which would lead to the greatest impact for all receptors or receptor groups, when selected from a range of values. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within Volume 1, Chapter 3 (Project Description) (e.g., different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

9.9.10. Table 9-38 presents the worst-case design scenario for each cumulative impact associated with the benthic subtidal and intertidal ecology CEA**,** along with justification.

Table 9-38 Worst Case Design Scenarios with respect to the Benthic Subtidal and Intertidal Ecology CEA

Cumulative Effects	Tier	Worst Case Design Scenario
Construction, Operation and Maintenance and Decommissioning		
Cumulative temporary increase in SSC and sediment deposition	**Tier 1:** • Operation of North Buchan Ness disposal site • Operation of Peterhead Harbour disposal site • Operation of Fraserburgh (CR060) disposal site • Construction/ Operation of Green Volt ECC • Operation of Hywind OWF and ECC **Tier 2:** • Construction/ Operation of Salamander OWF and ECC	If construction or intermittent O&M activities overlap temporally with either the construction or O&M of the Proposed Development, there is potential for cumulative SSC and sediment deposition to occur within the wider benthic subtidal ecology study area.

CONSTRUCTION CEA

CUMULATIVE TEMPORARY INCREASES IN SSC AND ASSOCIATED DEPOSITION

9.9.11. Due to uncertainty associated with the exact timing of other projects and activities, there is insufficient data on which to undertake a quantitative or semi-quantitative assessment. As such, the discussion presented here is qualitative. It is considered highly unlikely that each of the identified projects would be undertaking major maintenance works, in particular asset reburial or repairs, as these are infrequent occurrences during the lifetime of developments.

TIER 1

MAGNITUDE OF CUMULATIVE IMPACT

9.9.12. North Buchan Ness, Peterhead Harbour, and Fraserburgh disposal are located approximately 0.98 km, 1.13 km, and 0.98 km from the Proposed Development offshore ECC, respectively (Table 9-37; Figure 9-8). On the basis of sediment plume modelling presented in Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report) and Volume 3, Appendix 7.2 (Marine Processes Modelling Report), it can reasonably be assumed that sediment plumes may be advected this distance from the Proposed Development infrastructure. This means that, should construction activities associated with the Proposed Development be occurring at the same time as aggregate extraction, there could be the potential for cumulative changes in SSC and bed levels. According to figures provided by British Marine Aggregate Producers Association (BMAPA) for the last five years, dredging intensity within these areas primarily ranges from low (<15 minutes) to medium (15 minutes to 75 minutes), with only a small proportion dredged at a high intensity (>75 minutes).

9.9.13. O&M activities of the Hywind OWF and ECC could contribute to potential cumulative changes in SSC and sediment deposition. The Hywind OWF EIAR considered SSC and deposition as an integral part of the assessment of temporary habitat disturbance, concluding that increased temporary habitat disturbance (including SSC and sediment deposition) would be localised, occurring predominantly within the array area and offshore ECC. The Hywind OWF EIAR concluded that the impacts related to temporary habitat disturbance (including SSC and sediment deposition) were expected to be of minor magnitude and not significant (Hywind, 2015).

9.9.14. The Green Volt OWF ECC overlaps with that of the Proposed Development (0.0 km). The Green Volt OWF EIAR concluded that impacts from increased SSC and sediment deposition arising from construction activities are expected to be of low magnitude, with any increase in SSC and sedimentation unlikely to be significant or sustained for long periods, being likely to remain within the natural variability of the system (Green Volt, 2022). The EIAR did not assess the potential for impacts from maintenance works in the ECC, however any impacts from intermittent maintenance works, are considered to be significantly less than those assessed for the construction phase of the development.

9.9.15. As detailed by the numerical modelling within Volume 3, Appendix 7.1 (Marine and Coastal Processes Technical Report) and Volume 3, Appendix 7.2 (Marine Processes Modelling Report), the levels of sediment dispersion associated with the Proposed Development are high. However almost all sediment plumes are indistinguishable from background levels after 20 hours. Given the short-lived nature of the sediment plumes, and the location of other infrastructure, there is not anticipated to be a notable overlap with concentrated sediment plumes created from other industry activities. Any overlap expected with aggregate dredging activities is likely to be temporary and restricted to the near field. The potential maximum magnitude of cumulative effects is assessed as low due to the short-term duration of construction, maintenance, and decommissioning activities, as well as the intermittent, localised, and temporary nature of changes in SSC and sediment deposition.

SENSITIVITY OF RECEPTORS

9.9.16. Full discussion of the sensitivity of benthic subtidal and intertidal ecology receptors to increased SSC and sediment deposition is discussed in paragraph 9.7.19 *et seq.*, which concludes that the habitats that have the potential to be indirectly affected by increased SSC and deposition within the benthic subtidal and intertidal ecology study areas have a worst-case high sensitivity to the expected levels of SSC and deposition.

SIGNIFICANCE OF CUMULATIVE EFFECT

9.9.17. The impact of cumulative temporary increases in SSC and deposition from Tier 1 projects is considered to be of low magnitude, and the maximum sensitivity of receptors affected is considered to be medium for benthic receptors. The significance of the effect is therefore concluded to be minor, which is not significant in EIA terms.

Table 9-39 Significance of Tier 1 cumulative effect

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	Medium	**Minor**

TIER 2

MAGNITUDE OF CUMULATIVE IMPACT

9.9.18. The construction phase for the Salamander OWF project overlaps with the construction phase for the Proposed Development. The Salamander OWF and ECC are located 9.1km and 0.0 km, respectively from the offshore ECC of the Proposed Development (within the secondary ZoI), and therefore there is the potential for a cumulative impact. This project is therefore screened into the assessment.

9.9.19. As detailed in the Salamander OWF EIAR, any significant sediment deposition will be limited to within the boundary of the Salamander OWF development and will likely persist over a limited temporal period (Orsted, 2024). In the far-field zone of Salamander OWF (>500 m from the disturbance event) it is predicted that there will be lesser degree of SSC increase, with no measurable thickness of deposition. SSC is predicted to decrease and disperse rapidly, returning to background SSC levels between six to 24 hours (Orsted, 2024). A low magnitude impact was therefore concluded for the construction phase of the Salamander OWF. The conclusions form the Salamander EIA were medium sensitivity and low magnitude of impact would result in an effect of Minor effect, concluding increased suspended sediments from construction activities was not significant in EIA terms (Orsted, 2024). The EIAR did not assess the potential for impacts from maintenance works in the ECC, however any impacts from intermittent maintenance works, are considered to be significantly less than those assessed for the construction phase of the development.

9.9.20. Taking this into consideration, the magnitude of impact of the potential cumulative increases in SSC and deposition, from Tier 2 projects (including Tier 1 projects) is concluded to be low i.e. the same as the Proposed Development alone.

SENSITIVITY OF RECEPTORS

9.9.21. Full discussion of the sensitivity of benthic subtidal and intertidal ecology receptors to increased SSC and sediment deposition is discussed in paragraph 9.7.19 *et seq.*, which concludes that the habitats that have the potential to be indirectly affected by increased SSC and deposition within the benthic subtidal and intertidal ecology study areas have a worst-case medium sensitivity to the expected levels of SSC and deposition.

SIGNIFICANCE OF CUMULATIVE EFFECT

9.9.22. The impact of cumulative temporary increases in SSC and deposition from Tier 2 projects is considered to be of low magnitude, and the maximum sensitivity of receptors affected is considered to be medium for benthic receptors. The significance of the effect is therefore concluded to be minor, which is not significant in EIA terms.

Table 9-40 Significance of Tier 2 Cumulative Effect

Receptor/Location	Magnitude	Sensitivity	Significance
All benthic subtidal receptors	Low	Medium	**Minor**

SECONDARY MITIGATION AND RESIDUAL EFFECT

9.9.23. No additional benthic subtidal and intertidal ecology mitigation is considered necessary because the likely cumulative effect in the absence of further mitigation (beyond the embedded commitments outlined in Section 9.6) is not significant in EIA terms.

DECOMMISSIONING CEA

9.9.24. The decommissioning phase is expected to involve similar activities as the construction phase. Therefore, any cumulative effects arising from the decommissioning process are anticipated to be comparable or even lesser in significance that the cumulative effects assessed for the construction phase. Consequently, it is not anticipated that the decommissioning activities would result in significant adverse effects on benthic receptors when considering the potential for cumulative effects.

PROPOSED MONITORING FOR CUMULATIVE EFFECTS

9.9.25. No benthic subtidal and intertidal ecology monitoring is proposed to test the predictions made within the assessment of cumulative effects on benthic subtidal and intertidal ecology receptors as no likely significant effects were predicted during construction, O&M and decommissioning phases of the Proposed Development.

9.10. TRANSBOUNDARY EFFECTS

9.10.1. Transboundary effects are defined as those effects upon the receiving environment of other European Economic Area (EEA) states, whether occurring from the Proposed Development alone, or cumulatively with other projects in the wider area. A screening of potential transboundary effects was undertaken at Scoping which identified that there was no LSE to occur in relation to benthic subtidal and intertidal ecology.

9.10.2. Transboundary impacts related to benthic subtidal and intertidal ecology are not anticipated to arise from construction, O&M or decommissioning stages of the Proposed Development. Any impacts on benthic subtidal and intertidal ecology receptors will be localised in nature and any indirect effects will likely be limited to one tidal excursion from the impact source. The Proposed Development is a significant distance from the nearest adjacent exclusive economic zone (EEZ) of another state and, therefore, it is considered that transboundary impacts will not occur and will therefore be scoped out from further consideration within the EIA, a decision agreed to by The Scottish Ministers in their response to Scoping Report (as noted in Table 9-3).

9.11. INTER-RELATED EFFECTS

9.11.1. Inter-related effects may occur due to multiple impacts on a receptor or a group of receptors from the Proposed Development. This includes the following:

- **Proposed Development Lifecycle Effects** - Interactions between impacts across different phases of the Proposed Development i.e., interaction of impacts across construction, operation and maintenance and decommissioning; and
- **Inter-related Receptor Effects** - Interactions between impacts on a receptor or group of receptors within an offshore Project stage (Inter-related Receptor Effects).

9.11.2. Proposed Development Lifecycle and Receptor led inter-related effects from benthic subtidal and intertidal ecology are presented in Table 9-41.

9.11.3. An assessment of ecosystem level effects for the Proposed Development is provided in Volume 3, Appendix 6.4 (Ecosystem Level Effects).

Table 9-41 Inter-related effects of Benthic Subtidal and Intertidal Ecology

Impact	Significant Inter-Related Effects
Project lifecycle effects	
Temporary habitat loss across all three project phases	When habitat loss or disturbance is considered additively across all phases, although the total area of habitat affected is larger, the habitats affected are typically widespread. Furthermore, all benthic habitats are predicted to recover to the baseline condition within two to ten years. Therefore, across the Proposed Development lifetime, the effects on benthic ecology receptors are not anticipated to in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase. There will therefore be no inter-related effects of greater significance compared to the impacts considered alone.
Indirect impacts to benthic ecology because of the temporary increase in SSC and sediment deposition	The majority of the seabed disturbance (resulting in the highest SSC and sediment deposition) will occur during the construction and decommissioning phases, with any effects being short-lived. Due to this, and the recoverability of the species and habitats affected, the interaction of these impacts across all stages of the development is not predicted to result in an effect of any greater significance than those assessed in the individual project phases.

Impact	Significant Inter-Related Effects
Receptor Led Effects	
There is the potential for spatial and temporal interactions between the effects arising from habitat loss/disturbance and increased SSC and sediment deposition during the Proposed Development lifetime. The greatest potential for inter-related effects is predicted to occur through the interaction of both temporary and permanent habitat loss/disturbance from foundation installation/jack-up vessels/anchor placement/scour, indirect habitat disturbance due to sediment deposition and indirect effects of changes in physical processes due the presence of infrastructure in the operational wind farm. With respect to this interaction, these individual impacts were assigned a significance of negligible to minor adverse significance as standalone impacts and although potential combined impacts may arise (i.e., spatial and temporal overlap of direct habitat disturbance), it is predicted that this will not be any more significant than the individual impacts in isolation. This is because the combined amount of habitat potentially affected would be very limited and where temporary disturbance occurs, full recovery of the benthos is predicted. In addition, any effects due to changes in the physical processes are likely to be limited, both in extent and in magnitude, with receptors having low sensitivity to the scale of changes predicted. As such, these interactions are predicted to be no greater in significance than that for the individual effects assessed in isolation.	

9.11.4. Overall, the inter-related assessment for the Proposed Development does not identify any significant inter-related effects that were not already covered by the topic-specific assessment set out in the preceding Chapters. However, certain individual effects were identified that did interact with each other whilst not leading to any greater significance of effect.

9.12. ASSESSMENT SUMMARY

9.12.1. A summary of the findings of the effects and cumulative effects assessments undertaken in Section 9.7and Section 9.9 is given in Table 9-42 and Table 9-43, respectively. This includes residual effect significance after any required secondary mitigation and proposed monitoring.

Table 9-42 Summary of assessment of effects on Benthic Subtidal and Intertidal Ecology (magnitude and sensitivity represents the worst-case summary for all receptors grouped, for each effect)

Effect	Receptor	Magnitude of Impact	Receptor Sensitivity	Effect Significance	Secondary Mitigation	Residual Effect	Proposed Monitoring
Construction							
Impact 1: Increases in SSCs and changes to seabed levels.	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
	All benthic intertidal receptors	Low	Medium	Minor	None	No significant residual effect	None
Impact 2: Temporary habitat disturbance	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
Impact 3: Direct and indirect seabed disturbance leading to release of sediment contaminants	All benthic subtidal receptors	Negligible	High	Negligible	None	No significant residual effect	None
Operation and Maintenance							
Impact 4: Permanent and/or long-term habitat loss/alteration due to the addition of infrastructure to the area	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
Impact 5: Temporary habitat disturbance	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
Impact 6: Colonisation of hard substrates	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
Impact 7: Risk of introductions and/ or spreading of INNS particularly due to presence of infrastructure and vessel movements (e.g., ballast water) which may affect benthic ecology and biodiversity.	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
Impact 8: Indirect effects on benthic ecology from EMF effects generated by dynamic cables and buried cables.	All benthic subtidal receptors	Negligible	Low	Negligible	None	No significant residual effect	None
Impact 9: Changes in physical processes resulting from the presence of subsea infrastructure e.g., scour effects, changes in wave/ tidal current regimes and resulting	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None

Effect	Receptor	Magnitude of Impact	Receptor Sensitivity	Effect Significance	Secondary Mitigation	Residual Effect	Proposed Monitoring
effects on sediment transport							
Decommissioning							
Impact 10: Increases in SSCs and changes to seabed levels.	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
	All benthic intertidal receptors	Low	Medium	Minor	None	No significant residual effect	None
Impact 11: Temporary habitat disturbance	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None
Impact 12: Direct and indirect seabed disturbance leading to release of sediment contaminants	All benthic subtidal receptors	Negligible	High	Negligible	None	No significant residual effect	None
Impact 13: Removal of hard substrate during decommissioning	All benthic subtidal receptors	Low	High	Minor	None	No significant residual effect	None

Table 9-43 Summary of Assessment of Cumulative Effects on Benthic Subtidal and Intertidal Ecology (magnitude and sensitivity represents the worst-case for all benthic receptors grouped)

Effect	CEA Tier	Receptor	Magnitude of Cumulative Impact	Receptor Sensitivity	Cumulative Effect Significance	Secondary Mitigation	Residual Cumulative Effect	Proposed Monitoring
Construction								
Temporary increases in SSC and associated deposition	Tier 1 and 2	All benthic subtidal receptors	Low	Medium	Minor	None	No significant residual effect	None

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