Code: UKCAL-CWF-CON-EIA-RPT-00003-3004

Volume 3 Caledonia North

Chapter 4 Benthic Subtidal and Intertidal Ecology

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Code	UKCAL-CWF-CON-EIA-RPT-00003-3004
Revision	Issued
Date	18 October 2024

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Acronyms and Abbreviations

B-field	Magnetic Field
BOWL	Beatrice Offshore Wind Farm Ltd
CaP	Cable Plan
CBRA	Cable Burial Risk Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute for Ecology and Environmental Management
CPS	Cable Protection System
CTV	Crew Transfer Vessel
DBT	Dibutyltin
DE	Design Envelope
DP	Decommissioning Plan
EAC	Environmental Assessment Criteria
eDNA	Environmental DNA
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
E-field	Electric Field
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EMF	Electromagnetic Field
EMP	Environmental Monitoring Plan
ERL	Effects Range Low

ERM	Effects Range Median
EUNIS	European Nature Information Systems
FEGQ	Federal Environmental Quality Guidelines
FOCI	Feature of Conservation Interest
GES	Good Environmental Status
HDD	Horizontal Directional Drilling
HRA	Habitats Regulations Appraisal
HVDC	High Voltage Direct Current
iE-field	Induced Electric Field
IMO	International Maritime Organization
INNS	Invasive Non-Native Species
JNCC	Joint Nature Conservation Committee
JUV	Jack-Up Vessel
LAT	Lowest Astronomical Tide
LOD	Limit of Detection
MarESA	Marine Evidence-based Sensitivity Assessment
MarLIN	Marine Life Information Network
MCCIP	Marine Climate Change Impacts Partnership
MD-LOT	Marine Directorate - Licensing Operations Team
MFE	Max Flow Excavation
MHWS	Mean High Water Springs
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MSFD	Marine Strategy Framework Directive

NERC	Natural Environmental and Rural Communities
NMP	National Marine Plan
NPF	National Planning Framework
OCP	Organochloropesticide
OECC	Offshore Export Cable Corridor
OESEA3	Offshore Energy Strategic Environmental Assessment 3
OSP	Offshore Substation Platform
OSPAR	Convention for the Protection of the Marine Environment of the North East Atlantic
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbon
PBDE	Polybrominated Diphenyl Ether
PCB	Polychlorinated Biphenyl
PMF	Priority Marine Feature
PMSL	Precision Marine Survey Limited
PSA	Particle Size Analysis
SAC	Special Area of Conservation
SBL	Scottish Biodiversity List
SNH	Scottish Natural Heritage
SSC	Suspended Sediment Concentration
SSS	Subsurface Scattering
SSSI	Site of Special Scientific Interest
TBT	Tributytin
TOC	Total Organic Carbon

TSHD	Trailer Suction Hopper Dredger
UK BAP	United Kingdom Biodiversity Action Plan
VER	Valued Ecological Receptor
WCA	Wildlife and Countryside Act
WCS	Worst-case Scenario
WTG	Wind Turbine Generator
ZoI	Zone of Influence

Executive Summary

This Benthic Subtidal and Intertidal Ecology Chapter of the Caledonia Offshore Wind Farm (OWF) Environmental Impact Assessment Report presents an overview of the existing benthic ecology characteristics and identifies the potential effects on these receptors associated with the construction, operation and decommissioning of Caledonia North seaward of Mean High Water Spring. Further consideration of the overlap of receptors between onshore and offshore environments within the intertidal zone (i.e., between Mean High Water Springs and Mean Low Water Springs) is provided in Volume 6, Chapter 5: Intertidal Assessment.

The study area has been determined based upon Caledonia North location and proposed infrastructure, alongside spring tidal excursion data.

Site-specific surveys were undertaken to provide an up-to-date characterisation of the habitats and species occurring within the area of Caledonia North. Subtidal surveys were conducted between 19 March and 12 June 2023. In January 2022, an intertidal survey was conducted that was primarily focused on Phase I intertidal biotope mapping following the UK Marine Habitat Classification.

Caledonia North, located in water depths up to 60m below Lowest Astronomical Tide within the Moray Firth, is comprised of sands, and the presence of mobile bedforms in discreet locations indicating an active sediment transport regime. The rocky habitats in the vicinity of the Stake Ness Landfall Site are characterised by a structurally complex combination of bedrock, boulder and angular bedrock ridges and gullies.

The following valued ecological receptors were recorded across the Caledonia North Site (i.e., Array Area) and Caledonia North Offshore Export Cable Corridor:

- Coarse and mixed sediments with moderate to high infaunal diversity and epibenthic communities;
- Sandy sediments with low infaunal diversity and sparse epibenthic communities;
- Burrowed mud communities;
- Kelp and red seaweeds communities;
- Rockpools communities;
- Fucoids on sheltered marine shore communities;
- Barnacles and fucoids on moderately exposed shore communities;
- Lichens or small green algae on supralittoral and littoral fringe rock communities;
- Mussel and/or barnacle communities;
- Robust fucoid and/or red seaweed communities;
- Littoral coarse sediment communities;
- *Arctica islandica*; and
- *Devonia perrieri*.

Consideration of the Design Envelope has been undertaken to identify the Worst-case Scenario with respect to benthic ecology. Adopting a source-pathway-receptor approach, the potential impacts associated with Caledonia North have been assessed, in accordance with the Scoping Opinion and subsequent stakeholder engagement, using a suite of methodologies which include numerical modelling, the evidence-base and expert judgement. Receptors identified include both designated sites with qualifying benthic ecology features and non-designated sites. Specifically, the following impacts have been considered:

- Temporary habitat disturbance;
- Temporary increases in Suspended Sediment Concentrations (SSCs) and changes to seabed levels;
- Direct and indirect seabed disturbance leading to release of sediment contaminants;
- Long-term habitat loss/alteration due to the addition of infrastructure to the area;
- Colonisation of hard substrates;
- Increased risk of introduction and/or spread of Invasive Non-Native Species;
- Changes in physical processes resulting from the presence of the OWF subsea; infrastructure (e.g., scour effects, changes in wave/tidal current regimes and resulting effects on sediment transport);
- EMF effects generated by inter-array, interconnector and export cables;
- Seabed sediment heating from subsea cables;
- Long-term habitat loss/alteration due to the removal of infrastructure; and
- Cumulative temporary increases in SSCs and changes to seabed levels

The results of this impact assessment demonstrate that Caledonia North is likely to have a negligible to minor significance, which is considered not significant in Environmental Impact Assessment terms.

4 Benthic Subtidal and Intertidal Ecology

4.1 Introduction

4.1.1.1 This chapter of the Environmental Impact Assessment Report (EIAR) identifies the potential effects on Benthic Subtidal and Intertidal Ecology associated with the construction, operation and maintenance (O&M) and decommissioning of the Caledonia Offshore Wind Farm (OWF), specifically Caledonia North. This includes the Caledonia North Site (Array Area) as well as the Caledonia North Offshore Export Cable Corridor (OECC) seaward of Mean High Water Spring (MHWS), hereby referred to as Caledonia North.

4.1.1.2 Table 4–1: below provides a list of supporting studies which relate to and should be read in conjunction with the benthic ecology impact assessment. All supporting studies are appended to this EIAR.

Table 4–1: Supporting studies.

Details of Study	Locations of Supporting Study
Caledonia Offshore Wind Farm Phase 2 Array Area Environmental Baseline Report	Volume 7B, Appendix 4-1: Environmental Baseline Report (Array Area)
Caledonia Offshore Wind Farm Phase 2 Export Cable Route Environmental Baseline Report	Volume 7B, Appendix 4-2: Environmental Baseline Report (Offshore Export Cable Corridor)
Caledonia Offshore Wind Farm Phase 2 Array Area Habitat Assessment Report	Volume 7B, Appendix 4-3: Habitat Assessment Report (Array Area)
Caledonia Offshore Wind Farm Phase 2 Export Cable Route Habitat Assessment Report	Volume 7B, Appendix 4-4: Habitat Assessment Report (Offshore Export Cable Corridor)
Caledonia Offshore Wind Farm Intertidal Survey Report	Volume 7B, Appendix 4-5: Intertidal Survey Report
Caledonia Offshore Wind Farm Reconnaissance Geophysical Survey	Volume 7B, Appendix 4-6: Reconnaissance Geophysical Survey Interpretation Report

4.1.1.3 The impact assessment presented herein draws upon information presented within other impact assessments within this EIAR, including:

- Volume 3, Chapter 2: Marine and Coastal Processes, which assesses the impacts associated with the suspension of sediments;

- Volume 3, Chapter 3: Marine Water and Sediment Quality, which assesses the impacts associated with the release of sediment bound contaminants; and,
- Volume 3, Chapter 5: Fish and Shellfish Ecology, which assesses the impacts on fish and shellfish, including species dependent on the benthic environment.

4.1.1.4 Equally, this benthic subtidal and intertidal ecology also informs other impact assessments. The interaction between the impacts assessed within different topic-specific chapters on a receptor is defined as an 'inter-relationship'. For ecological topics, inter-relationships form the basis of understanding for wider ecosystems impacts, which are considered throughout this assessment. Indirect effects as a result of changes in benthic habitats or species that would affect prey availability for fish and shellfish, offshore ornithology and marine mammals are discussed in:

- Volume 3, Chapter 5: Fish and Shellfish Ecology;
- Volume 3, Chapter 6: Offshore Ornithology; and
- Volume 3, Chapter 7: Marine Mammals.

4.1.1.5 Further consideration of the overlap of receptors between onshore and offshore environments within the intertidal zone (i.e., between MHWS and Mean Low Water Springs) is provided in Volume 6, Chapter 5: Intertidal Assessment. Additionally, the impacts on benthic and subtidal ecology as features of protected sites has been assessed within Application Document 9: Marine Protected Area (MPA) Assessment.

4.2 Legislation, Policy and Guidance

4.2.1.1 Volume 1, Chapter 2: Legislation and Policy of this EIAR sets out the policy and legislation associated with Caledonia North.

4.2.1.2 Legislation, policy and guidance that related to the benthic subtidal and intertidal ecology assessment are identified and described in Table 4–2:.

Table 4–2: Legislation, policy and guidance relevant to benthic subtidal and intertidal ecology.

Relevant Legislation, Policy and Guidance	Description
Legislation	
EU Habitats Directive (Directive 92/43/EEC) (The Council of the European Committees, 1992[1]) and associated Habitats Regulations: 1) The Conservation of Habitats and Species Regulations 2017 (as amended) (UK Parliament, 2017a[2]) 2) The Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) (UK Parliament, 2017b[3]) 3) The Conservation (Natural Habitats &C.) Regulations 1994 (UK Parliament, 1994[4])	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. The EU Habitats Directive lists 13 marine habitats and eight marine species in Annexes I and II respectively. Special Areas of Conservation (SACs) have been designated in UK waters to meet the requirements outlined in Article 3 of the Directive. Of those benthic and intertidal habitats listed in Annex I of the Directive, the following have the potential to occur in the vicinity of Caledonia North: ▪ Reefs (rocky and biogenic) 'Stony reef'; ▪ Sandbanks which are slightly covered by sea water all the time; ▪ Horse mussel (*Modiolus modiolus*) beds; and ▪ Ross worm (Sabellaria spinulosa) There are currently no designated or identified offshore SACs for the presence of benthic or intertidal habitats or species within the benthic ecology study area of Caledonia North. There is an inshore SAC located in the Moray Firth (Moray Firth SAC), this site qualified as an SAC due to the presence of sandbanks. However, this SAC does not overlap with the benthic ecology study area, potential impacts to SACs are assessed within the Habitats Regulations Appraisal (HRA). Information provided in Application Document 13.
The Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR Convention) (OSPAR Convention, 1992[5])	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. OSPAR, in 2008, compiled a catalogue of marine habitats and species facing threats or decline in the northeast Atlantic, and it is noteworthy that some of these may be present in the vicinity or have the potential to occur within Caledonia North:

Relevant Legislation, Policy and Guidance	Description
	▪ Ross worm (*S. spinulosa*) reef; ▪ Seapen and burrowing megafauna communities; ▪ Ocean quahog (*A. islandica*); and ▪ Horse mussel (*M. modiolus*). The relevant annexes to benthic ecology include Annex III: Prevention and elimination of pollution from offshore sources, Annex IV: Assessment of the quality of the marine environment, and Annex V: On the protection and conservation of the ecosystems and biological diversity of the maritime area.
Marine (Scotland) Act 2010 (Scottish Parliament, 2010[6])	The Marine (Scotland) Act 2010 provides the legislative and management framework for the marine environment within Scottish Territorial Waters (from MHWS out to 12nm). Under section 21 of the Marine (Scotland) Act 2010, Caledonia North requires a Marine Licence for marine licensable activities below MHWS. The Marine (Scotland) Act 2010 has established new powers to designate MPAs in Scottish Territorial Waters, including those for nature conservation. The Caledonia North OECC extends approximately 22km into the southern tip of the Southern Trench MPA, a Scottish Nature Conservation MPA supporting a wide diversity of marine species including minke whales and biogenic reefs formed by *S. spinulosa*. Potential impacts on this proposed MPA are therefore considered (also see Application Document 9).
Marine and Coastal Access Act 2009 (UK Parliament, 2009[7])	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 200nm). Under section 66 of the Marine and Coastal Access Act 2009 (in the context of the Scottish Offshore Region), Caledonia North requires a Marine License for the marine licensable activities beyond 12nm. The Marine and Coastal Act 2009 sets out new powers for the UK Government to designate MPAs in UK offshore waters, within which there are provisions for the Scottish Ministers to designate MPAs in offshore waters adjacent to Scotland. The Caledonia North OECC extends approximately 22km into the southern tip of the Southern Trench MPA, a Scottish Nature Conservation MPA supporting a wide diversity of marine species including minke whales and biogenic reefs formed by *S. spinulosa*. Potential impacts on this proposed MPA are therefore considered (also see Application Document 9).

Relevant Legislation, Policy and Guidance	Description
The Wildlife and Countryside Act (WCA) 1981 (as amended) (UK Parliament, 1981[8])	While the WCA primarily addresses land-based conservation, its provisions can extend to offshore areas, particularly where activities such as offshore wind energy development may impact protected species, habitats, or designated sites. Developers must ensure compliance with the Act and associated regulations to minimise environmental harm and adhere to conservation objectives. The WCA prohibits the release of any animal species that are "not ordinarily resident in and is not a regular visitor to Great Britain in a wild state". It prohibits the establishment of non-native plant species. The act also gives protection to native species, controls the release of non-native species, enhances the protection of Sites of Special Scientific Interest (SSSI). The law on non-native species is covered by the Wildlife and Countryside Act 1981. This document will consider the WCA regulations on non-native species.
The Marine Strategy Framework Directive (2008/56/EC) (MSFD) adopted in July 2008 (The Council of the European Committees, 2008[9])	The overarching goal of the Directive is to achieve 'Good Environmental Status' (GES) by 2020 across Europe's marine environment. To this end, Annex I of the Directive identifies 11 high level qualitative descriptors for determining GES. In the interests of avoiding repetition these are not repeated, and instead those descriptors that are considered to be relevant to the benthic and intertidal ecology assessment for Caledonia North are listed in Table 4–12. As detailed within the supporting text these receptors have been taken through to the assessment (Section 4.7).
Policy	
Scottish National Marine Plan (NMP) (Scottish Government, 2015[10])	Sets out policies and objectives requiring marine planners and decision-makers to consider the potential impacts of development on benthic ecology and is useful to identify some of the key concerns and issues that should be addressed in any impact assessment. Policies under General Polices GEN 9 and GEN 10 are considered relevant to benthic ecology. ▪ This plan covers the management of both Scottish inshore waters (out to 12nm) and offshore waters (12 to 20nm). ▪ GEN 9 Natural heritage: 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.

Relevant Legislation, Policy and Guidance	Description
	GEN 10 Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.
National Planning Framework 4 (NPF4) (Scottish Government, 2023[11])	National Planning Framework 4 (NPF4) serves as Scotland's overarching spatial strategy, outlining our spatial principles, regional priorities, national developments, and planning policies. It should be comprehensively reviewed and replaces both NPF3 and Scottish Planning Policy. NPF4 is taken into consideration in this EIAR in terms of the biodiversity policies (Policy 3).
Sectoral Marine Plan for Offshore Wind Energy (Scottish Government, 2020[12])	Seeks to pinpoint sustainable planning possibilities for future commercial-scale offshore wind energy development in Scotland, encompassing deep-water wind technologies, and spanning both Scottish inshore and offshore waters. The Strategic Environmental Assessment and the HRA of the Sectoral Marine Plan identifies site 'NE4' as an important foraging area for seabirds including kittiwake and razorbill from multiple Special Protection Areas (SPAs). The benthic subtidal and intertidal ecology study area has been based on the maximum tidal excursion to encompass all potential indirect effects through changes in physical processes. Consequently, the study area includes a 10km buffer outside of Caledonia North in order to assess the potential impacts on benthic habitats outside the boundary of Caledonia North. This aims to mitigate any impacts on important prey species for seabirds, including those in NE4.
Guidance	
Scottish Priority Marine Features (PMFs) (Scottish Government, 2014[13])	NatureScot and the JNCC collaborated with Marine Scotland to establish a Priority Marine Features (PMFs) list, which identifies crucial marine habitats and species in Scotland's seas. It functions as a focused roadmap for future conservation endeavours in Scotland (Tyler-Walters *et al*., 2016b[14]). Within this compilation, the subsequent benthic and intertidal species and habitats have either been previously documented in the surrounding area or have the potential to exist within Caledonia North. The Scoping Opinion received from NatureScot made specific reference to consideration of PMFs that could be present within Caledonia North: ▪ Burrowed mud (Seapen and burrowing megafauna communities); ▪ Offshore deep-sea muds;

Relevant Legislation, Policy and Guidance	Description
	▪ Kelp and seaweed communities on sublittoral sediment; ▪ Offshore subtidal sands and gravels; ▪ Ocean quahog *A. islandica*; and ▪ Sandeels (*Ammodytes marinus* and *Ammodytes tobianus*) (which is assessed in detail within Volume 3, Chapter 5: Fish and Shellfish Ecology).
United Kingdom Biodiversity Action Plan (UK BAP) (UK Government, 1994[15])	UK BAP is a comprehensive strategy aimed at conserving and enhancing biodiversity across the UK. It is a collaborative effort involving governments, non-governmental organisations, businesses, and the public to address the decline of biodiversity and promote sustainable practices. The Scottish Biodiversity List (Scottish Biodiversity List | NatureScot, n.d.) comprises animals, plants, and habitats that Scottish Ministers deem to be of primary significance for biodiversity conservation in Scotland. The main UK BAP priority habitats from this list which have potential to occur within Caledonia North are: ▪ Subtidal sands and gravels (Annex I; UK BAP Species) ▪ Horse mussel *M. modiolus* beds (EC Habitats Directive Annex I, Habitat feature of conservation importance (FOCI), OSPAR Threatened and/ or declining Habitat) [unlikely in survey area] ▪ Lesser sandeel (*A. marinus*) (Species FOCI) ▪ Atlantic herring (*Clupea harengus*) spawning grounds ▪ Stony reef (EC Habitats Directive Annex I) Ross worm *S. spinulosa* (Annex I; UK BAP Species; Rare habitat)
Scottish Biodiversity Strategy 2045 (Scottish Government, 2022[16])	This roadmap delineates the essential tasks required to achieve the international Aichi Targets for biodiversity and enhance the condition of nature in Scotland. A comprehensive assessment of the potential impacts of this development on marine habitats has been undertaken in Section 4.7. No significant effects were concluded on sensitive marine habitats and therefore the health, condition, and resilience of benthic ecology features will not be compromised by the development of Caledonia North.
Joint Nature Conservation Committee (JNCC), Marine	This handbook provides legislative background for monitoring of SACs and includes advice on monitoring programmes for Annex I habitats and Annex II species.

Relevant Legislation, Policy and Guidance	Description
Monitoring Handbook, (Davies, 2001[17])	Of those benthic and intertidal habitats listed in Annex I of the Directive, the following have the potential to occur in the vicinity of Caledonia North: ▪ Reefs (rocky and biogenic) 'Stony reef'; ▪ Sandbanks which are slightly covered by sea water all the time; ▪ Horse mussel (*M. modiolus*) beds; ▪ Ross worm (*S. spinulosa*) There are currently no designated or identified offshore SACs for the presence of benthic or intertidal habitats or species within the benthic ecology study area of Caledonia North. There is an inshore SAC located in the Moray Firth (Moray Firth SAC), this site qualified as an SAC due to the presence of sandbanks. However, this SAC does not overlap with the benthic ecology study area, potential impacts to SACs are assessed within the Habitats Regulations Appraisal (HRA). Information provided in Application Document 13.
Marine Scotland, Consenting and Licensing Guidance: For Offshore Wind, Wave and Tidal Energy Applications (Scottish Government, 2018a[18]).	This document provides guidance on applying for consents and marine licences for offshore renewable energy projects within both Scottish Territorial Waters (out to 12nm) and Scottish Offshore Waters (12-200nm). It updates and replaces the draft Marine Scotland Licensing and Consents Manual published in 2013. Scottish-specific guidance has been followed in this EIAR chapter.
Guidance on non-native species, approved by the Scottish Parliament (Scottish Government, 2012[19]).	This guidance provides information on the marine invasive non-native species that could be a threat to the natural ecology of Scottish waters, what they look like and how they are spread. An assessment of the impacts of marine Invasive Non-Native Species (INNS) is provided within Section 4.7.2. Embedded mitigation and control of invasive species measures in line with International Maritime Organization (IMO) (2019[20]) have been incorporated and will be included in the Offshore Environmental Management Plan (EMP) to ensure that no significant effects will arise from INNS (Table 4–19).

4.3 Stakeholder Engagement

4.3.1 Overview

4.3.1.1 The Offshore Scoping Report (Volume 7, Appendix 2) was submitted to Marine Directorate - Licensing Operations Team (MD-LOT)[i] in September 2022, who then circulated the report to relevant consultees. A Scoping Opinion (Volume 7, Appendix 3) was received from MD-LOT on 13 January 2023.

4.3.1.2 A summary of the key issues raised during consultation to date, specific to benthic subtidal and intertidal ecology is outlined in Table 4–3 below, together with how these issues have been considered in the production of this EIA.

4.3.1.3 Further consultation has been undertaken throughout the pre-application stage. Table 4–4 summarises the consultation activities carried out relevant to benthic subtidal and intertidal ecology.

[i] In 2023, Marine Scotland was renamed Marine Directorate, and thus the marine licensing and consents team is now referred to as Marine Directorate - Licensing Operations Team (MD-LOT).

Table 4–3: Scoping opinion response.

Consultee	Comment	Response
MD-LOT	The Scottish Ministers are content with the proposed study area. Additionally, the Scottish Ministers are broadly content with the baseline data sources identified in Table 8.1 of the Scoping Report and are content with the approach to the baseline environment. In addition, and in line with the NatureScot representation, the Scottish Ministers advise that consideration should be given to the use of innovative environmental DNA sampling to complement the traditional methods planned for site-specific survey data collection.	Environmental DNA (eDNA) data has been explored as an option to compliment traditional methods; however, at present, eDNA is not very useful for capturing what species are present in the benthic environment (see Section 4.4.6). eDNA is more applicable to pelagic species and is outlined in Volume 3, Chapter 5: Fish and Shellfish Ecology.
MD-LOT	In Table 8.3 of the Scoping Report the Developer summarises the potential impacts to benthic subtidal and intertidal ecology during the different phases of Caledonia North. The Scottish Ministers broadly agree with the impacts scoped into the EIA Report but disagree with some of the impacts scoped out. The Scottish Ministers advises that increased risk of invasive non-native species, changes in physical processes, Electromagnetic Field ("EMF") effects and thermal load should be scoped into the EIA Report and the NatureScot and the Highland Council representation must be fully addressed by the Developer in this regard.	An assessment of the impacts of marine Invasive Non-Native Species (INNS) is provided within Section 4.7.2. Embedded mitigation and control of invasive species measures in line with International Maritime Organisation (IMO, 2019[20]) have been incorporated and will be included in the EMP to ensure that no significant effects will arise from INNS (Table 4–19). An assessment of changes in physical processes resulting from the presence of the offshore wind farm (OWF) subsea infrastructure on benthic species during operation is provided in Section 4.7.2. An assessment of EMF effects and thermal load generated by inter-array and export cables on benthic species during operational activities is provided in Section 4.7.2.
MD-LOT	The Scottish Ministers highlight the Aberdeenshire Council representation which advises that any impacts of the cable Landfall Site on SSSIs in the area of search from Sandend to Macduff should be considered in the EIA	Less destructive, trenchless techniques are to be utilised at the Landfall Site (which will include horizontal directional drilling (HDD)), which allow ducts to be installed under an obstruction without breaking open the

Consultee	Comment	Response
	Report. The Developer must fully address the NatureScot and Aberdeenshire Council representations in the EIA Report.	ground and digging a trench. Intertidal ecology has been assessed in Section 4.4; however, due to the use of HDD, SSSIs in the intertidal zone should remain unaffected.
Aberdeenshire Council	The benthic subtidal and intertidal ecology will be scoped into the environmental appraisal, and this will cover the cable Landfall Site. The area of search for the Landfall Site is the Sandend to Macduff coastline which is mostly designated as a SSSI. The potential impact of the cable Landfall Site on this will have to be considered, although this is a matter that NatureScot will likely have raised through its consultations.	Less destructive, trenchless techniques are to be utilised at the Landfall Site (which will include HDD), which allow ducts to be installed under an obstruction without breaking open the ground and digging a trench. Intertidal ecology has been assessed in Section 4.4; however, due to the use of HDD, as part of the embedded mitigation listed in Table 4–19 (M-106), SSSIs in the intertidal zone should remain unaffected.
NatureScot	The information presented for data sources, baseline environment and features of conservation interest are all fine. Site-specific survey data collection is planned to inform the EIA, including geophysical surveys, grab sampling and drop down cameras. In addition, we recommend the developer should consider the use of innovative eDNA sampling to complement these traditional methods.	eDNA data has been explored as an option to compliment traditional methods (marine sediment and water eDNA was collected as part of the subtidal survey scope conducted by Gardline Ltd.); however, at present, eDNA is not very useful for capturing what species are present in the benthic environment (see Section 4.4.6). eDNA is more applicable to pelagic species and is outlined in Volume 3, Chapter 5: Fish and Shellfish Ecology.
NatureScot	We agree with the activities proposed to be scoped in. However, we advise the following pathways should also be scoped in, due to current high uncertainty about potential impacts: increased risk of invasive non-native species; changes in physical processes; EMF and thermal load.	An assessment of the impacts of marine INNS is provided within Section 4.7.2. Embedded mitigation and control of invasive species measures in line with IMO (2019[20]) have been incorporated and will be included in the EMP to ensure that no significant effects will arise from INNS (Table 4–19). An assessment of changes in physical processes resulting from the presence of the OWF subsea infrastructure on benthic species during operation is provided in Section 4.7.2.

Consultee	Comment	Response
		An assessment of EMF effects and thermal load generated by inter-array and export cables on benthic species during operation is provided in Section 4.7.2.
The Highland Council	Chapter 8 'Benthic Subtidal and Intertidal Ecology' and Chapter 9 'Fish and Shellfish Ecology' both propose to scope out risk of impact from INNS on the basis that embedded mitigation (M-8, M-12) will adequately address the risk. However, I would note that the introduction of INNS can have a regional significance (thereby having potential to affect THC area) and that whilst the sourcing of vessels and equipment is unknown the risk level is also unclear. I would therefore suggest this risk/impact be considered further either within the EIA or in updates to accompanying embedded mitigation document. This comment is subject to the advice provided on the matter by Marine Scotland Science.	An assessment of the impacts of marine INNS is provided within Section 4.7.2. Embedded mitigation and control of invasive species measures in line with IMO (2019[20]) have been incorporated and will be included in the EMP to ensure that no significant effects will arise from INNS (Table 4–19).

Table 4–4: Stakeholder engagement activities.

Date	Consultee and Type of Consultation	Summary
04 July 2023	NatureScot; Meeting	NatureScot agreed to provide details of suggested references and guidance regarding the preparation of a blue carbon assessment (see Volume 6, Chapter 4: Greenhouse Gases). The location of the development proposal can have an influence on the blue carbon resources (e.g., sedimentary carbon content). However, there are many evidence gaps regarding the fate of sedimentary organic carbon when it's disturbed. For example, some of it will be oxidised (lost) in the water column, some of it won't be (too old and refractory to be 'eaten'), some of it will resettle and could potentially become reburied, and some of it may be transported laterally to a new burial site while the sediment is within the water column, etc. NatureScot provided some background to this and the evidence gaps within a recently published literature review by Cunningham and Hunt (2023[21]). The impact of the development proposal on blue carbon will be a result of factors such as: ▪ Depth of disturbance; ▪ Sediment type; ▪ Sedimentation and accumulation rates for the area (if these are low, then the impact is greater because recovery back to the original situation will take longer); ▪ Organic carbon density and reactivity; ▪ Benthic activity; ▪ Currents; and ▪ Temperature/oxygenation.

4.4 Baseline Characterisation

4.4.1 Overview

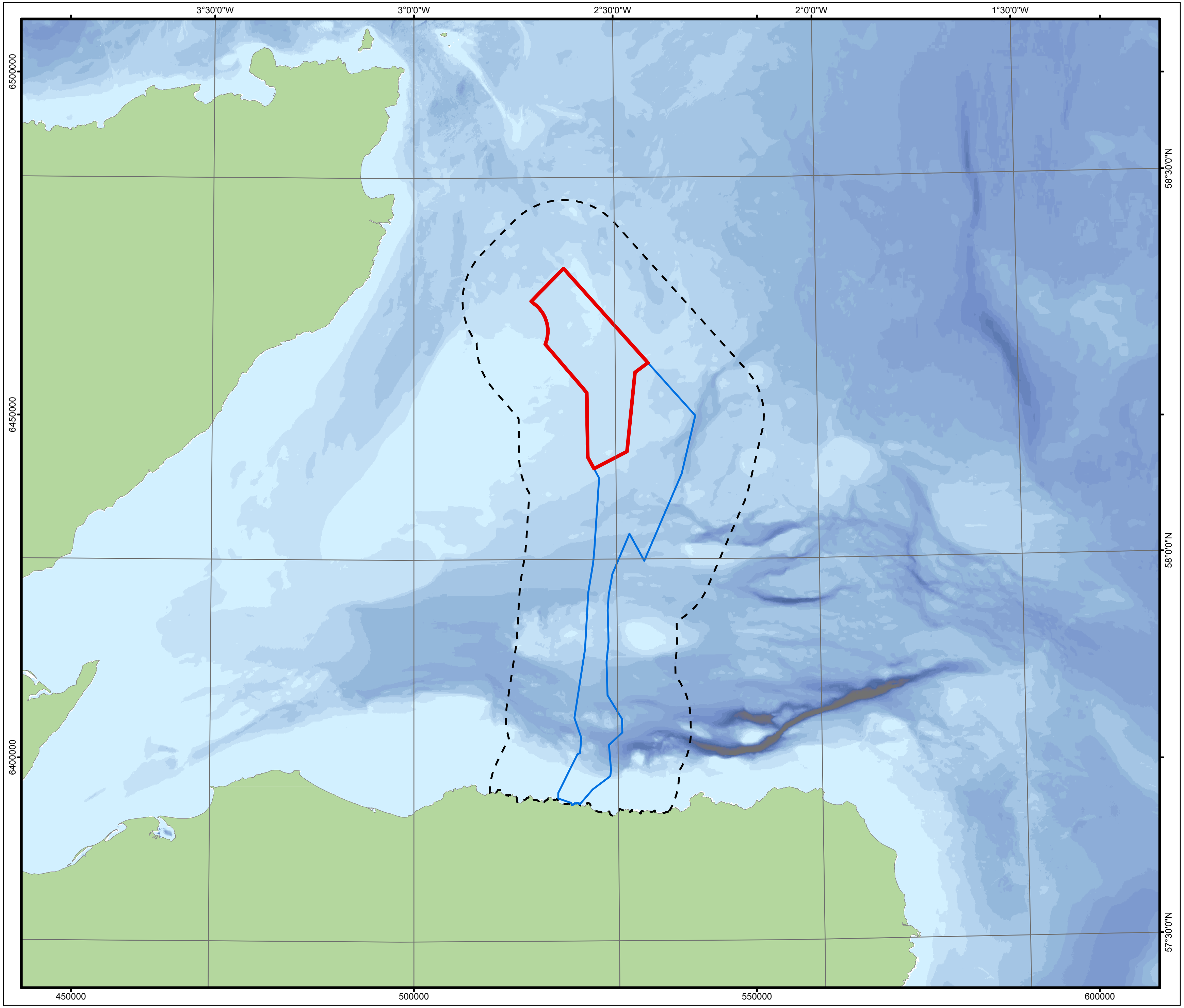
4.4.1.1 This section outlines the current baseline for benthic subtidal and intertidal ecology within the benthic subtidal and intertidal ecology study area. The baseline has been characterised using desk-based sources (Table 4–5), site-specific surveys (Table 4–6) and data sources provided through consultation.

4.4.2 Benthic Subtidal and Intertidal Ecology Study Area

4.4.2.1 The study area is defined by Caledonia North and a larger area formed by buffers around Caledonia North as outlined below.

4.4.2.2 Caledonia North consists of the Caledonia North Site (i.e., Array Area) and Caledonia North OECC, within which the offshore infrastructure, including Wind Turbine Generators (WTGs) and associated foundations and substructures, the Offshore Substation Platforms (OSPs) and associated foundations, the inter-array cables, interconnector cables and offshore export cables will be installed. This includes the intertidal area along the coast which takes into account the potential offshore export cable Landfall Site prior to selection of Stake Ness Landfall Site where intertidal habitat assessments have been undertaken.

4.4.2.3 The benthic subtidal and intertidal study area has been established using a 10km buffer around the Caledonia North Site and Caledonia North OECC (Figure 4-1). This 10km buffer is based on the maximum distance suspended sediments will travel in one tidal excursion on a mean spring tide, and therefore represents the maximum distance over which indirect impacts on benthic subtidal ecology arising from Caledonia North could interact cumulatively with impacts from other plans or projects (hereafter referred to as the Zone of Influence (ZoI)).



Caledonia North Site
Caledonia North Offshore Export Cable Corridor
10km Benthic Ecology Study Area

Depth (m)

0 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100
100 - 110
110 - 120
120 - 130
130 - 140
140 - 150
150 - 160
160 - 170
170 - 180
180 - 190
190 - 200
>200

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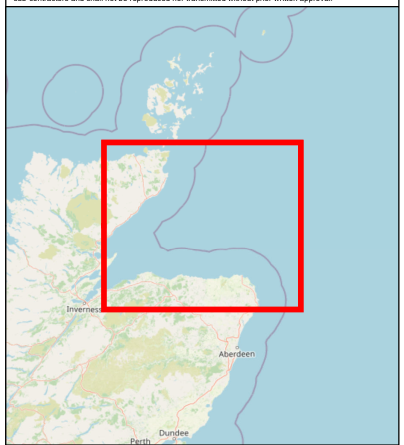

0 5 10 15 20 km

REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
01	09/09/2024	Approved	EV	BB	DH

CALEDONIA Offshore Wind Farm
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CONTRACTOR DRAWING NO: UKCAL1_GO_WNF_BEN_MAP_00137
CONTRACTOR REV: 01
GEODETIC PARAMETERS: WGS 84 / UTM zone 30N (EPSG: 32630)
DRAWING TITLE:

Figure 4-1: Caledonia North Benthic Subtidal and Intertidal Ecology Study Area

STATUS: Approved
SCALE: 1:750,000
DRAWING NUMBER: N/A
SHEET NO: 01 of 01
REV: N/A

4.4.3 Data Sources

Desktop Study

4.4.3.1 Information on the benthic subtidal and intertidal communities within the study area was collected through a detailed desktop review of existing literature and data sources, complemented by site-specific surveys. These have provided coverage across large areas of the study area and wider region.

4.4.3.2 The data sources that have been used to inform this Benthic Subtidal and Intertidal Ecology chapter of the EIAR are presented in Table 4–5.

Table 4–5: Key sources of benthic subtidal and intertidal ecology data.

Title	Author	Year
Existing Project Data		
Beatrice OWF Post-Construction Monitoring Year 2 (2021): Benthic Grab Survey Report	Beatrice Offshore Wind Farm Ltd[22]	2022
Beatrice O&G Field Decommissioning EIA	Repsol Sinopec Resources UK Limited[23]	2018
Moray West OWF Intertidal Survey Report	Moray OWF (West) Ltd[24]	2018
Moray West OWF Benthic Survey Report	Moray OWF (West) Ltd[25]	2018
Moray East Environmental Statement Technical Appendices – Benthic Subtidal and Intertidal Ecology Characterisation Reports	Moray Offshore Renewables Ltd[26] Moray Offshore Renewables[27]	2011; 2014
Publicly Available Datasets		
EMODnet broad scale seabed habitat map for Europe (EUSeaMap) (2021) European Nature Information System (EUNIS) 2019 habitat types	EMODnet[28]	2021
MPA network (SPAs, SSSIs, MPAs, SACs).	Scottish Government[29]	2018
Kelp bed habitat information	Scottish Government[30]	2018
Burrowed mud habitat information	Scottish Government[31]	2018
Ocean Quahog habitat information	Scottish Government[32]	2018

Title	Author	Year
EMODnet Seabed Habitats collated habitat point data (in EUNIS system)	EMODnet[33]	2019
Centre for Environment, Fisheries and Aquaculture Science (Cefas) OneBenthic Baseline Tool	Cefas[34]	2017
Literature		
A big data approach to macrofaunal baseline assessment, monitoring and sustainable exploitation of the seabed	Cooper and Barry[35]	2017
Towards Quantitative Spatial Models of Seabed Sediment Composition	Stephens and Diesing[36]	2015

Site Specific Surveys

4.4.3.3 Site-specific surveys were undertaken to provide an up-to-date characterisation of the habitats and species occurring within the Caledonia North Site and Caledonia North OECC. The subtidal surveys were conducted between 19 March and 12 June 2023 by Gardline Limited. In January 2022, Precision Marine Survey Limited (PMSL) carried out the intertidal survey that was primarily focused on Phase I intertidal biotope mapping following the UK Marine Habitat Classification (JNCC, 2022[37]; Connor *et al*., 2004[38]).

4.4.3.4 A full description of the site-specific survey methodologies and sample analysis is presented within the following reports:

- Volume 7B, Appendix 4-1: Environmental Baseline Report (Array Area);
- Volume 7B, Appendix 4-2: Environmental Baseline Report (Offshore Export Cable Corridor);
- Volume 7B, Appendix 4-3: Habitat Assessment Report (Array Area);
- Volume 7B, Appendix 4-4: Habitat Assessment Report (Offshore Export Cable Corridor), and
- Volume 7B, Appendix 4-5: Intertidal Survey Report.

4.4.3.5 Table 4–6 presents details of the site-specific survey data collected.

Table 4–6: Site-specific benthic subtidal and intertidal survey data.

Title	Summary	Coverage of Caledonia North
Caledonia OWF Phase 2 Array Area Environmental Baseline Report (Volume 7B, Appendix 4-1)	Geophysical survey using single-beam and multi-beam echo sounders (SBES and MBES), side scan sonar (SSS), magnetometer, hull-mounted pinger, ultra-short baseline (USBL) and 2D ultra-high resolution seismic equipment. Water CTD profiles were taken at four stations. Four samples for water eDNA were collected at a subset of four stations (see Chapter 5: Fish and Shellfish Ecology). Samples were used for geophysical summary, seabed imagery analysis, water physical-chemical profiling, sediment characteristics, seabed chemistry, DNA metabarcoding, macrofaunal interpretation and EUNIS habitat classification.	Caledonia North Site
Caledonia OWF Phase 2 Export Cable Route Environmental Baseline Report (Volume 7B, Appendix 4-2)	Geophysical survey using SBES and MBES, SSS, magnetometer, hull-mounted pinger, USBL positioning beacons and single channel high resolution seismic equipment. Water CTD profiles were taken at eight stations. Seabed sampling was conducted at 40 stations using a $0.1m^2$ mini-Hamon grab (PSA and macrofaunal samples) (sampling effort detailed above) and a $0.1m^2$ Day grab (eDNA and chemistry samples). Two samples for sediment eDNA and four for water eDNA were collected at a subset of eight stations. Samples used for geophysical summary, seabed imagery analysis, water physical-chemical profiling, sediment characteristics, seabed chemistry DNA metabarcoding, macrofaunal interpretation and EUNIS habitat classification.	Caledonia North OECC
Caledonia OWF Phase 2 Array Area Habitat Assessment Report (Volume 7B, Appendix 4-3)	Seabed sampling was conducted at 17 stations using a $0.1m^2$ mini-Hamon grab (Particle Size Analysis (PSA) and macrofauna samples) and a $0.1m^2$ Day grab sample for eDNA and sediment chemistry was collected at a subset of four stations. Samples were used for seabed imagery analysis, PSA and EUNIS habitat classification.	Caledonia North Site

Title	Summary	Coverage of Caledonia North
Caledonia OWF Phase 2 Export Cable Route Habitat Assessment Report (Volume 7B, Appendix 4-4)	Seabed sampling was conducted at 40 stations using a 0.1m² mini-Hamon grab (PSA and macrofauna samples) and a 0.1m² Day grab sample for eDNA and sediment chemistry was collected at a subset of nine stations. Camera transects were conducted at 64 stations. Samples used for seabed imagery analysis, particle size analysis and EUNIS habitat classification.	Caledonia North OECC
Caledonia Offshore Wind Farm Intertidal Habitat Survey (Volume 7B, Appendix 4-5)	Transect based Phase I intertidal habitat survey characterising the main biotopes and habitats present and illustrating their zonation across representative sections of intertidal habitat within the survey area. Three transects carried out: East, Central and West.	Representative coverage of the intertidal area

4.4.4 Baseline Description

4.4.4.1 The following sections provide the broad regional characterisation of the benthic subtidal and intertidal ecology study area before focussing on the site-specific data within the offshore components of Caledonia North. Detailed baseline descriptions and associated data including univariate and multivariate statistical analyses are presented within the technical appendices that accompany this chapter, along with habitat maps and figures. The following section provides a summary of the detail within those reports and therefore should be read in conjunction with the following:

- Volume 1, Chapter 3: Proposed Development Description (Offshore);
- Volume 3, Chapter 2: Marine and Coastal Processes;
- Volume 3, Chapter 3: Marine Water and Sediment Quality;
- Volume 3, Chapter 5: Fish and Shellfish Ecology;
- Volume 3, Chapter 13: Other Human Activities;
- Volume 7B, Appendix 2-1: Marine and Coastal Processes Baseline Technical Report;
- Volume 7B, Appendix 4-1: Environmental Baseline Report (Array Area);
- Volume 7B, Appendix 4-2: Environmental Baseline Report (Offshore Export Cable Corridor);
- Volume 7B, Appendix 4-3: Habitat Assessment Report (Array Area);

- Volume 7B, Appendix 4-4: Habitat Assessment Report (Offshore Export Cable Corridor;
- Volume 7B, Appendix 4-5: Intertidal Survey Report; and
- Volume 7B, Appendix 4-6: Reconnaissance Geophysical Survey Interpretation Report.

Bathymetry Seabed Features

Regional Context

4.4.4.2 Caledonia North is located within the Moray Firth off the northeast coast of Scotland, with the northern limit of the Caledonia North Site approximately 22km from Wick.

4.4.4.3 The Caledonia North Site is bound to the west by Smith Bank, an extensive sandbank. The main body of Smith Bank is underpinned by solid bedrock, with variable thickness layers of stable overlying sediment deposits and a more mobile sediment veneer.

4.4.4.4 The southern part of the Caledonia North OECC passes through the Southern Trench feature. The Southern Trench is an enclosed seabed basin 58km long and up to 250m deep. It is located off the Aberdeenshire coast in the southeastern part of the outer Moray Firth, stretching from Buckie in the west to Peterhead in the east (Brooks *et al*., 2013[39]). The Southern Trench acts as a sink for fine grain sediments (Holmes *et al*., 2004[40]). To the north of the Southern Trench is an isolated plateau, the top of which ranges from approximately 40 to 50m depth (LAT). Seabed photography in this region identified the seabed was characterised by well-rounded pebbles, cobbles and boulders (Holmes *et al*., 2004[40]).

4.4.4.5 Smiler's Hole is a 25km long, 175m deep enclosed basin located to the east of the Caledonia North OECC. Sediment samples taken from within the basin have been classified as muddy sands, with polymodal distribution patterns consistent with an environment allowing both sedimentation of the finest grained muds and a process of resuspension under conditions of stronger near-bed currents (Holmes *et al*., 2004).

Caledonia North Site

4.4.4.6 Across the Caledonia North Site, water depths range between approximately 35 and 60m (Lowest Astronomical Tide (LAT)), with the majority between 50 and 60m (LAT). The shallowest depths are found in the north-eastern part of the Caledonia North Site, on the outer edges of Smith Bank, and the deepest area is located in the south-east, corresponding to the east part of a trench, which is approximately 19km long orientated south-west to north-east.

4.4.4.7 Data reported separately in the geophysical interpretation report (Volume 7B, Appendix 4-6: Reconnaissance Geophysical Survey Interpretation Report) outlined that water depth across the survey area varies between 39.6m LAT in the east of the Caledonia North Site to 60m LAT in the north, generally undulating with an average gradient of less than 1°. Numerous shoal features are present across the Caledonia North Site typically related to underlying Glacial Till.

4.4.4.8 Trenches generally orientated west to east in the northwest of the Caledonia North Site are interpreted as furrows. These furrows have measured depths of less than 1m below the surrounding seabed with gradients up to 5° on the flanks.

4.4.4.9 Ripples were observed within furrows. Crests are orientated in a north to south direction with wavelengths of approximately 1m, and heights of less than 0.1m. Gradients associated with ripples are negligible.

Caledonia North OECC

4.4.4.10 Geophysical data reported in the Environmental Baseline Survey (Volume 7B, Appendix 4-6) indicated that water depth across the Caledonia North OECC varied between 0.3m (LAT) in the south as the Caledonia North OECC approached the shore, to 109m (LAT) in the southeast, around 10km from the shore and varying with an average gradient of less than 1°. In the south of the Caledonia North OECC, prominent north to south orientated ridges with localised gradients up to 70° were interpreted from the geophysical data as outcropping bedrock. In the central part of the Caledonia North OECC, trenches orientated from east to west, with measured depths of less than 1m below the surrounding seabed and gradients up to 5° on the flanks. Ripples with north to south orientated crests were seen within the furrows, with wavelengths of approximately 1m and heights of less than 0.1m.

4.4.4.11 Within the Southern Trench feature to the south of Caledonia North OECC, depths ranged between 70 and 150m (LAT). An isolated plateau is presented to the north of the Southern Trench, located towards the middle of Caledonia North OECC, with shallower depths on 40 to 60m (LAT).

4.4.4.12 Seabed sediments were predominantly comprised of sand with areas of slightly gravelly sand and slightly gravelly clayey sand. Areas of relatively low subsurface scattering (SSS) reflectivity were described as slightly gravelly sand, representing outcropping Glaciomarine Sands and Clays. Areas of high SSS reflectivity were located in the central and southern portions of the Caledonia North OECC and were largely associated with bathymetric highs, interpreted as slightly gravelly clayey sand and representing outcropping Glacial Till. These areas were also characterised by numerous large boulders. The southern nearshore section of the Caledonia North OECC was associated with well-defined areas of chaotic high SSS reflectivity. This was characterised by bathymetric highs, locally steep gradients and north to south trending ridges, which were considered to be conglomerate outcrops.

4.4.4.13 Three export cables run from Moray East through the southern approximately 9km of the Caledonia North OECC from the west to the south. These cables are trenched (buried) in the north, with areas of partially infilled trench to the central south section. The cables are intermittently covered by areas of rock dump up to 2.5m high towards the south before the cable is buried and not seen.

Intertidal

4.4.4.14 An intertidal survey (Volume 7B, Appendix 4-5) conducted in-situ by PMSL in August 2023 described the coastal area at Stake Ness Landfall Site as a complex mosaic of rocky platforms, angular bedrock ridges and large boulders.

Sediment Characteristics

Regional Context

4.4.4.15 Particle Size Analysis (PSA) PSA at Moray West OWF determined that sediments were highly variable. Along the export cable route, sediments included slightly gravelly sands (often with a small amount of mud), slightly gravelly muddy sands, sandy mud, sandy gravel and gravel. The wind farm sampling stations included slightly gravelly sand or muddy sand, sandy gravel, gravelly sand and mixed gravelly muddy sand or muddy sandy gravel (Moray Offshore Wind Farm (West) Limited, 2018b[41]).

Caledonia North Site

4.4.4.16 EUNIS biotope complexes identified through site-specific grab sampling and seabed imagery are presented in Table 4–8, with spatial distribution of these biotopes presented in Figure 4-3. It can be seen from this data that the Caledonia North Site is dominated by coarse and mixed sediment biotopes.

4.4.4.17 Sediment descriptions using the Folk (Folk, 1954[42]) classification indicated that the Caledonia North Site ranged from sand to sandy gravel with sandy gravel sediments being dominant throughout. Finer sediment classified as 'Sand' (Folk, 1954[42]) was found at three stations, two to the north and one to the east of the Caledonia North Site.

4.4.4.18 Broadscale regional habitat mapping, detailing biological zone and substrate (Figure 4-2) identifies that the dominant habitats across the Caledonia North Site are deep circalittoral sand and deep circalittoral coarse sediment.

Caledonia North OECC

4.4.4.19 EUNIS biotope complexes identified through grab sampling and seabed imagery are presented in Table 4–9, with spatial distribution of these biotopes presented in Figure 4-3. It can be seen from this data that the Caledonia North OECC is dominated by 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud' (EUNIS code: MC6216) which is a burrowed mud biotope.

4.4.4.20 Across the Caledonia North OECC, mean particle size varied from 41µm to 1813µm. The five stations closest to the shore were situated in water depths of less than 35m and were dominated by sand (>95%). These stations were described as moderate to moderately well sorted based on Folk and Ward

(Folk and Ward, 1957[43]) statistics. The 24 stations sampled in water depths greater than 70m were dominated by fine sand to very fine sand with fines content ranging from 11% to 45%. These stations were recorded as poorly to very poorly sorted sediment classified as muddy sand under modified Folk (Folk, 1954[42]). The nine remaining stations were located in or near areas of higher or mottled SSS reflectivity and recorded variable gravel content ranging from <1% to 39%. Fines content was also variable, ranging from 1.8% at a station in the south of the Caledonia North OECC, to 25% at a station in the north of the Caledonia North OECC.

4.4.4.21 Sediment descriptions using the Folk (Folk, 1954[42]) classification indicated that sediment in the Caledonia North OECC ranged from muddy sand to sandy gravel. The seabed was primarily classified as muddy sand (25 stations). The remaining stations were described as sand (five stations), sandy gravel (two stations), slightly gravelly sandy mud, (two stations), gravelly muddy sand (two stations), gravelly sand (one station) and slightly gravelly muddy sand (one station).

4.4.4.22 Broadscale regional habitat mapping, detailing biological zone and substrate (Figure 4-2) identifies that the north portion of the Caledonia North OECC is classified as deep circalittoral sand, with the northwest corner classified as deep circalittoral coarse sediment. Towards the south of the Caledonia North OECC, there is a band of deep circalittoral mud towards the south, and deep circalittoral coarse sediment, circalittoral coarse sediment and infralittoral coarse sediment towards the inshore region of the Caledonia North OECC.

Intertidal

4.4.4.23 Upon commencement of the intertidal survey (Volume 7B, Appendix 4-5) conducted by PMSL in August 2023, it was evident that no appreciable areas of soft sediment were present along the survey transects so Phase 2 core sampling for infauna and contaminants was not undertaken. The rocky habitats in the vicinity of the Stake Ness Landfall Site are characterised by a structurally complex combination of bedrock, boulder and angular bedrock ridges and gullies.

Sediment Chemistry

Regional Context

4.4.4.24 Contaminant analysis of sediment grab samples across the Moray West OWF and export cable route indicated that all metals were at concentrations below respective guidelines with no samples above UK limits or Dutch/Canadian standards. Polycyclic aromatic hydrocarbons (PAH) concentrations were generally below the limit of detection (LOD), although LODs for Acenaphthene, Acenaphthylene, Dibenzo(ah)anthracene were slightly higher than the Canadian threshold effect level values (Moray Offshore Wind Farm (West) Limited, 2018b[41]). The environmental assessment at Moray East OWF concluded that sediment contaminants were below guideline values so that no deleterious effects on marine life were expected as a result of the proposed scheme (Moray OWF (East) Limited, 2012[44]).

4.4.4.25 The environmental assessment at Moray East OWF concluded that sediment contaminants were below guideline values.

Caledonia North Site

4.4.4.26 Total Organic Carbon (TOC) was relatively low across the Caledonia North Site. Concentrations of TOC at all stations were relatively uniform with concentrations ranging from 0.21% at Station ENV18 to 0.29% at Station ENV35.

4.4.4.27 Further details of sediment contamination are provided in Volume 3, Chapter 3: Marine Water and Sediment Quality and associated baseline appendices. However, in summary, contaminant levels in sediment samples collected within the Caledonia North Site were consistently low (often below LOD) and typically well below respective assessment thresholds, including for metals, organotins, polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), PAHs and total hydrocarbon content (THC).

Caledonia North OECC

4.4.4.28 As noted above for the Caledonia North Site, further details of sediment contamination (and TOC) are provided in Volume 3, Chapter 3: Marine Water and Sediment Quality and associated baseline appendices. However, in summary, contaminant levels in sediment samples collected within the Caledonia North OECC were consistently low (often below LOD) and typically well below respective assessment thresholds, including for metals, organotins, PCBs, PBDEs, PAHs and THC.

Intertidal

4.4.4.29 Upon commencement of the intertidal survey (Volume 7B, Appendix 4-5) conducted by PMSL in August 2023, it was evident that no appreciable areas of soft sediment were present along the survey transects (or wider Landfall Site) so Phase 2 core sampling for infauna and contaminants was not undertaken.

Benthic Habitat and Communities

Regional Context

4.4.4.30 The Cefas OneBenthic faunal data (Figure 4-2) indicates that the macrofaunal assemblages across the benthic subtidal and intertidal ecology study area are characterised by group D2b across the lower portion of the Caledonia North OECC. This group is represented by low numbers of taxa, commonly Spionidae, Amphiuridae, Nephtyidae, Lumbrineridae, Oweniidae, Cirratulidae, Capitellidae, Nemertea, Semelidae and Amphartetidae. This group is likely to be located where there are higher percentages of mud.

4.4.4.31 A review of data from surveys of epibenthic fauna in the North Sea (including a sample site in the outer Moray Firth), noted that the sessile fauna was diverse, with abundant hydrozoans, bryozoans and tube-dwelling polychaetes, and was dominated by crustaceans such as *Pagurus bernhardus* and echinoderms such as *Asterias rubens* (Callaway *et al*., 2002[45]). Jennings et al. (1999[46]) classified the mobile epifauna as a 'central' North Sea sub-group, dominated by *A. rubens, P. bernhardus* and *Crangon allmanni*. Sessile epifauna belonged to a 'north' North Sea subgroup and was dominated by the hydroid *Hydrallmania falcata* and the bryozoan *Flustra foliacea*. Survey data from SEA 5 for the outer Moray Firth (DTI, 2004[47]) noted relatively consistent macrofauna, with dominant taxa including species characteristic of stable fine sands (e.g., the polychaete worm *Galathowenia oculata*, the echinoid *Echinocyamus pusillus* and the amphipods *Ampelisca tenuicornis* and *Harpinia antennaria*). Sediments in the area ranged from generally coarse sediment to muddy, very fine to fine sands becoming finer with depth.

4.4.4.32 Across the Moray West OWF, which is located further inshore to the west of Caledonia North, predominantly sandy habitats were present, and numbers of taxa, infaunal abundance and diversity were moderate and highly variable (Moray Offshore Wind Farm (West) Limited, 2018a[48]). Annelid worms (predominantly polychaetes) were the most dominant phylum, followed by molluscs. The pea urchin *E. pusillus* was the most abundant and ubiquitous taxon. The western side of the Moray West OWF was characterised by the biotope 'Infralittoral sand' (EUNIS code: MB5), while the eastern half and the eastern fringe were described as 'Circalittoral coarse sediment' (EUNIS code: MC3) to 'Circalittoral mixed sediments' (EUNIS code: MC4) (Moray Offshore Wind Farm (West) Limited, 2018a[48]).

4.4.4.33 The two OWFs which are located within the benthic subtidal ecology ZoI are Beatrice OWF and Moray East OWF. Biotopes found within these OWFs, and therefore considered as part of the impact assessment for Caledonia North are detailed in Table 4–7. Some additional detail for the Beatrice OWF and Moray East OWF is provided below.

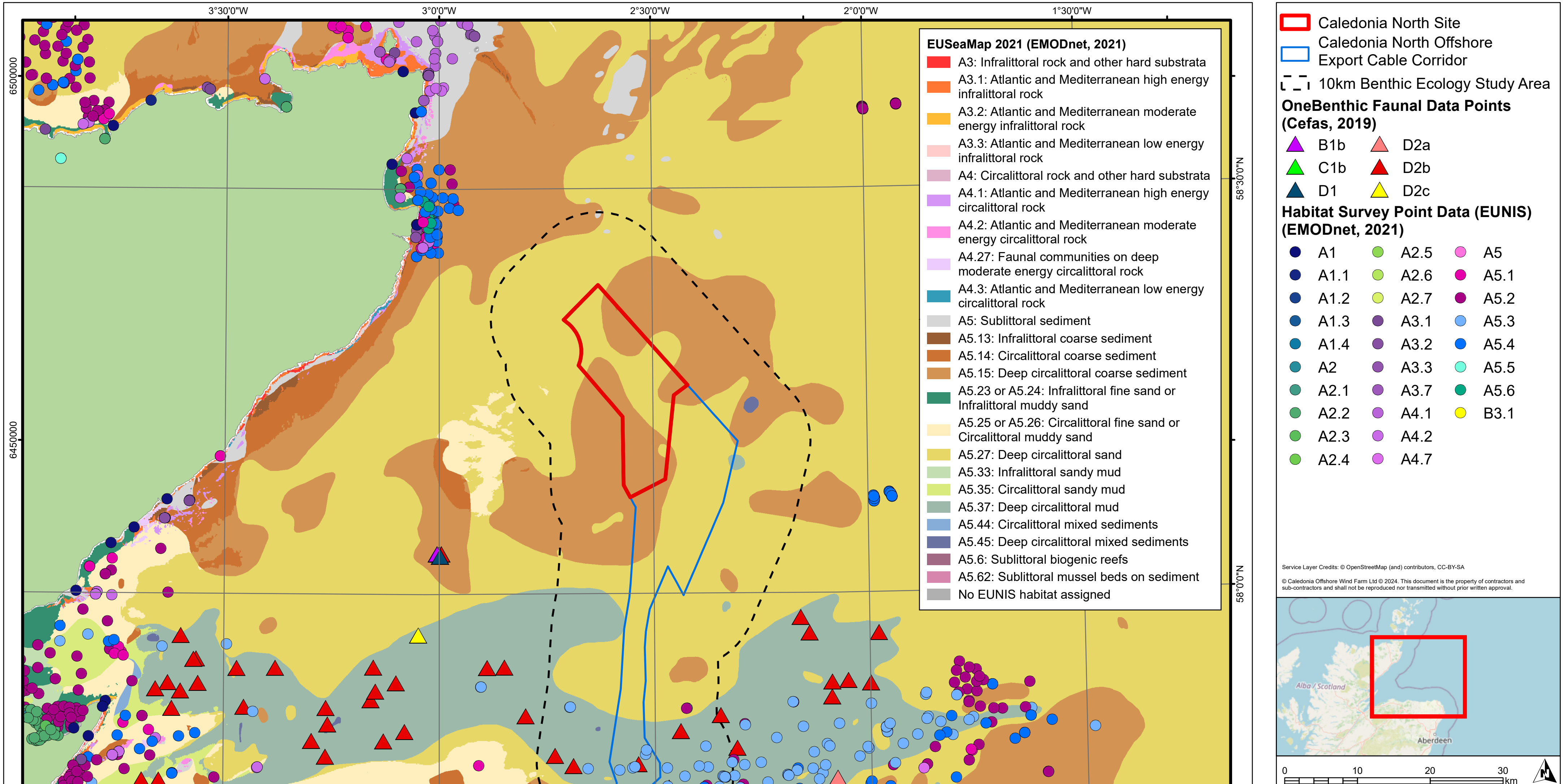
4.4.4.34 The Beatrice OWF is located to the west of Caledonia North. The post-construction monitoring benthic survey report (BOWL, 2022[49]) indicates that the sediment type across the entire survey area was predominantly made up of sandy sediments, with mud and gravel representing a very small proportion of the total sediment composition. For the 2021 survey, only one level 5 biotope was recorded within the Caledonia North Site: '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (EUNIS code: MC5211), and it was recorded at nine of the 12 stations (BOWL, 2022[49]). It is worth noting, however, that the 2020 survey results indicated that '*Moerella* spp. with venerid bivalves in Atlantic infralittoral gravelly sand' (EUNIS code: MB3233) was the dominant biotope across stations, and changes in the abundances of key taxa drive variation in the dominance of these two biotopes at the Beatrice OWF site (BOWL, 2022[49]).

4.4.4.35 Site-specific surveys conducted for the Moray East OWF (Moray Offshore Renewables Ltd, 2011[50]) identified seven biotopes across the array area, which is located adjacent to the Caledonia North Site:

- MD4211 - Polychaete-rich deep *Venus* community in offshore mixed sediments;
- MC3212 – *Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel;
- MB3235 – *Glycera lapidum* in impoverished infralittoral mobile gravel and sand;
- MD5212 – *Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand;
- MB5236 – *Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand
- MB3233 – *Moerella* spp. with venerid bivalves in infralittoral gravelly sand; and
- MC5211 – *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand.

Table 4–7: Biotopes found across the Caledonia North benthic subtidal and intertidal ecology study area and wider region informed by other OWFs.

EUNIS Code	Biotope Name	JNCC 04.05 Code
MC5211	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	SS.SSa.CFiSa.EpusOborApri
MD4211	Polychaete-rich deep *Venus* community in offshore mixed sediments	SS.SMx.OMx.PoVen
MC3212	*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	SS.SCS.CCS.MedLumVen
MB3235	*Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand	SS.SCS.ICS.Glap
MD5212	*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand	SS.SSa.Osa.OfusAfil
MB5236	*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in infralittoral compacted fine muddy sand	SS.SSa.IMuSa.FfabMag
MB3233	*Moerella* spp. with venerid bivalves in infralittoral gravelly sand	SS.SCS.ICS.MoeVen



REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
01	09/09/2024	Approved	EV	BB	DH

CALEDONIA Offshore Wind Farm

GoBe APEM Group

CONTRACTOR DRAWING NO: UKCAL1_GO_WNF_BEN_MAP_00138

CONTRACTOR REV: 01

GEODETIC PARAMETERS: WGS 84 / UTM zone 30N (EPSG: 32630)

DRAWING TITLE:

Figure 4-2: Seabed Substrate Data, Overlayed Habitat Survey Point Data (EUNIS) and Faunal Point Data (Cefas, 2019; EMODnet, 2019; 2021)

STATUS: Approved

SCALE: 1:750,000

DRAWING NUMBER: N/A

SHEET NO: 01 of 01

REV: N/A

Caledonia North Site

4.4.4.36 As detailed in Volume 7B, Appendix 4-1: Environmental Baseline Report (Array Area), grab samples were conducted at 17 stations across the Caledonia North Site (one biological sample analysed at each station). Camera transects were conducted at 21 stations, consisting of the 17 grab sampling stations and an additional four camera only stations (Table 4–6).

4.4.4.37 A total of 786 individuals were recorded from 16 macrofaunal grab samples (one sampling effort was unsuccessful). Benthic subtidal community structure and composition was generally dominated by Annelida (Polychaeta) which comprised most of the enumerated taxa composition, followed by Arthropoda (Malacostraca), Mollusca and Echinodermata. The 'Others' Category comprised 6% of the taxa and this group was represented by Annelida (Clitellata, Sipuncula), Arthropoda (Pycnogonida), Chaetognatha, Cnidarida (Anthozoa), Foraminifera, Hemichordata, Nemertea, Phoronida and Platyhelminthes. Overall, the univariate statistics showed a generally diverse and evenly distributed community across the Caledonia North Site, influenced predominantly by natural variability in sediment characteristics. Multivariate indices identified a 78% correlation between adult macrofauna abundance and mean particle diameter and fines content.

4.4.4.38 Seabed imagery confirmed that sediments were generally comprised of sand with occasional gravel and shell material. Fauna was generally sparse. *A. islandica* siphons were observed. This species is on the OSPAR (OSPAR, 2008a[51]) list of threatened and/or declining species and habitat and is listed as a low or limited mobility species PMF in Scottish offshore waters (Tyler-Walters *et al*., 2016a[52]).

4.4.4.39 By combining and collectively considering the macrofaunal data, seabed imagery data, PSA data and geophysical data, three EUNIS biotope complexes (EUNIS level 4) were identified within the Caledonia North Site. Further classification of the macrofaunal community to EUNIS level 5 was attempted with limited success due to an imperfect fit against the information available for the biotope communities (European Environment Agency (EEA), 2019[53]; JNCC, 2022[54]) in addition to a physical mismatch of dominant taxa with sediment type. The EUNIS habitat codes (and corresponding JNCC 04.05 biotope code) identified are presented in Table 4–8.

4.4.4.40 Of the three biotope complexes recorded, two were dominant across the Caledonia North Site. The first of these was 'Faunal communities in Atlantic offshore circalittoral mixed sediment' (EUNIS code: MD421) which are classified as circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. The second predominant biotope complex was 'Faunal communities in Atlantic offshore circalittoral sand' (EUNIS code: MD521) which are classified as fine sands or non-cohesive muddy sands. The third biotope complex was identified in deeper sediment towards the east of the Caledonia North Site; 'Faunal communities on Atlantic offshore circalittoral mud' (Biotope code: MD621) which are classified as sublittoral muds, occurring below moderate depths of 15-20m, either on the open coast or in marine inlets.

4.4.4.41 Further in-house analysis of the macrofauna data characterised three level 5 biotopes across the Caledonia North Site. The biotope 'Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment' (EUNIS code: MD4211) was recorded to the north of the Caledonia North Site. This biotope varied from the standard description as there was a lack of dominant bivalves. The biotope '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel' (EUNIS code: MC3212) was recorded throughout the Caledonia North Site. However, it contained high numbers of *Antalis entalis* which was considered to be unusual for this biotope. '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (EUNIS code: MC5211) was recorded towards the north of the Caledonia North Site.

Table 4–8: Biotopes found across Caledonia North Site.

EUNIS Code	Biotope Name	JNCC 04.05 Code
MD421	Faunal communities in Atlantic offshore circalittoral mixed sediment	SS.SMx.CMx
MD521	Faunal communities in Atlantic offshore circalittoral sand	SS.SSa.CFiSa
MD621	Faunal communities on Atlantic offshore circalittoral mud	SS.SMu.OMu
MD4211	Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	SS.SMx.OMx.PoVen
MC5211	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	SS.SSa.CFiSa.EpusOborApri
MC3212	*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in Atlantic circalittoral coarse sand or gravel	SS.SCS.CCS.MedLumVen

Caledonia North OECC

4.4.4.42 As detailed in Volume 7B, Appendix 4-2: Environmental Baseline Report (Array Area), grab samples were conducted at 40 stations across the Caledonia North OECC (one biological sample analysed at each station). Camera transects were conducted at 59 stations, consisting of the 40 grab sampling stations and an additional 19 camera only stations (Table 4–6).

4.4.4.43 Across the Caledonia North OECC the macrofaunal dataset comprised 247 taxa and 1896 individuals from the 39 successful grab samples. Annelida (Polychaeta) comprised most of the enumerated taxa (44%), followed by Mollusca (23%), Arthropoda (Malacostraca) (21%) and Echinodermata (6%).

The 'Others' category comprised 6% of taxa and this group was represented by Annelida (Sipuncula), Arthropoda (Pyconogonida), Cnidaria (Anthozoa), Foraminifera, Hemichordata, Nemertea, Phoronida and Platyhelminthes. Pielou's eveness statistics suggested that the communities at stations were relatively evenly distributed which was further supported by low Simpson's dominance values. Multivariate indices identified a 75% correlation between adult macrofauna abundance and mean particle diameter and fines content.

4.4.4.44 Seabed imagery confirmed that sediments in the Caledonia North OECC ranged from muddy fine to coarse sand with varying amounts of gravel and shell fragments. Fauna was generally sparse, with 52% of images containing no visible fauna. Evidence of faunal burrows and/or sea pens was observed at 20 of the 27 stations. Analysis of densities against JNCC (JNCC, 2014[55]) criteria indicated some similarity to a 'sea pen and burrowing megafauna communities' habitat as defined by OSPAR (OSPAR, 2010[56]). This is classified as a threatened and/or declining habitat (OSPAR, 2008a[51]) and a PMF in Scotland's waters (Tyler-Walters *et al*., 2016a[52]). Potential stony reef was observed at seven stations along the Caledonia North OECC. Only two stations (stations ENV56 and ENV63) indicated a medium resemblance to reef, and the rest were low resemblance.

4.4.4.45 These discrete patches of stony habitat resemblance to Annex I stony reef, as per the qualifying criteria set out in regulatory guidance (Irving 2009). Additional to setting out the reef qualifying criteria thresholds, this guidance also suggests that "when determining whether an area of the seabed should be considered as Annex I stony reef, if a 'low' is scored in any of the four characteristics (composition, elevation, extent or biota), then a strong justification would be required for this area to be considered as contributing to the Marine Natura site network of qualifying reefs in terms of the EU Habitats Directive". This suggests that the patches identified during this survey would not be considered as contributing to the National Site Network unless there is strong justification.

4.4.4.46 There were also observations of *A. islandica* siphons, which is on the OSPAR (2008a[51]) list of threatened and/or declining species and habitat and is listed as a PMF (Tyler-Walters *et al*., 2016a[52]).

4.4.4.47 By combining and collectively considering the macrofaunal data, seabed imagery data, PSA data and geophysical data, six EUNIS level 4 and two EUNIS level 5 biotope complexes were identified along the Caledonia North OECC. The EUNIS habitat codes (and corresponding JNCC 04.05 biotope code) identified are presented in Figure 4-3 and Table 4–9.

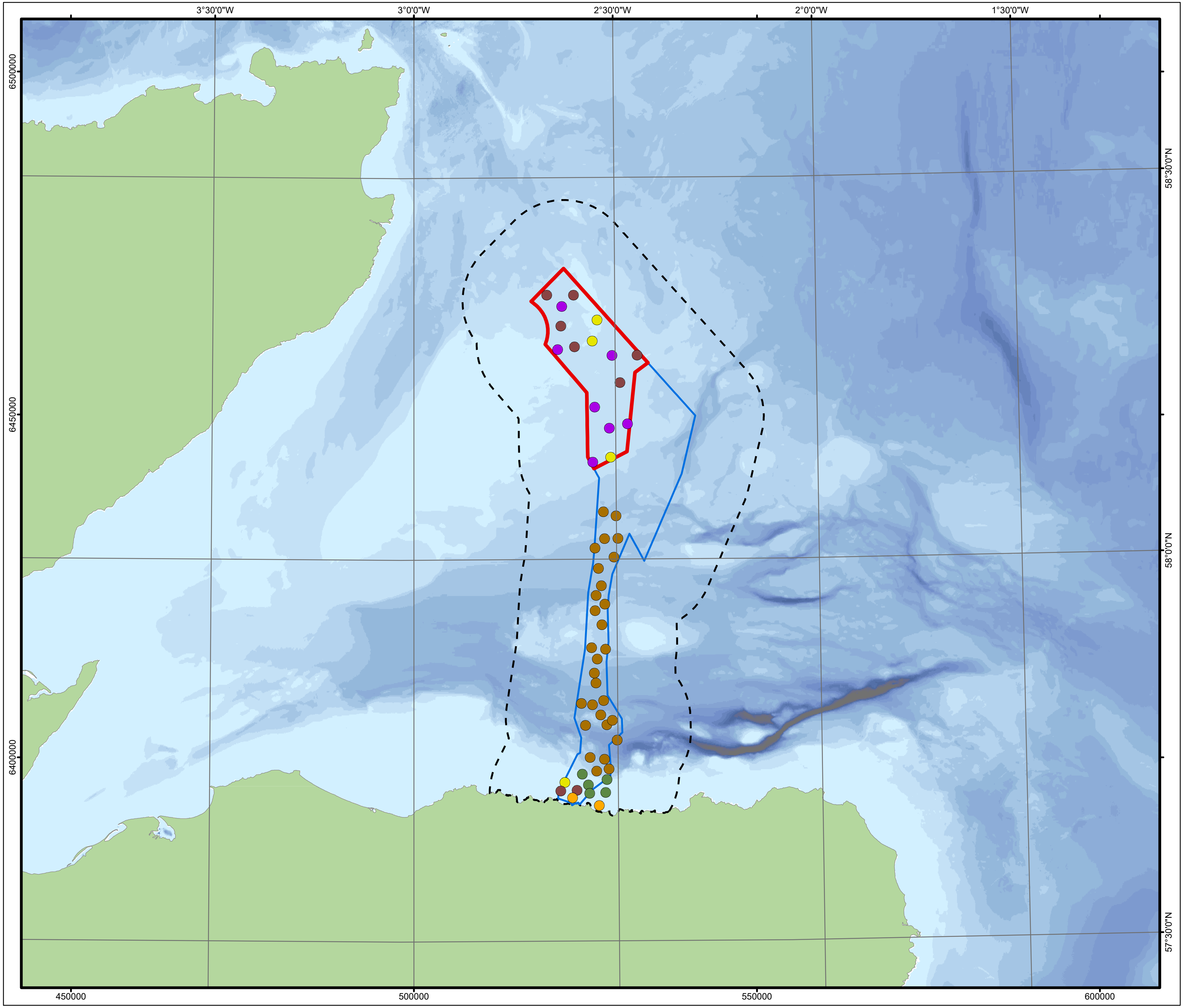
4.4.4.48 Three of the EUNIS level 4 biotope complexes recorded in the Caledonia North OECC were also recorded in Caledonia North Site: 'Faunal communities in Atlantic offshore circalittoral mixed sediment' (EUNIS code: MD421), 'Faunal communities in Atlantic offshore circalittoral sand' (EUNIS code: MD521) and 'Faunal communities on Atlantic offshore circalittoral mud' (EUNIS code: MD621). An additional, three EUNIS level 4 biotope complexes were identified along the Caledonia North OECC which were: 'Faunal communities of full salinity Atlantic infralittoral sand' (EUNIS code: MB523), which are classified as sands occurring in shallow water on the open coast or in tide swept channels; 'Faunal communities of Atlantic circalittoral mixed sediment' (EUNIS code: MC421), which are classified as mixed sediment habitats in the circalittoral zone including well mixed muddy gravelly sands or very poorly sorted mosaics of shell, cobbles and pebbles embedded in or lying upon mud, sand or gravel; and 'Faunal communities of Atlantic circalittoral sand (EUNIS code: MC521), which are classified as sand communities either on the open coast or in tide swept channels of marine inlets in depths of over 15-20m.

4.4.4.49 In addition, the following five EUNIS level 5 biotopes were recorded in the Caledonia North OECC: '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (EUNIS code: MB5233) is described as well-sorted medium and fine sands characterised by *N. cirrosa* and *Bathyporeia* spp. (and sometimes *Pontocrates* spp.) which occur in the shallow sublittoral to at least 30m depth; 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud' (EUNIS code: MC6212) was characterised from the seabed imagery analysis, however, it was considered that there was a mismatch of visible and infaunal taxa with the sediment type.

4.4.4.50 Further in-house analysis of the macrofauna data characterised a further three level 5 biotopes along Caledonia North OECC: 'Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment' (EUNIS code: MD4211) was recorded at one station in the south of the Caledonia North OECC (this was noted as a variant of this biotope as it lacked the most dominant bivalves); '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (EUNIS code: MC5211) was also recorded in the south of the Caledonia North OECC and was noted as a variant without *A.prismatica*; and '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand' (EUNIS code: MD5121) was recorded in the south as a possible biotope as there were high number of Thracioidea which is not in the standard description.

Table 4–9: Biotopes found across Caledonia North OECC.

EUNIS Code	Biotope Name	JNCC 04.05 Code
MB523	Faunal communities of full salinity Atlantic infralittoral sand	SS.SSa.IFiSa
MC421	Faunal communities of Atlantic circalittoral mixed sediment	SS.SMx.CMx
MC521	Faunal communities of Atlantic circalittoral sand	SS.SSa.CFiSa
MD421	Faunal communities in Atlantic offshore circalittoral mixed sediment	SS.SMx.OMx
MD521	Faunal communities in Atlantic offshore circalittoral sand	SS.SSa.OSa
MD621	Faunal communities on Atlantic offshore circalittoral mud	SS.SMu.OMu
MB5233	*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand	SS.SSa.IFiSa.NcirBat
MC6216	Sea pens and burrowing megafauna in Atlantic circalittoral fine mud	SS.SMu.CFiMu.SpnMeg
MD4211	Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	SS.SMx.OMx.PoVen
MC5211	*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	SS.SSa.CFiSa.EpusOborApri
MD5212	*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand	SS.SSa.Osa.OfusAfil



Caledonia North Site
Caledonia North Offshore Export Cable Corridor
10km Benthic Ecology Study Area

Depth (m)

- 0 - 50
- 50 - 60
- 60 - 70
- 70 - 80
- 80 - 90
- 90 - 100
- 100 - 110
- 110 - 120
- 120 - 130
- 130 - 140
- 140 - 150
- 150 - 160
- 160 - 170
- 170 - 180
- 180 - 190
- 190 - 200
- >200

Biotope Code

- MC3212
- MD4211
- MC5211
- MD5212
- MB5233
- MC6216

Service Layer Credits: © OpenStreetMap (and) contributors, CC-BY-SA

0 10 20 30 km

REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
01	09/09/2024	Approved	EV	BB	DH

CONTRACTOR DRAWING NO: UKCAL1_GO_WNF_BEN_MAP_00139

CONTRACTOR REV: 01

GEODETIC PARAMETERS: WGS 84 / UTM zone 30N (EPSG: 32630)

DRAWING TITLE

Figure 4-3: Biotope Classification

STATUS: Approved

SCALE: 1:750,000

DRAWING NUMBER: N/A

SHEET NO: 01 of 01

REV: N/A

Intertidal

4.4.4.51 The rocky habitats in the vicinity of the Stake Ness Landfall Site are characterised by a structurally complex combination of bedrock, boulder and angular bedrock ridges and gullies. This rather complex topography is reflected in the biological communities present along the survey transects which included a variety of predominantly fucoid or barnacle-dominated communities. These habitats were often characterised by intermediate or transitional examples of rocky shore communities and sometimes formed mosaics comprising of several biotopes. This habitat heterogeneity reflected the rapid changes in elevation/topography and exposure within the survey area.

4.4.4.52 Despite the inherent complexity of the observed rocky shore communities, a broadly similar range of biotopes was recorded across all three transects (all biotopes recorded are depicted in Figure 11 of the Intertidal Survey Report; Volume 7B, Appendix 4-5). The extreme low shore was typically characterised by kelp biotopes such as '*Laminaria digitata* on moderately exposed sublittoral fringe bedrock' (EUNIS code: MB12171) whilst low to mid shore habitats included a range of fucoid and/or barnacle dominated biotopes such as '*Semibalanus balanoides, Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock' (EUNIS code: MA12231), '*Semibalanus balanoides*, *Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock' (EUNIS code: MA12232) (or possibly '*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock' (EUNIS code: MA1243)) and '*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock' (EUNIS code: MA12441) with such habitats often interspersed with rock pools (typically' Coralline crust-dominated shallow eulittoral rockpools' (EUNIS code: MA1262) and 'Fucoids and kelp in deep eulittoral rockpools' (EUNIS code: MA1263)).

4.4.4.53 On the mid to upper shore, more impoverished barnacle communities were often present grading into rather sparse or intermediate mosaics of communities associated with the algae *Pelvetia canaliculata* or *Fucus spiralis* (e.g., '*Pelvetia canaliculata* on sheltered variable salinity littoral fringe rock' (EUNIS code: MA1251) or '*Fucus spiralis* on sheltered upper eulittoral rock' (EUNIS code: MA123C)) often with more impoverished rock pools populated by filamentous green algae i.e., green seaweeds; *Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools' (EUNIS code: MA1261). The extreme upper shore areas tended to be characterised by lichens predominantly 'Yellow and grey lichens on Atlantic supralittoral rock' (EUNIS code: MA1211) or occasionally '*Verrucaria maura* on littoral fringe rock' (EUNIS code: MA1213) with a band of barren rock and stones/cobble 'Barren littoral shingle' (EUNIS code: MA3211) often present at (or above) high water. The west transect tended to be the least diverse in terms of the range of biotopes and algal communities present although in general terms all three transects exhibited a broadly similar gradation of littoral rocky shore communities which are typical for moderately exposed rocky shores and characteristic of this section of the coastline. All biotopes recorded are detailed in Table 4–10.

Table 4–10: Biotopes recorded in the intertidal area.

EUNIS Code	Biotope Name	JNCC 04.05 code
MB12171	*Laminaria digitata* on moderately exposed sublittoral fringe rock	IR.MIR.KR.Ldig
MB121A	*Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock	IR.MIR.KR.Lhyp
MA1233	*Himanthalia elongata* and red seaweeds on exposed lower eulittoral rock	LR.HLR.FR.Him
MA12231	*Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock	LR.HLR.MusB.Sem.Sem
MA12441	*Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock	LR.MLR.BF.Fser.R.
MA1263	Fucoids and kelp in deep eulittoral rockpools	LR.FLR.Rkp.FK
MA1251	*Pelvetia canaliculata* on sheltered variable salinity littoral fringe rock	LR.LLR.F.Pel
MA123C	*Fucus spiralis* on sheltered upper eulittoral rock	LR.LLR.F.Fspi
MA1242	*Fucus spiralis* on full salinity exposed to moderately exposed upper eulittoral rock	LR.MLR.BF.FspiB
MA1262	Coralline crust-dominated shallow eulittoral rockpools	LR.FLR.Rkp.Cor
MA126	Communities of littoral rockpools	LR.FLR.Rkp
MA1261	Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools	LR.FLR.Rkp.G.
MA121	Lichens or small green algae on Atlantic supralittoral and littoral fringe rock	LR.FLR.Lic
MA1211	Yellow and grey lichens on Atlantic supralittoral rock	LR.FLR.Lic.YG
MA1213	*Verrucaria maura* on littoral fringe rock	LR.FLR.Lic.Ver

EUNIS Code	Biotope Name	JNCC 04.05 code
MA12232	*Semibalanus balanoides*, *Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock	LR.HLR.MusB.Sem.FvesR
MA1243	*Fucus vesiculosus* and barnacle mosaics on moderately exposed mid eulittoral rock	LR.MLR.BF.FvesB
MA12621	Coralline crusts and *Corallina officinalis* in shallow eulittoral rockpools	LR.FLR.Rkp.Cor.Cor
MA1241	*Pelvetia canaliculata* and barnacles on moderately exposed littoral fringe rock	LR.MLR.BF.PelB
MA3211	Barren littoral shingle	LS.LCS.BarSh
MA3	Littoral coarse sediment	LS.LCS

Protected Habitats and Communities

4.4.4.54 The nature designations which have been included for consideration in the benthic and intertidal ecology assessment comprise sites within the National Site Network (i.e., SACs and SPAs with benthic subtidal and intertidal ecology features) or nationally designated sites (e.g., SSSIs). This section identifies designated sites which are within the benthic subtidal and intertidal ecology study area therefore interact with Caledonia North.

4.4.4.55 The Caledonia North OECC overlaps with 107.57km^2 (4.48%) of the Southern Trench MPA which is designated for burrowed mud. Burrowed mud provides habitat for seapens and burrowing megafauna.

4.4.4.56 The sites that lie in the area of the subtidal ecology study area are identified in Table 4–11. Table 4–11 also summarises the qualifying features that relate to the seabed habitats and benthic subtidal and intertidal ecology and the distance from the closest part to Caledonia North. The location of the designated sites is presented in Figure 4-4.

4.4.4.57 An assessment of direct impacts and indirect impacts (e.g., changes in SSC and sediment deposition) as informed through the physical processes modelling presented in Volume 7B, Appendix 2-2: Marine and Coastal Processes Numerical Modelling Report, has been undertaken on relevant benthic subtidal and intertidal ecology features within sites that have the potential to be affected by Caledonia North. Those benthic subtidal and intertidal ecology and seabed habitat features of designated sites within the wider subtidal ecology study area have been screened into the assessment for indirect impacts.

Table 4–11: National and international conservation designations of relevance to benthic subtidal and intertidal ecology within the area of potential direct and indirect impact of Caledonia North.

Site	Qualifying Features	Distance from Caledonia North
Southern Trench MPA	Burrowed mud	▪ 26.06km (Caledonia North Site); and ▪ 0km (Caledonia North OECC)
East Caithness Cliffs MPA	Kelp beds	▪ 21.31km (Caledonia North Site); and ▪ 42.25km (Caledonia North OECC)
Noss Head MPA	Horse mussel beds	▪ 20.74km (Caledonia North Site); and ▪ 45.79km (Caledonia North OECC)
Moray Firth SAC	Kelp beds, ocean quahog, burrowed mud	▪ 57.67km (Caledonia North Site); and ▪ 37.76km (Caledonia North OECC)
Buchan Ness to Collieston Coast SPA	No benthic features	▪ 68.73km (Caledonia North Site); and ▪ 50.50km (Caledonia North OECC)
Dornoch Firth and Loch Fleet SPA	No benthic features	▪ 77.06km (Caledonia North Site); and ▪ 69.54km (Caledonia North OECC)
East Caithness Cliffs SPA	Kelp beds	▪ 21.31km (Caledonia North Site); and ▪ 42.25km (Caledonia North OECC)
Moray and Nairn Coast SPA	No benthic features	▪ 53.36km (Caledonia North Site); and ▪ 26.55km (Caledonia North OECC)
Moray Firth SPA	Kelp beds, ocean quahog, burrowed mud	▪ 34.88km (Caledonia North Site); and ▪ 3.83km (Caledonia North OECC)
North Caithness Clifft SPA	Kelp beds	▪ 31.22km (Caledonia North Site); and ▪ 59.04km (Caledonia North OECC)
Troup, Pennan and Lion's Heads SPA	Kelp beds	▪ 47.18km (Caledonia North Site); and ▪ 9.69km (Caledonia North OECC)

4.4.4.58 Important species potentially found in the Moray Firth include the horse mussel *M. modiolus* (which is not protected at the species level but does form *M. modiolus* reef, which is an Annex I habitat, a PMF and is on the Scottish Biodiversity List (SBL)) and the fan mussel *Atrina fragilis* which is a PMF and is on the SBL. *M. modiolus* is common throughout the Inner Moray Firth, however there are no known areas of *M. modiolus* reef.

4.4.4.59 The Moray West Benthic Survey Report (Moray Offshore Wind Farm (West) Limited, 2018b[41]) noted two benthic species of conservation interest: the ocean quahog *A. islandica* and the flame shell *Limaria hians*. The ocean quahog is a PMF species and is listed as an OSPAR (2008a[51]) threatened and/or declining species. It is a slow growing clam considered to be the longest living mollusc and is found in the subtidal between depths of 10-280m. It can be found around all Scottish coasts, with 70% of the British records occurring in Scottish waters (Tyler-Walters *et al*., 2016a[52]). The flame shell *L. hians* forms the PMF habitat '*Limaria hians* beds in tide-swept sublittoral muddy mixed sediment'. It should be noted that both of these species were recorded in very low numbers. The survey also identified the following biotopes of conservation interest along the offshore cable corridor:

- Seapens and burrowing megafauna in circalittoral fine mud (EUNIS code: MC6216) (a PMF and is classified as a threatened and/or declining habitat; OSPAR, 2008a[51]);
- *Moerella* spp. with venerid bivalves in Atlantic infralittoral gravelly sand (EUNIS code: MB3233) (a PMF); and
- *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand (EUNIS code: MC5211) (a PMF).

4.4.4.60 The Beatrice Offshore Wind Farm Post-Construction Monitoring Year 2 (2021): Benthic Grab Survey Report recorded the ocean quahog *A. islandica*.

4.4.4.61 The following features of nature conservation interest were found during site-specific sampling at the Moray East Site: ocean quahog *A. islandica*, 'Subtidal sands and gravels' which is a priority habitat on the SBL as a result of its importance for the conservation of biodiversity and the biotope '*Moerella* spp. with venerid bivalves in Atlantic infralittoral gravelly sand' (EUNIS code: MB3233) which is listed as a PMF.

Caledonia North Site

4.4.4.62 During analysis of seabed imagery collected during site-specific surveys *A. islandica* siphons were recorded. Individuals of *A. islandica* were also identified in grab samples.

4.4.4.63 Individual sea pens and burrows were recorded but not frequently enough for the area to be considered a 'sea pen and burrowing megafauna communities' habitat.

Caledonia North OECC

4.4.4.64 Analysis of seabed imagery indicated that there was evidence of faunal burrows and/or sea pens at 20 of the 27 camera transect stations (27 of the camera transects were selected as a sub-set for analysis to determine the occurrence and distribution of any habitats or species of conservation interest). Three individuals of the phosphorescent sea pen *Pennatual phosphorea* were recovered at one grab sampling station. Analysis against JNCC (2014[55]) criteria indicated some similarity of the 20 camera transects to a 'sea pen and burrowing megafauna communities' habitat (OSPAR, 2010[57]).

4.4.4.65 Potential rocky reef was observed at seven stations along the Caledonia North OECC, with low and medium resemblance to stony reef (Irving, 2009[58]) indicated at one and two stations, respectively. This habitat is listed under Annex I of the Habitats Directive.

4.4.4.66 There were observation of *A. islandica* siphons in the seabed imagery. Two juveniles were recorded from the grab samples. The sediment invertebrate eDNA detected *A. islandica* at a station in the northern portion of the Caledonia North OECC.

4.4.4.67 A single adult specimen of the bivalve *Devonia perrieri* was collected at one grab sampling station. This species is on the Scottish Biodiversity List (NatureScot, 2020a[59]).

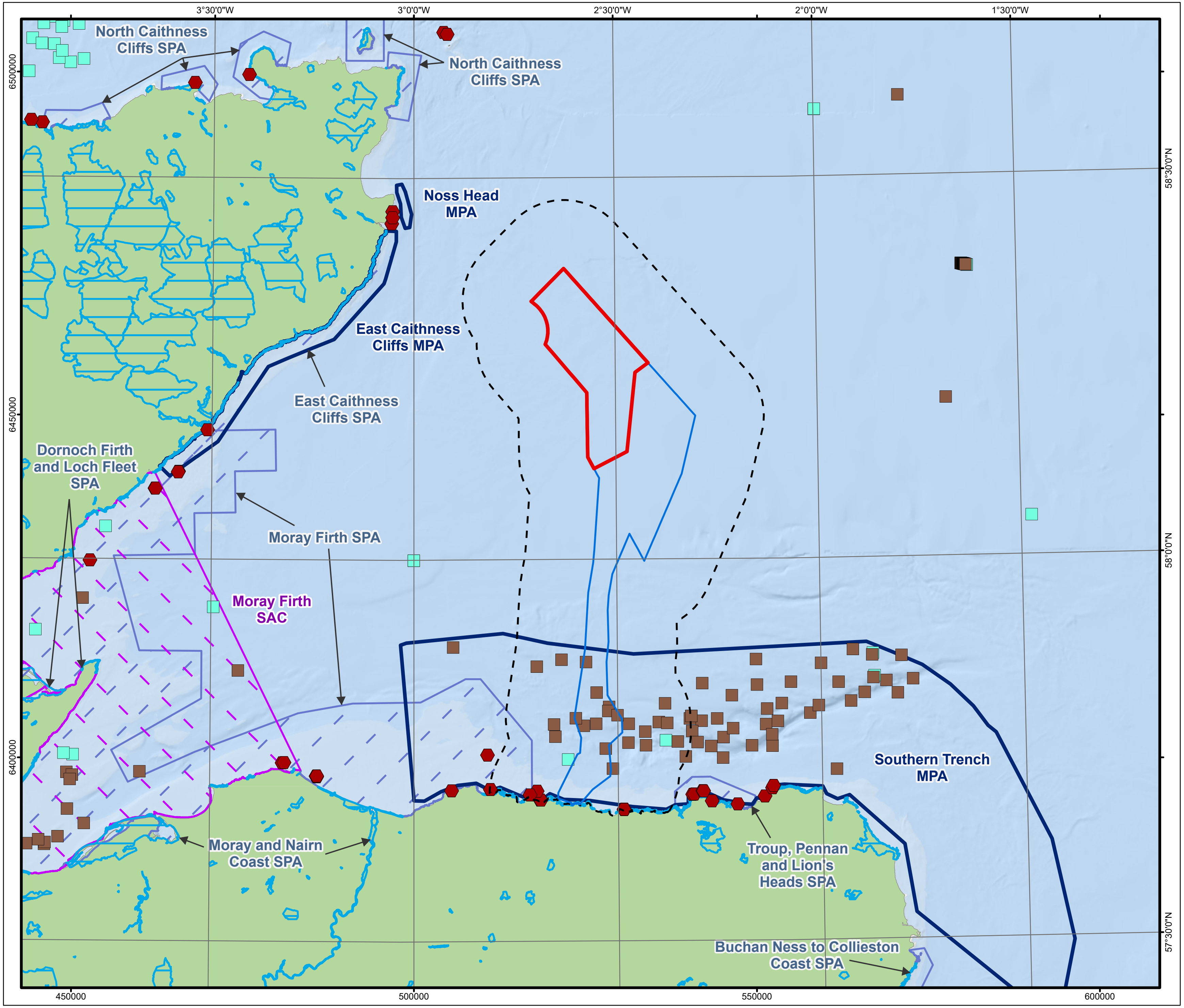
4.4.4.68 The Caledonia North OECC passes through the Southern Trench MPA (Figure 4-4), which is located in the outer Moray Firth and is designated to protect marine mammals, burrowed mud, fronts and shelf deeps. The Southern Trench MPA is a 58km long, 9km wide and 250m deep trench that runs parallel to the coastline. It features a dynamic mixing zone of warm and cold water which attracts shoals of fish including herring, cod and mackerel to the area. In addition, the soft sands provide abundant habitat for sandeels. These then provide food for migratory marine mammals, such as minke whales (NatureScot, 2020b[60]). Figure 4-4 shows the location of the Southern Trench MPA in relation to Caledonia North, and the distribution of its protected features. Figure 4-3 shows the locations of biotopes within the Caledonia North OECC, including 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud', a biotope typically associated with burrowed mud.

4.4.4.69 The burrowed mud habitat present in the MPA (which is characterised by the presence of sea pens, anemones, Norway lobster *Nephrops norvegicus* and crabs), is in favourable condition but is listed as a threatened and/ or declining habitat (OSPAR, 2008a[51]).

Intertidal

4.4.4.70 The extreme low shore was typically characterised by kelp biotopes such as '*Laminaria digitata* on moderately exposed sublittoral fringe bedrock' (EUNIS code: MB12171) and '*Laminaria hyperborea* and foliose red seaweeds on moderately exposed infralittoral rock' (EUNIS code: MB121A). Both the latter biotopes are consistent with kelp beds which is a PMF. 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 forms 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.

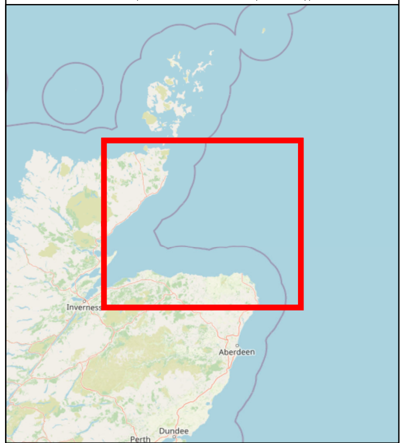
4.4.4.71 It is considered, however, that there is no pathway to direct effects on intertidal kelp beds as the Caledonia North design envelope involves the use of HDD to connect the offshore export cable to land (HDD consists of running the export cable underground (beneath the intertidal zone) meaning any intertidal benthic habitats will not be impacted by construction). As a result, only indirect effects on intertidal kelp beds will be considered (specifically impacts from increased suspended sediment concentration (SSC)/deposition).



- Caledonia North Site
- Caledonia North Offshore Export Cable Corridor
- 10km Benthic Ecology Study Area
- Special Protection Area (SPA)
- Special Area of Conservation (SAC)
- Site Of Special Scientific Interest (SSSI)
- Marine Protected Area (MPA)

Priority Marine Features (Scottish Gov., 2018)

- Kelp Beds
- Ocean Quahog (Arctica islandica)
- Burrowed Mud
- Burrowed Mud (Area)



0 10 20 30 km

REV	DATE	DOC STATUS	ORIGIN	REVIEW	APP
01	09/09/2024	Approved	EV	BB	DH

CALEDONIA Offshore Wind Farm

GoBe APEM Group

CONTRACTOR DRAWING NO: UKCAL1_GO_WNF_BEN_MAP_00140	CONTRACTOR REV: 01
GEODETIC PARAMETERS: WGS 84 / UTM zone 30N (EPSG: 32630)	

DRAWING TITLE

Figure 4-4: Sites Designated for Nature Conservation and Priority Marine Features (PMFs; Scottish Government, 2018; 2022)

STATUS: Approved	SCALE: 1:750,000	
DRAWING NUMBER: N/A	SHEET NO: 01 of 01	REV: N/A

Valued Ecological Receptors (VERs)

4.4.4.72 The value of ecological features is dependent upon their biodiversity, social, and economic value within a geographic framework of appropriate reference (CIEEM, 2016[61]). 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, habitats/species on the SBL 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.

4.4.4.73 Table 4–12 presents the VERs, their conservation status and importance within the Caledonia North benthic subtidal and intertidal ecology study area and the justification and regional importance of each receptor. Where VERs were found within the Caledonia North Site and Caledonia North OECC, they have been assessed within this chapter for direct and indirect impacts. VERs located within the wider subtidal ecology study area have been assessed for indirect impacts only (Section 4.7).

4.4.4.74 The current baseline description above provides an accurate reflection of the current state of the existing environment. Caledonia North has an expected operational life of 35 years. 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.

Table 4–12: VERs within the Caledonia North benthic subtidal and intertidal ecology study area.

VER	Representative Biotope (EUNIS, 2022)	Protection Status	Conservation Interest	Distribution within the Study Area
Subtidal				
Coarse and mixed sediments with moderate to high infaunal diversity and epibenthic communities	▪ MD4211 ▪ MC3212 ▪ MB3235	▪ None	▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest ▪ UK BAP habitat	Located within the Caledonia North Site, the Caledonia North OECC and in the wider subtidal ecology study area as identified in Table 4–7.
Sandy sediments with low infaunal diversity and sparse epibenthic communities	▪ MB5236 ▪ MB5233	▪ None	▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest ▪ UK BAP habitat	Located within the Caledonia North OECC and in the wider subtidal ecology study area as identified in Table 4–7.
Intertidal				
Kelp and red seaweeds communities	▪ MB12171	▪ EC Habitats Directive Annex I	▪ UK BAP habitat	Located in the intertidal study area.
Rockpool communities	▪ MA126 ▪ MA1261 ▪ MA1262 ▪ MA1263 ▪ MA12621	▪ EC Habitats Directive Annex I	▪ UK BAP habitat	Located in the intertidal study area.
Fucoids on sheltered marine shore communities	▪ MA1251 ▪ MA123C	▪ EC Habitats Directive Annex I	▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest	Located in the intertidal study area.

VER	Representative Biotope (EUNIS, 2022)	Protection Status	Conservation Interest	Distribution within the Study Area
			▪ UK BAP habitat	
Barnacles and fucoids on moderately exposed shore communities	▪ MA1241 ▪ MA1242 ▪ MA1243 ▪ MA12441	▪ EC Habitats Directive Annex I	▪ None	Located in the intertidal study area.
Lichens or small green algae on supralittoral and littoral fringe rock communities	▪ MA121 ▪ MA1211 ▪ MA1213	▪ EC Habitats Directive Annex I	▪ Habitat of Principal Importance ▪ UK BAP habitat	Located in the intertidal study area.
Mussel and/or barnacle communities	▪ MA12231 ▪ MA12232	▪ EC Habitats Directive Annex I	▪ None	Located in the intertidal study area.
Robust fucoid and/or red seaweed communities	▪ MA1233	▪ EC Habitats Directive Annex I	▪ None	Located in the intertidal study area.
Littoral coarse sediment communities	▪ MA3 ▪ MA3211	▪ None	▪ None	Located in the intertidal study area.
Priority Marine Features				
Burrowed mud	▪ MC6216	▪ Within an MPA (Southern Trench) ▪ 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	Located within the Caledonia North OECC.

VER	Representative Biotope (EUNIS, 2022)	Protection Status	Conservation Interest	Distribution within the Study Area
Offshore subtidal sands and gravels	▪ MC5211 ▪ MD5212	▪ None	▪ Scottish Biodiversity List ▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest	Located within the Caledonia North Site, Caledonia North OECC and in the wider subtidal ecology study area as identified in Table 4–7.
Tide-swept coarse sands with burrowing bivalves	▪ MB3233	▪ EC Habitats Directive Annex I (Subtidal sandbanks)	▪ Scottish Biodiversity List ▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest	Located in the wider subtidal ecology study area as identified in Table 4–7.
Kelp beds	▪ MB121A	▪ EC Habitats Directive Annex I (Reefs)	▪ Scottish Biodiversity List	Located in the intertidal study area.
Horse mussel beds *Modiolus modiolus*	▪ N/A	▪ EC Habitats Directive Annex I (Biogenic reef habitat)	▪ Scottish Biodiversity List ▪ OSPAR List of Threatened and/or Declining Species and Habitats ▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest ▪ UK BAP habitat	Potentially present within the wider Moray Firth area.
Flame shell beds *Limaria hians*	▪ N/A	▪ None	▪ Scottish Biodiversity List ▪ Habitat of Principal Importance ▪ Habitat of Conservation Interest ▪ UK BAP habitat	Potentially present within the wider Moray Firth area.

VER	Representative Biotope (EUNIS, 2022)	Protection Status	Conservation Interest	Distribution within the Study Area
Ocean quahog *Arctica islandica*	N/A	None	OSPAR List of Threatened and/or Declining Species and Habitats	Located within the Caledonia North Site, the Caledonia North OECC and in the wider subtidal ecology study area as identified in Table 4–7.
Fan mussel *Atrina fragilis*	N/A	Wildlife and Countryside Act (1981)	Scottish Biodiversity List UK BAP habitat	Potentially present within the wider Moray Firth area.
Devonia perrieri	N/A	None	Scottish Biodiversity List	One specimen located within the Caledonia North OECC.

4.4.5 Do Nothing Baseline

4.4.5.1 If Caledonia North is not constructed, an assessment of the future baseline conditions has also been carried out and is described within this section. The baseline environment will exhibit some degree of natural change over time due to naturally occurring processes and cycles, with or without Caledonia North in place.

4.4.5.2 In addition to potential change associated with existing processes and cycles, it is necessary to consider the potential impacts of climate change on the marine environment. Direct and indirect changes to benthic habitats and communities in the mid- to long-term may be brought about by variability and long-term changes on physical influences (UK Offshore Energy Strategic Environmental Assessment 3 (OESEA3), 2016[62]). There is strong evidence to suggest that long-term changes to benthic ecology may be related to long-term changes in the climate (OESEA3, 2016[62]), with climatic processes driving shifts in benthic community abundance and species composition (Marine Climate Change Impacts Partnership (MCCIP), 2015[63]).

4.4.5.3 In the UK, modelling of sea surface temperature in relation to climate change has shown that the rate of temperature increase over the last 50 years has been greater in waters off the east coast compared to the west coast, and this is predicted to continue for the next 50 years (MCCIP, 2013[64]). Benthic ecology studies have indicated that over the last three decades, biomass has increased by at least 250-400%. Furthermore, there has been an increase in the biomass of opportunistic and short-lived species, and a decrease in the biomass of long-living sessile species (Kröncke, 1995[65]; Kröncke, 2011[66]).

4.4.5.4 Therefore, the baseline characterisation of Caledonia North Site and Caledonia North OECC described in section 4.4 represents a 'snapshot' of the present benthic ecosystem within a gradual yet continuously changing environment. Any changes that may occur during the 35-year lifetime of Caledonia North should be considered in the context of greater variability and sustained trends occurring on national and international scales within the marine environment.

4.4.6 Data Gaps and Limitations

4.4.6.1 Grab sampling and video surveys, while providing detailed information on the infauna and epifauna present, cannot cover wide swaths of the seabed and consequently represent point samples that must be interpreted in combination with the geophysical datasets to produce benthic maps that provide comprehensive cover.

4.4.6.2 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 cannot be precisely defined.

4.4.6.3 Consequently, the benthic habitats and biotopes presented in the baseline environment and the rest of the 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.

4.4.6.4 There are additional limitations inherent within the Marine Evidence-based Sensitivity Assessment (MarESA). These include the assessments not being site-specific and consequently there may be differences in sensitivity within a species in different habitats. These limitations are included within the confidence score assigned to the MarESA assessment, for which the full details and rationale are provided on the Marine Life Information Network (MarLIN) website, and in the assessment summaries.

4.4.6.5 The overall confidence in the evidence used for the MarESA sensitivity assessments is assessed for three categories: the quality of the evidence/ information used; the degree to which the evidence is applicable to the assessment; and the degree of concordance (agreement) between the available evidence. A 'low', 'medium' or 'high' confidence score can be applied to the different categories:

- For quality of the evidence – the assessment is based on expert judgment (i.e., insufficient scientific evidence or grey literature);
- For applicability of the evidence – the assessment is based on the proxies for the pressure (e.g., based on natural disturbance events rather than anthropogenic); and
- For the degree of concordance of the evidence – the available evidence does not agree on direction or magnitude of the impact or recoverability.

4.4.6.6 The confidence of the sensitivity assessment is based on the confidence of the assessments for the resilience and resistance of each habitat. For example, if the confidence for the resilience or resistance assessment in 'low' or 'not relevant' then the corresponding confidence for the sensitivity assessment will also be low. If confidence for resilience or resistance is 'medium' or 'high', this will be reflected in the overall confidence value for the assessment. This is related to the quality of the evidence that is available.

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

4.4.6.8 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[67]). 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[67]). 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).

4.5 EIA Approach and Methodology

4.5.1 Overview

4.5.1.1 This section outlines the methodology for assessing the likely significant effects on benthic subtidal and intertidal ecology due to the construction, operation and decommissioning phases of Caledonia North.

4.5.2 Impacts Scoped into the Assessment

4.5.2.1 The Offshore Scoping Report (Volume 7, Appendix 2) was submitted to MD-LOT in September 2022. The Offshore Scoping Report set out the overall approach to assessment and allowed for the refinement of Caledonia North over the course of the assessment. The proposed scope of the assessment is set out in Table 4–13.

Table 4–13: Impacts scoped in for benthic subtidal and intertidal ecology.

Potential Impact	Phase	Nature of Impact
Temporary habitat disturbance	All phases (construction, operation and decommissioning)	Direct
Temporary increases in SSCs and changes to seabed levels	Construction (and decommissioning)	Direct and indirect
Direct and indirect seabed disturbance leading to release of sediment contaminants	Construction (and decommissioning)	Direct and indirect
Long-term habitat loss/alteration due to the addition of infrastructure to the area	Operation	Direct
Colonisation of hard substrates	Operation	Direct
Increased risk of introduction and/or spread of INNS	Operation	Direct
Changes in physical processes resulting from the presence of the OWF subsea infrastructure (e.g., scour effects, changes in wave/tidal current regimes and resulting effects on sediment transport)	Operation	Direct and indirect
EMF effects generated by inter-array, interconnector and export cables	Operation	Direct
Seabed sediment heating from subsea cables	Operation	Direct
Long-term habitat loss/alteration due to the removal of infrastructure	Decommissioning	Direct

4.5.4 Impacts Scoped out of the Assessment

4.5.4.1 The impacts scoped out of the assessment during EIA scoping, and the justification for this, are listed in Table 4–14.

Table 4–14: Impacts scoped out for benthic subtidal and intertidal ecology.

Potential Impact	Justification
Accidental pollution event during construction or decommissioning activity	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. In addition, all vessels on Caledonia North will be required to comply with strict environmental controls set out in the EMP and Marine Pollution Contingency Plan (MPCP) which will minimise the risk and set out provisions for responding to spills during construction and 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.
Accidental pollution events during operational activity	See justification described for accidental pollution events during construction and decommissioning activity above.

4.5.5 Assessment Methodology

4.5.5.1 The project-wide generic approach to assessment is set out in Volume 1, Chapter 7: EIA Methodology. The assessment methodology for Benthic Subtidal and Intertidal Ecology for the EIAR is consistent with that provided in the Offshore Scoping Report (Volume 7, Appendix 2).

4.5.5.2 The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of the receptors and the magnitude of the potential impacts. This section describes the specific criteria applied in this chapter to assign values to the sensitivity of receptors and the magnitude of potential impacts.

4.5.5.3 The magnitude of potential impacts is defined by a series of factors, including the spatial extent of any interaction, the likelihood, frequency and duration of a potential impact. The definitions of magnitude used in the assessment are defined in Table 4–15. Potential impacts have been considered in terms of permanent or temporary, and adverse or beneficial effects. Where an effect could reasonable be assigned more than one level of magnitude, professional judgement has been used to determine which rating is applicable.

Table 4–15: Impact magnitude.

Impact Magnitude	Description
High	Complete loss and/or alteration to qualifying/key element and features of the receptor or receiving environment.
Medium	Partial loss and/or alteration to qualifying/key elements and features of the receptor or receiving environment.
Low	Minor loss/divergence from baseline conditions.
Negligible	Very slight/no change to baseline conditions.

4.5.5.4 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[68]). 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.

4.5.5.5 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 4–16.

Table 4–16: Sensitivity/importance of the environment.

Receptor Sensitivity/ Importance	Definition
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 years or up to 25 years or not at all (resilience is 'Low').
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

Receptor Sensitivity/ Importance	Definition
	over medium timescales, i.e., >2 years 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 short timescales, i.e., <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').
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 short timescales, i.e., <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').
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 a short timescale, i.e., <2 years (resilience is 'High').

4.5.5.6 The consideration of the magnitude of a potential impact and sensitivity of the receptor determines and expression for the overall significance of the adverse or positive effects. This determination may be quantitative or qualitative and is often informed by expert judgement.

4.5.5.7 Table 4–17 below sets out how impact magnitude and receptor sensitivity interact to facilitate a judgement of significance of effect.

Table 4–17: Relationship between impact magnitude and receptor sensitivity to assign significance of effect

Significance of Effect		Sensitivity of Receptor			
		Negligible	Low	Medium	High
Impact Magnitude	Negligible	Negligible	Negligible	Negligible	Negligible
	Low	Negligible	Negligible	Minor	Minor
	Medium	Negligible	Minor	Moderate	Moderate
	High	Negligible	Minor	Moderate	Major

4.5.5.8 For the purposes of this assessment, any effect that is of major or moderate significance is considered to be 'significant' in EIA terms, as highlighted in grey in Table 4–17. Any effect that has a significance of minor or negligible is considered to be 'not significant' in EIA terms. A typical categorisation for effect significance is provided in Table 4–18. An assessment of the significance of potential effects is described in Sections 4.7 and 4.8.

Table 4–18: Categorisation for effect significance.

Expression	Definition	Significance
Major	A fundamental change to the environment or receptor, resulting in a significant effect	Significant
Moderate	A material but non-fundamental change to the environment or receptor, resulting in a possible significant effect	Significant
Minor	A detectable but non-material change to the environment or receptor resulting in no significant effect or small-scale temporary changes	Not Significant
Negligible	No detectable change to the environment or receptor resulting in no significant effect	Not Significant

4.5.6 Approach to Cumulative Effects

4.5.6.1 The Cumulative Impact Assessment (CIA) assesses the impact associated with Caledonia North together with other relevant plans, projects and activities. Cumulative effects are therefore the combined effect of Caledonia North in combination with the effects from a number of different projects, on the same receptor or resource.

4.5.6.2 The approach to the CIA for Benthic Subtidal and Intertidal Ecology follows the process outlined in Volume 1, Chapter 7: EIA Methodology.

4.5.6.3 The list of relevant developments for inclusion within the CIA is outlined in Volume 7A, Appendix 7-1: Cumulative Impact Assessment Methodology.

4.5.6.4 Developments which are located within 10km of the benthic subtidal and intertidal ecology study area have the potential to result in a cumulative effect. Developments which are either operational or in the decommissioning stage are considered to be part of the baseline and are not considered within the assessment.

4.5.7 Embedded Mitigation

4.5.7.1 Where possible, mitigation measures will be embedded into the design of Caledonia North. These measures will be included with the objective to reduce the potential for impacts on the environment.

4.5.7.2 Where embedded mitigation measures have been developed into the design of Caledonia North with specific regard to benthic subtidal and intertidal ecology, these are described in Table 4–19. The impact assessment presented in Sections 4.7 to 4.10 take into account this embedded mitigation.

Table 4–19: Embedded mitigation.

Code	Mitigation Measure	Securing Mechanism
M-1	Development of and adherence to a Cable Plan (CaP). The CaP will confirm planned cable routing, burial and any addition protection and will set out methods for post-installation cable monitoring.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.
M-5	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.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.
M-6	Wind farm infrastructure will be micro-sited, where possible, around any sensitive seabed habitats including Annex I habitat (if present) to avoid any developmental impacts on these conservation features.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.
M-7	Suitable implementation and monitoring of cable protection (via burial, or external protection where adequate burial depth as identified via the CBRA is not feasible), as detailed within the CaP.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.
M-8	Development of and adherence to an Offshore Environmental Management Plan (EMP). The EMP will set out mitigation measures and procedures relevant to environmental management, including but not limited to the following topics: chemical usage, invasive non-native marine species, dropped objects, pollution prevention and contingency planning, and waste management.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.
M-9	Development of and adherence to a MPCP. The MPCP will identify potential sources of pollution and associated spill response and reporting procedures.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.
M-10	Development of and adherence to a Decommissioning Plan (DP). The DP will outline measures for the decommissioning of Caledonia North.	To be secured as a condition of the Generation Asset and Transmission Asset Marine Licences.

Code	Mitigation Measure	Securing Mechanism
M-106	Trenchless techniques (Horizontal Directional Drilling) will be used as installation methodology at landfall to avoid direct impacts to the intertidal area.	To be secured as a condition of the Transmission Asset Marine Licence.

4.6 Key Parameters for Assessment

4.6.1.1 Volume 1, Chapter 3: Proposed Development Description (Offshore) details the parameters of Caledonia North using the Design Envelope approach. This section identifies those parameters during construction, operation and decommissioning relevant to potential impacts on Benthic Subtidal and Intertidal Ecology.

4.6.1.2 The worst-case assumptions with regard to benthic subtidal and intertidal ecology are summarised in Table 4–20.

Table 4–20: Worst-Case Design Scenario considered for each impact as part of the assessment of likely significant effects.

Potential Impact	Assessment Parameter	Explanation
Construction		
Impact 1: Temporary habitat disturbance	Maximum temporary habitat disturbance within Caledonia North = **9,608,026m²**. **Caledonia North Site:** ▪ Foundation seabed preparation = 908,500m² o 77 WTGs (jacket foundations with suction caissons (including scour protection)) = 885,500m² o Two OSPs (jacket foundations with suction cassions (including scour protection)) = 23,000m² ▪ Jack-up Vessels (JUVs) and anchoring operations= 149,310m² o Maximum seabed footprint for JUVs (145,530m² (77 WTGs) and 3,780m² (two OSPs)) = 149,310m² ▪ Cable seabed preparation and installation in the Caledonia North Site= 5,850,000m² o Maximum total area of seabed disturbed installation of 77 inter-array cables (total length = 360km) = 5,400,000m² o Maximum total area of seabed disturbed by installation of one interconnector cable (total length 30km) = 450,000m² **Caledonia North OECC:** ▪ Cable seabed preparation in the Caledonia North OECC = 2,700,216m²	The temporary habitat disturbance relates to seabed preparation for foundations and cables, jack up and anchoring operations, and cable installation. It should be noted that where boulder clearance overlaps with sandwave clearance, the boulder clearance footprint will be within the sandwave clearance footprint and therefore not counted twice. For foundations (WTGs and OSPs), jacket foundations with suction caissons have been selected and assessed as the worst-case scenario due to having the largest footprint of all the foundation types. 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 Caledonia North Site and Caledonia North OECC. 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. Given the extensive rocky habitat and exposed bedrock features at Stake Ness Landfall Site (see Volume 7B, Appendix 4-5: Intertidal Survey Report), it is anticipated that the HDD punch-out location will be situated within the shallow subtidal (likely between 10m and 40m water depths). It is not envisaged that cofferdams will be required at the HDD punch-out

Potential Impact	Assessment Parameter	Explanation
	o Maximum total area of seabed disturbed during installation of offshore export cables (total length 180km) = 2,700,000m² o HDD installation will require two HDD pits (15m x 6m x 1.2m), the maximum area of HDD pits = 216m².	locations, and it is considered unlikely that access to the foreshore at Stake Ness Landfall Site will be required.
Impact 2: Temporary increases in SSCs and changes to seabed levels	**Construction/installation:** ▪ Dredging WTG and OSP foundations: o 77 WTGs on jacket with suction caissons foundations; o The volume of sediment disturbed per WTG is estimated at 90,750m^3, which correspond to a total of 6,987,750m^3; o Two OSPs on jacket with suction caissons foundations; o The volume of sediment disturbed per OSP is anticipated to be 90,750m^3, which correspond to a total of 181,500m^3; o Overall total sediment disturbed by dredging = **7,169,250m^3** (WTG and OSP foundations); ▪ 77 inter-array cables, with a total length of 360km: o Circular cross section trench shape; o Affected seabed width of 15m; o Burial depth of 3m; o Jet trencher installation method; o Assumed installation rate of minimum to 300m/hr; o Total volume of disturbance = **16,200,000m^3**; ▪ One interconnector cable with a total length of 30km; o Circular cross section trench shape; o Affected seabed width of 15m;	The worst-case-scenario for sediment disturbance activities will be temporally and spatially variable (depending upon the metocean conditions at the time). For sediment plumes, the worst-case-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 (see details in Volume 7B, Appendix 2-2: Marine and Coastal Processes Numerical Modelling Report). The same applies for sediment deposition at the bed, where the worst-case-scenario is a representation of maximum deposit thickness, maximum footprint extent or likely duration. The creation of biogenic reef is not expected to result in any increases in SSC. Seabed preparation works would be required prior to installation. The use of a Trailer Suction Hopper Dredger (TSHD) is considered to be the realistic worst-case-scenario option. Sediment volumes disturbed through seabed levelling are greatest for the WTGs and OSPs with suction caissons foundations. It is noted that the drilling of monopile WTG and OSP foundations could give rise to increased SSCs, however

Potential Impact	Assessment Parameter	Explanation
	o Burial depth of 3m; o Jet trencher installation method; o Assumed installation rate of up to 700m/hr; o Total volume of disturbance = **1,350,000m³**. ▪ Two offshore export cables with a total length of 180km; o Circular cross section trench shape; o Affected seabed width of 15m; o Affected depth of 3m; o Jet trencher installation method; o Assumed installation rate of up to 700m/hr o Total volume of disturbance = **8,100,000m³**; ▪ Savewave clearance via dredging (cables within the Caledonia North Site); ▪ Sandwave clearance via dredging (offshore export cables); ▪ HDD drilling fluid release: o Volume and mass of drilling fluid released per HDD conduit: 450m³; o Number of HDD conduits: 2; and o Total volume and mass of drilling fluid released = **900m³**.	the worst-case scenario in terms of maximum temporary disturbance has been assumed to be dredging associated with the installation of jacket with suction caisson foundations. Cable installation may require some combination of jetting, ploughing, trenching and/or cutting type installation techniques. The realistic worst-case scenario option is represented by the use of jet trenching methods, which develops the largest trench cross-section with the greatest potential to displace fine sediments into the water column to the same height as the depth of the trench. The fastest trenching rate of 700m/hr represents the highest release rate of sediments operating in locations with the largest contribution of fine sediments. HDD operations are expected to have localised and short-term effects on SSC concentrations due to the potential release of bentonite during punch-out in the nearshore exit pit. The period of release for bentonite is estimated to be 12 hours to accommodate both initial punch-out and the subsequent reaming processes. Accordingly, the release rate has been estimated at 3,195g/s over this period. The assessment of sandwave clearance requirements for the Caledonia North Site and Caledonia North OECC have been considered separately in Volume 3, Chapter 2, Marine and Coastal Processes.
Impact 3: Direct and indirect seabed disturbance leading to release of sediment contaminants	Refer to Impact 2.	The 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.

Potential Impact	Assessment Parameter	Explanation
Operation and Maintenance		

Impact 4: Long-term habitat loss/alteration due to the addition of infrastructure to the area	Maximum long-term habitat loss/alteration = **5,108,500m²**.
	
	- Maximum WTG footprints and scour protection = **908,500m²**:
	  o Turbine total structure footprint including scour protection, based on 77 jacket foundations with suction caissons = 885,500m²;
	  o Structure footprint of two OSPs (jacket foundations) = 23,000m².
	- Maximum cable protection in the Caledonia North Site = **2,376,000m²**:
	  o Maximum total area of seabed covered by cable protection for inter-array cables (based on cable protection being required for 108 km of inter-array cables) = 2,160,000m²;
	  o Maximum total area of seabed covered by cable protection for interconnector cables (based on cable protection being required for 9km of interconnector cables) = 180,000m²;
	  o Total area of seabed covered by cable protection for inter-array cable crossings (based on ten (150m x 20m) cable crossings) = 30,000m²;
	  o Total area of seabed covered by cable protection for interconnector cable crossings (based on two (150m x 20m) cable crossings) = 6,000m².
	- Maximum cable protection footprint in the Caledonia North OECC = **1,824,000m²**:
	  o Maximum total area of seabed covered by cable protection for offshore export cables (based on
		The worst-case design scenario is defined by the maximum area of seabed lost by the footprint of anchors on the seabed, OSP foundations, scour and cable protection, and cable crossings. Habitat loss from drilling and drill arisings is of a smaller magnitude than presence of infrastructure.
		
		Worst-case scenario footprints for cable protection have been determined based on a precautionary:
		- Up to 30% of cable protection being required for the inter-array cables;
		- Up to 30% of cable protection being required for the interconnector cables; and,
		- Up to 50% of cable protection being required for the offshore export cables.

Potential Impact	Assessment Parameter	Explanation
	cable protection being required for 90km of the offshore export cables) = 1,800,000m²; and o Total area of seabed covered by cable protection for offshore export cable crossings (based on eight (150m x 20m) cable crossings) = 24,000m².	
Impact 5: Temporary habitat disturbance	Total direct disturbance to seabed from maintenance activities = **407,900m²**. **Caledonia North Site:** ▪ WTG repairs = **56,700m²**: o Total seabed disturbance by JUV events for WTG maintenance (1,890m² disturbance per JUV event x 30 JUV events) = 56,700m². ▪ Inter-array cable repair and replacement activities = **194,500m²**: o Seabed disturbance per major fault for inter-array cable maintenance (1,890m² footprint per JUV x 10 JUV events) = 18,900m² of disturbance per major fault; o 1km of cable replacement per major fault = 20,000m²; o Estimated number of major faults: 5. **Caledonia North OECC:** ▪ Offshore export cable repair and replacement activities = **156,700m²**: o Seabed disturbance per major fault for offshore export cable maintenance (1,890m² disturbance per JUV x 6 JUV events) = 11,340m² per major fault.	The worst-case design scenario is defined by the maximum area of habitat disturbance arising from maintenance activities during the 35-year operational phase. The worst-case scenario is defined by the maximum number of JUV and anchoring operations and the total cable replacement and repairs through maintenance activities that could have an interaction with the seabed during operation. The O&M strategy of the project is not yet defined, so the values given are predicted from previous project experience. A precautionary estimate assumes: ▪ 30 JUV events for WTG maintenance; ▪ 10 JUV events to repair one major inter-array cable fault (the length of repair will be 1km of cable replaced); ▪ 6 JUV events to repair one major offshore export cable fault (the length of repair will be 1km of cable replaced); and ▪ 5 major events for inter-array cables and 5 major events offshore export cables throughout the lifetime of Caledonia North.

Potential Impact	Assessment Parameter	Explanation
	o 1km of offshore export cable replacement per major fault = 20,000m²; o Estimated number of major faults: 5.	
Impact 6: Colonisation of hard substrates	Total surface area of introduced hard substrates = **5,406,330m²**. ▪ Hard substrates in the water column = **297,830m²**: o 77 WTGs and two OSPs, jackets with suction caissons (79 towers total), each with a radius of 2.5m, within a maximum water depth of 60m, giving a per tower surface area of 3,770m², with a total area of 297,830m². ▪ Hard substrates on the seabed = **5,108,500m²**: o Total surface area of scour protection for 77 WTGs and two OSPs (79 total jacket foundations with suction caissons) = 908,500m²; o Total surface area of cable protection in the Caledonia North OECC = 1,824,000m²; and o Total surface area of cable protection in the Caledonia North Site (inter array and interconnector cables) = 2,376,000m².	The worst-case design scenario is defined by the maximum area of structure, introduced into the water column. Man-made substructures such as WTG and OSP foundations and any associated scour/cable protection on the seabed are expected to be colonised by marine organisms. This colonisation is expected to result in an increase in local biodiversity and alterations to the near field benthic ecology of the area.
Impact 7: Increased risk of introduction and/or spread of INNS	Total surface area of introduced hard substrates = **5,406,330m²** (refer to Impact 6). Increased risk of introduction or spread of INNS by operational vessel movements: ▪ Daily crew transfer vessel (CTV) trips, with two CTVs, plus weekly service operation vessel movements; ▪ 938 vessel movements annually; and up to	Maximum surface area created by offshore infrastructure in the water column and maximum number of vessel movements during the operational phase.

Potential Impact	Assessment Parameter	Explanation
	▪ 25 vessels on-site simultaneously (in the case of major maintenance.	
Impact 8: Changes in physical processes resulting from the presence of the OWF subsea infrastructure	The worst-case design scenario for changes in physical processes resulting from the presence of subsea infrastructure associated with Caledonia North is presented in Volume 3, Chapter 2: Marine and Coastal Processes (refer to Impacts 4, 5 and 6).	The impact is defined by any anticipated changes to marine and coastal processes, such as scour effects, changes in wave/tidal current regimes and resulting effects on sediment transport. Further details provided in Volume 3, Chapter 2: Marine and Coastal Processes.
Impact 9: EMF effects generated by inter-array, interconnector and export cables	▪ 77 inter-array cables: o 360km combined length, operating at up to 132kV; o Minimum cable burial depth: 1m; ▪ One interconnector cable: o 30km in length, operating at up to 275kV; o Minimum cable burial depth: 1m; ▪ Two offshore export cables: o 180km combined length, operating at up to 275kV; o Minimum cable burial depth: 1m; and ▪ Operational lifetime of Caledonia North: 35 years.	The maximum length and operating current of inter-array, interconnector and offshore export cables will result in the greatest potential for EMF effects. The minimum target cable burial depth represents the worst-case scenario as EMF exposure will be reduced with greater burial depth.
Impact 10: Seabed sediment heating from subsea cables	Refer to Impact 9.	The maximum length and operating current of inter-array, interconnector and offshore export cables will result in the greatest potential for seabed sediment heating effects.
Decommissioning		
Impact 11: Temporary habitat disturbance	The worst-case design scenario will be equal to (or less than) that of the construction phase. Refer to Impact 1.	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.

Potential Impact	Assessment Parameter	Explanation
Impact 12: Temporary increases in SSCs and changes to seabed levels	The worst-case design scenario will be equal to (or less than) that of the construction phase. Refer to 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 levels of suspended sediment and associated deposition during decommissioning.
Impact 13: Direct and indirect seabed disturbance leading to release of sediment contaminants	The worst-case design scenario will be equal to (or less than) that of the construction phase. Refer to 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 14: Long-term habitat loss/alteration due to the removal of infrastructure	The worst-case design scenario will be the removal of the area of introduced hard substrate outlined. Refer to Impact 6.	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 removed during decommissioning.

4.7 Potential Effects

4.7.1 Construction

4.7.1.1 This section presents the assessment of impacts arising from the construction phase of Caledonia North. The effects of construction of Caledonia North have been assessed for the benthic subtidal and intertidal ecology study area.

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

Impact 1: Temporary Habitat Disturbance

Magnitude of Impact

4.7.1.3 The total maximum area of temporary disturbance of subtidal habitat due to construction activities at Caledonia North is approximately 9.61km^2, as described in Table 4–20. This equates to approximately 1.54% of the total seabed area within Caledonia North. 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 Caledonia North Site and Caledonia North OECC. This approach effectively counts the footprint of the 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 project timescales. Based on current construction plans for Caledonia North, the worst-case scenario (maximum amount of time) between seabed clearance and cable installation is 21 months.

4.7.1.4 Of the total area of temporary habitat loss described in Table 4–20, approximately 6.91km^2 is predicted to be temporarily disturbed within Caledonia North Site as a result of seabed preparations for foundations, jack-up barge operations and the installation and burial of inter-array and interlink cables (including associated anchor placements). This equates to approximately 3.16% of the total seabed area within Caledonia North Site.

4.7.1.5 Of the total area of temporary habitat loss described in Table 4–20, a maximum of approximately 2.70km^2 will be temporarily disturbed within the subtidal areas of the Caledonia North OECC. This equates to approximately 0.67% of the total seabed area within the Caledonia North OECC.

4.7.1.6 As described in Section 4.4, the benthic habitats comprise macrofauna assemblages associated with the predominantly sandy habitats that characterise the Caledonia North Site and Caledonia North OECC. Whilst these are considered VERs (see Table 4–12), the majority of benthic habitats that are predicted to be affected by a direct temporary habitat disturbance of this nature are common and widespread throughout the wider region. The temporary habitat disturbance during construction activities would therefore impact a very limited footprint, particularly when compared to the overall extent of such habitats. This loss is not expected to undermine regional ecosystem functions or diminish biodiversity.

4.7.1.7 Whilst this impact will occur within the Southern Trench MPA, where the Caledonia North OECC overlaps (57.61% of the Caledonia North OECC overlaps with 4.48% of the MPA), the impact on benthic habitats is predicted to be of local spatial extent (i.e., restricted to discrete areas within Caledonia North), of a short-term duration (as it is limited to the duration of construction activities), 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 Receptor

4.7.1.8 The sensitivity of all biotopes that are known to characterise Caledonia North and that are anticipated to be present across the Caledonia North Site and Caledonia North OECC (Section 4.4) have been assessed according to the detailed MarESA sensitivity assessments (Table 4–21).

4.7.1.9 The ocean quahog (*A. islandica*) is included as a VER (Table 4–12). 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 *A. islandica* is listed as under threat and/or decline. The magnitude of the impact on *A. islandica* is therefore negligible. Irrespective of the sensitivity of the receptor, the significance of the impact on *A. islandica* is not significant as defined in the assessment of significance matrix (Table 4–17) and is therefore not considered further in this assessment.

Table 4–21: MarESA for the benthic habitats for abrasion/disturbance.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on 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
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in 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

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
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
Sea pens and burrowing megafauna in Atlantic circalittoral fine mud	MC6216	Medium (based on medium resistance and low resilience)	Confidence is medium as the assessment 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
Echinocyamus pusillus, *Ophelia borealis* and *Abra 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
Moerella spp. with venerid bivalves in Atlantic infralittoral gravelly sand	MB3233	Low (based on medium resistance and high resilience)	Confidence is low as the assessment is based on expert judgement

Coarse and Mixed Sediments with Moderate to High Infaunal Diversity and Epibenthic Communities

4.7.1.10 The biotope 'Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment' (MD4211) was recorded in multiple stations across the Caledonia North Site and one station in the Caledonia North OECC. However, it varies from the standard description due to a lack of dominant bivalves. The burrowing species associated with this biotope (such as *Glycera 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, MarESA describes the sensitivity as low for abrasion and disturbance (Tillin and Watson, 2023a[69]).

4.7.1.11 '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel' (MC3212) was recorded in the Caledonia North Site and is characterised by venerid bivalves which live close to the surface (Morton, 2009[70]) 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, MarESA biotope sensitivity is assessed as low (Tillin and Watson, 2024a[71]).

Sandy Sediments with Low Infaunal Diversity and Sparse Epibenthic Communities

4.7.1.12 The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) was recorded at two stations in the south of the Caledonia North OECC. 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[72]). Similarly, the polychaete *Nephtys 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 MarESA describes the sensitivity as low for abrasion and disturbance (Tillin *et al*., 2023[73]).

Burrowed Mud

4.7.1.13 The biotope 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud' (MC6216) was characterised at various stations along the Caledonia North OECC based on a review of the imagery. Most sea pens can avoid abrasion by withdrawing into the sediment, but frequent disturbance will probably reduce feeding time and viability. Therefore, MarESA suggests a resistance of medium. As the resilience is likely to be low, the sensitivity of this biotope is assessed to be medium. Given the low magnitude of the impacts, it is not expected that a large proportion of the sea pean population would be removed.

Offshore Subtidal Sands and Gravels

4.7.1.14 The biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) was recorded in two stations across the Caledonia North OECC. 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 is assessed to be low (Tillin and Watson, 2024b[74]).

4.7.1.15 The biotope '*Owenia fusiformis* and *Amphiura filiformis* in deep circalittoral sand or muddy sand' (MD5212) was recorded at multiple stations in the Caledonia North Site, and possibly across the Caledonia North OECC. However, in the Caledonia North Site it is represented by a variant with *Galathowenia* sp. but not *Owenia* sp., and across the Caledonia North OECC there were high numbers of Thracioidea which are not in the standard description. 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 is assessed as medium (De-Bastos, 2023[75]).

Tide-swept Coarse Sands with Burrowing Bivalves

4.7.1.16 The biotope '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (MB3233) was identified in site-specific surveys conducted for the Moray East OWF (Moray Offshore Renewables Ltd., 2011[50]). It is a named PMF within the habitat type 'tide-swept coarse sands with burrowing bivalves'. Abrasion is likely to damage epifauna associated with this biotope and may damage a proportion of the characterising species. Biotope resistance is therefore 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. Therefore, biotope sensitivity is assessed as low (Tillin and Watson, 2023b[76]).

Significance of Effect

4.7.1.17 The sensitivity of the benthic subtidal features within the boundary of Caledonia North is therefore considered to be worst case medium, 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.

4.7.1.18 The impact of temporary habitat disturbance on the subtidal benthic ecology is considered to be **Low** magnitude and the maximum sensitivity of the receptors affected is considered to be worst-case **Medium**. The significance of the residual effects is therefore concluded to be **Minor and Not Significant in EIA terms**.

Impact 2: Temporary Increases in SSCs and Changes to Seabed Levels

Subtidal

Magnitude of Impact

4.7.1.19 This assessment should be read in conjunction with Volume 3, Chapter 2: Marine and Coastal Processes, Volume 7B, Appendix 2-1: Marine and Coastal Processes Baseline Technical Report and Volume 7B, Appendix 2-2: Marine and Coastal Processes Numerical Modelling Report which provides the detailed offshore physical environment assessment (including project specific spreadsheet modelling of sediment plumes).

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

- Pre-lay cable trenching using a jet trencher tool at the seabed;
- Seabed preparation (including both seabed levelling for WTG foundations and sandwave clearance) including spoil disposal via a TSHD;
- Foundation installation using drilling techniques; and
- Drilling fluid release during HDD operations.

4.7.1.21 The worse-case scenario used for each of these scenarios is provided in Table 4–20, and each has been considered using numerical modelling both within the Caledonia North Site and along the Caledonia North OECC, for both spring and neap tides.

4.7.1.22 The release events that have been simulated within the numerical model, as described in Volume 7B, Appendix 2-2: Marine and Coastal Processes Numerical Modelling Report, have been specifically designed to capture the full range of realistic worst-case outcomes as the maximum:

- Sediment plume concentrations;
- Sediment plume extent;
- Vertical deposition depth (bed level change); and
- Horizontal extent of deposition (spatial extent (area) of bed level change).

4.7.1.23 A full assessment of the above, including the methodological approach used to assess the characteristics of sediment plumes and associated changes in bed level arising from settling of material is set out in Volume 7B, Appendix 2-2: Marine and Coastal Processes Numerical Modelling Report. To provide a robust assessment, a range of realistic combinations have been considered, based on conservatively representative location (environmental) and project (worst-case design scenario) specific information, including a range of water depths, heights of sediment ejection/initial resuspension, and sediment types.

4.7.1.24 The maximum distance and as such the overall spatial extent that any resultant plume might be reasonably experienced can be estimated as the spring tidal excursion distance. Any location beyond the tidal excursion distance is unlikely to experience any measurable change in SSC from a sediment plume. Given the nature of the sediment disturbance (temporary), any impacts are also anticipated to be short-lived, with any deposited material re-worked. Specifically, the numerical modelling for seabed disturbance resulting from MFE, seabed levelling and sandwave clearance indicated that:

- MFE, seabed levelling and sandwave clearance activities may produce sediment plumes with SSC up to thousands of mg/l, however these concentrations will be spatially restricted and short-lived. Elevated SSC may be advected by tidal currents up to 20km away, although these concentrations will be low. In the vast majority of cases, elevated SSC will be indistinguishable from background levels after 20 hours from the start of activities and can therefore be considered temporary and localised;

- 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. Sediment deposition following MFE activities of up to 50mm is expected in the immediate vicinity of the active disturbance. With thicknesses between 5 and 20mm deposited up to 600m away from the active disturbance area, reducing to low tens of mm downstream of the disturbance. Sediment deposition is generally not measurable beyond 3km to 5km away from the associated activities and is therefore 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.

4.7.1.25 Further information on sediment plume distances and modelling are provided in Volume 3, Chapter 2: Marine and Coastal Processes and Volume 7B, Appendix 2-2: Marine and Coastal Processes Numerical Modelling Report.

4.7.1.26 Note the sediment plume and deposition modelling takes into consideration a single sediment dispersion event, from the deposition of one hopper load of sediment. As informed by the modelling, a single deposition event will result in the rapid dissipation of the sediment plume and localised deposition impacts. However, due consideration should also be given to the volume of sediment dispersion and deposition during the entire construction phase (as detailed in Table 4–20). It is likely that the sediments being dispersed and deposited locally will be combined during dispersion events and therefore increased deposition and SSC are expected compared to the single event modelling, discussed above.

4.7.1.27 The subsea export cable ducts will be installed underneath the beach using trenchless installation techniques, with HDD techniques identified as the Worst-Case Design Scenario (Table 4–20). 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.

4.7.1.28 The results of bentonite release modelling demonstrate that:

- The maximum SSC during the 15-day period over which the statistics were calculated indicates a resultant plume up to 6km long (in east to west direction) and 2.5km wide (in north to south direction). The highest SSC (above 50mg/l) is simulated to occur over an area of less than 1km long (in an east to west direction) and 500m wide (in a north to south direction). SSC reduces to 15mg/l within 3km east to west and approximately 700m north to south within 3.6 hours;
- SSC is advected along the coast (following the tidal axis) to distances of up to 8km to the east and 6km to the west, although concentrations at this

distance are limited to below 1mg/l. All measurable SSC will have dispersed after 3 days. Considering generally higher background SSC conditions along the coast, these changes are likely to be indiscernible from background conditions; and

- Sediment deposition is predicted to be within several hundreds of meters of the exit pits, reducing rapidly to below 1mm. The maximum extent of deposition is predicted to be approximately 700m from release, with deposition less than 0.1mm identified at these distances. This deposition is small-scale, highly localised and likely to be rapidly redistributed by wave action.

4.7.1.29 Taking the above into consideration, the impact of increased SSC and smothering from sediment deposition associated with construction activities is noticeable but temporary, with the majority of effects limited to the near field. The magnitude of impact has therefore been assessed as low.

4.7.1.30 The indirect impacts from a single release event to the Moray Firth SPA (34.88km from the Caledonia North Site, 3.83km from the Caledonia North OECC), and the Troup, Pennan and Lion's Head SPA (47.18km from the Caledonia North Site, 9.69km from the Caledonia North OECC) are considered to be limited (noticeable but temporary).

4.7.1.31 The higher levels of smothering and deposition impacts that are most likely to significantly disturb benthic communities are considered to be within the immediate vicinity of the works. Whilst this will occur within the Southern Trench MPA (13.48km from the Caledonia North Site, 0km from the Caledonia North OECC), where the Caledonia North OECC overlaps (57.61% of the Caledonia North OECC overlaps with 4.48% the MPA), the magnitude of the impact is considered to be low and the impact is expected to be localised.

Sensitivity of Receptor

4.7.1.32 The sensitivity of the biotopes with reference to both the MarESA benchmarks for deposition and SSC, and for elevated SSCs and turbidity is summarised in Table 4–22 below.

Table 4–22: MarESA for the subtidal benthic habitats for changes in SSC, turbidity light smothering and heavy smothering.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	▪ Low sensitivity to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.
Glycera lapidum in impoverished Atlantic infralittoral mobile gravel and sand	MB3235	▪ Not sensitive to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.
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 (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence is medium for the SSC and turbidity assessments as they are 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 smothering and heavy smothering assessments as they are based on peer-reviewed literature.
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel	MC3212	▪ Low sensitivity to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.
Nephtys cirrosa and *Bathyporeia* spp. in	MB5233	▪ Low sensitivity to changes in SSC and turbidity	Confidence is low for the SSC and turbidity assessments as they are

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Atlantic infralittoral sand		▪ Not sensitive to light smothering (<5cm) ▪ Low sensitivity to heavy smothering (5-30cm)	based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments as they are based on peer-reviewed literature.
Sea pens and burrowing megafauna in Atlantic circalittoral fine mud	MC6216	▪ Not sensitive to changes in SSC and turbidity ▪ Not sensitive to light smothering (<5cm) ▪ Not sensitive to heavy smothering (5-30cm)	Confidence is medium for the SSC and turbidity assessments as they are 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 smothering and heavy smothering assessments as they are based on expert judgement.
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC5211	▪ Low sensitivity to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence is low for the SSC and turbidity assessments as they are based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments, however the applicability and agreement between the evidence is low to medium.
Moerella spp. with venerid bivalves in infralittoral gravelly sand	MB3233	▪ Low sensitivity to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm)	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
		▪ Medium sensitivity to heavy smothering (5-30cm)	
Fabulina fabula and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand	MB5236	▪ Low sensitivity to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence is low for the SSC and turbidity assessments as they are based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments, however the applicability and agreement between the evidence is low to medium.
Horse mussel beds *Modiolus modiolus*		▪ Not sensitive to changes in SSC and turbidity ▪ High sensitivity to light smothering (<5cm) ▪ High sensitivity to heavy smothering (5-30cm)	Confidence is low for all assessments as they are based on expert judgement.
Flame shell beds *Limaria hians*	N/A	▪ Medium sensitivity to changes in SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm) ▪ High sensitivity to heavy smothering (5-30cm)	Confidence is low for all assessments as they are based on expert judgement.
Ocean quahog *Arctica islandica*	N/A	▪ Not sensitive to changes in SSC and turbidity ▪ Not sensitive to light smothering (<5cm) ▪ Not sensitive to heavy smothering (5-30cm)	Confidence is low for the SSC and turbidity assessments as they are based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments as they are based on peer-reviewed literature.
Fan mussel *Atrina fragilis*		▪ Medium sensitivity to changes in SSC and turbidity	Confidence is medium for the SSC and turbidity assessments as they are

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
		▪ Medium sensitivity to light smothering (<5cm) ▪ High sensitivity to heavy smothering (5-30cm)	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 smothering and heavy smothering assessments as they are based on expert judgement.
Devonia perrieri		Assumption based on other venerid bivalve sensitivity assessments: ▪ Low sensitivity to changes in SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	N/A

4.7.1.33 The benthic subtidal habitats that characterise the benthic subtidal ecology study area are not sensitive or have low sensitivity to increases in SSC and turbidity, and light deposition (0-5cm) with a medium sensitivity to heavy deposition (5-30cm).

Coarse and Mixed Sediments with Moderate to High Infaunal Diversity and Epibenthic Communities

4.7.1.34 The biotope ‘Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment’ (MD4211) was recorded in multiple stations across the Caledonia North Site and one station in the Caledonia North OECC. However, it varies from the standard description due to a lack of dominant bivalves. 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 10-50cm 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 deposition (0-5cm) is assessed to be low (based on medium resistance and a high resilience). The sensitivity of MD4211 to heavy smothering (5-30cm) is assessed as medium (based on low resistance and medium resilience).

4.7.1.35 '*Mediomastus fragilis*, *Lumbrineris* spp. and venerid bivalves in circalittoral coarse sand or gravel' (MC3212) was recorded in the Caledonia North Site and is characterised by venerid bivalves which live close to the surface (Morton, 2009[70]) and burrowing species such as *G. lapidum* which are likely to be able to survive increased SSC and short periods under sediment (0-5cm). 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 assessment determined MC3212 as having low sensitivity to increased SSC and turbidity, and light smothering (0-5cm). 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 20cm (Bijkerk, 1988[79], cited in MarESA assessment). The MarESA assessment therefore classified MC3212 as having medium sensitivity to heavy smothering (5-30cm).

4.7.1.36 The biotope '*Glycera lapidum* in impoverished Atlantic infralittoral mobile gravel and sand' (MB3235) was found within the wider region in site-specific surveys conducted for the Moray East OWF (Moray Offshore Renewables Ltd., 2011[50]). Changes in turbidity are not predicted to directly affect *Glycera* spp. and *Nephtys* spp. which live within sediments, therefore the MarESA assessment determined MB3235 to be not sensitive to increased SSC and turbidity (Tillin and Watson, 2023c[77]). Characterising polychaetes of MB3235 (*Spio filicornis* and *Spiophanes bombyx*) are sensitive to strong fluctuations in sedimentation, however, their populations recover relatively quickly and can even benefit as this causes their population sizes to increase significantly after a strong fluctuation in sedimentation' (Gittenberger and Van Loon, 2011[78]). *Glycera alba* and *G. lapidum* were categorised as being sensitive to high sedimentation. They usually live in areas with some sedimentation, but do not easily recover from strong fluctuations in sedimentation (Gittenberger and Van Loon, 2011[78]). Bivalve and polychaete species have been reported to migrate through depositions of sediment greater that the benchmark (30cm of fine material added to the seabed in a single discrete event), however, the character of the overburden is an important factor determining the degree of vertical migration of buried bivalves and polychaetes, and it is not clear whether the characterising species are likely to be able to migrate through a maximum thickness of fine sediment because muds tend to be more cohesive and compacted than sand (Bijkerk, 1988[79]; Powilleit *et al*., 2009[80]; Maurer *et al*., 1982[81]). The MarESA assessment therefore determined MB3235 as having low sensitivity to light smothering (<5cm) and medium sensitivity to heavy smothering (5-30cm) (Tillin and Watson, 2023c[77]).

Sandy Sediments with Low Infaunal Diversity and Sparse Epibenthic Communities

4.7.1.37 The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) was recorded in two stations in the south of the Caledonia North OECC. 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 and Kanneworff, 1969[82]) 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 assessment 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 5cm layer of fine sediments, therefore MB5233 is considered to be not sensitive to light smothering (0-5cm). In terms of heavy smothering (5-30cm), 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[83]) and overall the sensitivity of MB5233 to heavy smothering is assessed as low.

4.7.1.38 The biotope '*Fabulina fabula* and *Magelona mirabilis* with venerid bivalves and amphipods in Atlantic infralittoral compacted fine muddy sand' (MB5236) was found within the wider region in site-specific surveys conducted for the Moray East OWF (Moray Offshore Renewables Ltd., 2011[50]). Increased SSC has the potential to alter food availability for filter feeding species which can negatively impact growth and biotope resistance is therefore assessed to be medium, however biotope resilience is assessed as high due to recoverability following restoration of typical conditions. Overall, the sensitivity of MB5236 to increased SSC and turbidity is assessed as low (Tillin and Rayment, 2023[84]). Characterising bivalves are capable of burrowing through sediment to feed (e.g., *Abra alba* are capable of upwardly migrating if lightly buried by additional sediment). There may be an energetic cost expended by species to either re-establish burrow openings, to self-clean feeding apparatus or to move up through the sediment, though this is not likely to be significant (Schäfer, 1972[85]). Burrowing species are likely to be able to burrow upwards, for example, it has been demonstrated that the polychaete *Nephtys hombergii* can successfully migrate to the surface of 32-41 cm deposited sediment layer (Powilleit *et al*. 2009[80]). Individuals are more likely to escape from a covering similar to the sediments in which the species is found than a different type.

Overall, the MarESA assessment indicated that MB5236 had low sensitivity to light smothering (<5cm) and medium sensitivity to heavy smothering (5-30cm) (Tillin and Rayment, 2023[84]).

Burrowed Mud

4.7.1.39 The biotope 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud' (MC6216) was recorded at various stations along the Caledonia North OECC based on a review of the imagery. 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[86]) and *V. mirabilis* has been observed to secrete copious amounts of mucus which could keep polyps clear of silt (Hiscock, 1983[87]). Due to high resistance and high resilience, it is considered that MC6216 is not sensitive to increased SSC and turbidity (Hill *et al*., 2023[88]). Both *P. phosphorea* and *V. mirabilis* can burrow and move into and out of their own burrows, it is therefore probable that deposition of 30cm 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 assessment considers that MC6216 is not sensitive to both light smothering (0-5cm) and heavy smothering (5-30cm) (Hill *et al*., 2023[88]).

Offshore Subtidal Sands and Gravel

4.7.1.40 The biotope '*Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand' (MC5211) (a PMF in Scottish waters) was recorded in two stations across the Caledonia North OECC. 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 as mentioned in 4.7.1.35, it is suggested that the maximum overburden of sediment through which small bivalves can migrate is 20cm (Bijkerk, 1988). As a result, the MarESA assessment determined MC5211 to have low sensitivity to increased SSC and turbidity, and light smothering (0-5cm), but a medium sensitivity to heavy smothering (5-30cm) (Tillin and Watson, 2024b[76]).

4.7.1.41 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 the Caledonia North Site, and possibly across the Caledonia North OECC. However, in the Caledonia North Site it is represented by a variant with *Galathowenia* sp. but not *Owenia* sp., and across the Caledonia North OECC there were high numbers of Thracioidea which are not in the standard description. 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 assessment 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 5cm of deposited sediment. It is suggested, however, that *Astropecten irregularis* can migrate through a maximum increase in sediment of 4cm (Christensen, 1970[89]) and resistance is therefore assessed as Medium (<25% loss) and resilience as High. Overall, MD5212 is considered to have low sensitivity to light smothering (0-5cm). Whilst the characterising species in MD5212 are burrowers, a deposition of 30cm 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 assessment has therefore determined this biotope as having medium sensitivity to heavy smothering (5-30cm).

Tide-swept Coarse Sands with Burrowing Bivalves

4.7.1.42 The biotope '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (MB3233) (a PMF in Scottish waters) was found within the wider region in site-specific surveys conducted for the Moray East OWF (Moray Offshore Renewables Ltd., 2011[50]) and has also been recorded at the Beatrice OWF site (BOWL, 2022[49]). The venerid bivalves characteristic of this biotope are shallow burrowing infauna and active suspension feeders which 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 (Maurer et al., 1986[81]). Smothering will result in temporary cessation of feeding and respiration. The energetic cost may impair growth and reproduction but is unlikely to cause mortality (Tillin and Watson, 2023b[90]). The MarESA assessment determined MB3233 to have a low sensitivity to increased SSC, turbidity, and light smothering (<5cm), and a medium sensitivity to heavy smothering (5-30cm) (Tillin and Watson, 2023b[90]).

Horse Mussel Beds (Modiolus modiolus)

4.7.1.43 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[91]) show that duration light smothering is a key factor determining survival, burial under even small amounts of fine sediment (2cm) 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[92]).

Flame Shell Beds (Limaria hians)

4.7.1.44 Flame shell beds are probably reasonably tolerant to changes in suspended sediment and siltation regimes. However, an increase in suspended sediment loads ins likely to reduce the feeding efficiency of *L. hians*. The resistance and resilience of *L. hians* to an increase in SSC is medium, giving a sensitivity score of medium. The deposition of fine sediment, as a single event, could cause the loss of a proportion of the gaping file shell population and resultant degradation of the byssal carpet and loss of some associated epifauna and, hence, species richness. However, in areas of strong to moderately strong water flow, any deposit is likely to be removed rapidly. Therefore, resistance is assessed as medium, resilience as medium, and sensitivity assessed as medium against light deposition of fine sediments. Heavy deposition on flame shell beds is likely to have more severe consequences. Should the material remain then it is assumed that all *L. hians* and many of the associated community would die of hypoxia. Therefore, resistance is assessed as none, resilience as very low and sensitivity as high (Tyler-Walters *et al*., 2023[93]).

Ocean Quahog (Arctica islandica)

4.7.1.45 A total of 30 pairs of *A. islandica* siphons were observed across multiple stations in the Caledonia North Site and the Caledonia North OECC. A. islandica is a PMF in Scottish waters 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[94]) 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[80]), also exposed *A. islandica* to smothering in the laboratory, in which Arctica islandica was able to burrow to the surface of 32-41cm of sediment and regained contact with the surface. The MarESA assessment determined that A. islandica is not sensitive to increased SSC and turbidity, light smothering (0-5cm) and heavy smothering (5-30cm) (Tyler-Walters and Sabatini, 2017[95]).

Fan Mussel (Atrina fragilis)

4.7.1.46 *Atrina fragilis* is probably well adapted to a sedimentary habitat and the occasional resuspension of sediment as individuals of this species are able to cleanse themselves quickly. Hewitt and Pilditch (2004[96]) examined the response of feeding in *A. zealandica* to 0-500 mg/l for ca one day. *A. zealandica* was able to reject filtered particles (75-100%) but maintain high organic absorption efficiencies. However, an increase in turbidity from, for example, 'clear' to turbid may be detrimental. Therefore, a resistance to changes in SSCs of medium has been assigned in the MarESA. Resilience is low and sensitivity has been assessed to be medium (Tyler-Walters and Wilding, 2022[97]).

4.7.1.47 *A. fragilis* cannot burrow upwards through sediment (Yonge, 1953[98]). However, one-third to one-half of the animal can protrude above the surface which, in adults, can be up to 10-15cm above the sediment surface. Therefore, adult specimens may not be affected by smothering by 5cm of fine sediment, however, small juveniles may be smothered and so the MarESA indicated resistance to light smothering is medium, resilience is low and sensitivity is medium (Tyler-Walters and Wilding, 2022[97]). Adult and juvenile specimens are likely to be smothered by 30cm of fine sediment. Therefore, resistance to heavy smothering is assessed as none, resilience is probably very low, and sensitivity is assessed as high (Tyler-Walters and Wilding, 2022[97]).

Devonia perrieri

4.7.1.48 A single adult specimen of the bivalve *D. perrieri* was collected at one grab sampling station in the Caledonia North OECC. There is not a specific assessment included in MarESA for this species, however, *D. perrieri* is a venerid bivalve with similar traits to other species included in this assessment. With similar characteristics to other venerid bivalve species, *D. perrieri* likely has a low sensitivity to increased SSC, turbidity, and light deposition (<5cm) and a medium sensitivity to heavy smothering (5-30cm).

Significance of Effect

4.7.1.49 The sensitivity of benthic subtidal features within the boundary of Caledonia North is therefore 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.

4.7.1.50 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 significance of the residual effects is therefore concluded to be **Minor and Not Significant in EIA terms**.

Intertidal

Magnitude of Impact

4.7.1.51 Temporary increases in SSC and associated sediment deposition in the intertidal 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 within the intertidal zone). Volume 3, Chapter 2: Marine and Coastal Processes provides a full description of the physical assessment, with a summary of the Worst-Case Design Scenario associated with the impact. As detailed in Table 4–20, the Worst-Case Design

Scenario associated with increases in SSC and deposition is associated with cable installation.

4.7.1.52 Those Caledonia North activities in the intertidal which has the potential to result in the greatest disturbance of seabed sediments are:

- Drilling fluid release during HDD operations.

4.7.1.53 The scenario that results in the greatest impact in the intertidal area is cable installation using HDD techniques, whilst the HDD punch out will be located within the nearshore (subtidal) environment, it is expected that the impact has the potential to reach the intertidal to some extent. As detailed within paragraph 4.7.1.28 *et seq*., the 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 (see paragraph 4.7.1.28). The magnitude of impact is therefore considered to be low.

Sensitivity of Receptor

4.7.1.54 As detailed within the VER table (Table 4–12) none of the biotopes that characterise the Landfall Site across the intertidal zone are rare or geographically restricted. The impact is also temporally restricted. The sensitivity of the biotopes is summarised Table 4–23 below.

Table 4–23: MarESA for the intertidal habitats for temporary increase in SSC and sediment deposition (changes in suspended solids, smothering and siltation rate).

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Laminaria digitata on moderately exposed sublittoral fringe rock	MB12171	▪ Low sensitivity to increased SSC and turbidity ▪ Not sensitive to light smothering (<5cm) ▪ Low sensitivity to heavy smothering (5-30cm)	Confidence is high for the SSC and turbidity assessments, and the light smothering assessments as they are based on peer reviewed literature. Confidence is medium for heavy smothering assessments as they are 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.
Laminaria hyperborea and foliose red seaweeds on moderately exposed infralittoral rock	MB121A	▪ Medium sensitivity to increased SSC and turbidity. ▪ Not sensitive to light smothering (<5cm) ▪ Not sensitive to heavy smothering (5-30cm)	Confidence is high for SSC and turbidity assessments, and the light smothering assessments as they are based on peer reviewed literature. Confidence is medium for the light and heavy smothering assessments as they are 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.
Himanthalia elongata and red seaweeds on moderately exposed lower eulittoral rock	MA1233	▪ Not sensitive to increased SSC and turbidity ▪ Not sensitive to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Semibalanus balanoides, Patella vulgata and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock	MA12231	▪ Low sensitivity to increased SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence is low for the SSC and turbidity assessments as they are based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments as they are based on peer-reviewed literature.
Fucus serratus and red seaweeds on moderately exposed lower eulittoral rock	MA12441	▪ Low sensitivity to increased SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ High sensitivity to heavy smothering (5-30cm)	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 smothering as it is based on expert judgement. Confidence is medium for the heavy smothering 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.
Fucoids and kelp in deep eulittoral rockpools	MA1263	▪ Medium sensitivity to increased SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm)	Confidence in these assessments is low as they are based on expert judgement.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
		▪ Medium sensitivity to heavy smothering (5-30cm)	
Pelvetia canaliculata on sheltered variable salinity littoral fringe rock	MA1251	▪ Not sensitive to increase SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the SSC and turbidity assessment 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. Confidence is low for the light smothering and heavy smothering assessments as they are based on expert judgement.
Fucus spiralis on sheltered upper eulittoral rock	MA123C	▪ Not sensitive to increased SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	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 smothering and heavy smothering assessments as they are based on peer-reviewed literature, however the applicability of the evidence and the agreement between evidence was determined medium.
Fucus spiralis on full salinity exposed to moderately exposed upper eulittoral rock	MA1242	▪ Medium sensitivity to increased SSC and turbidity	Confidence is medium for the SSC and turbidity assessment, and the light smothering assessment

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
		▪ Low sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	as they are 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 was high for the heavy smothering assessment as it is based on peer reviewed literature.
Coralline crust-dominated shallow eulittoral rockpools	MA1262	▪ Not sensitive to increased SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence is high for the SSC and turbidity assessment as it is based on peer reviewed literature. Confidence is high for the light smothering and heavy smothering assessments, although the applicability and agreement between the evidence is low to medium.
Green seaweeds (*Enteromorpha* spp. and *Cladophora* spp.) in shallow upper shore rockpools	MA1261	▪ Not sensitive to increased SSC and turbidity ▪ Low sensitivity to light smothering (<5cm) ▪ Low sensitivity to heavy smothering (5-30cm)	Confidence is low for the SSC and turbidity assessment as it is based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments as they are based on peer reviewed literature.
Yellow and grey lichens on Atlantic supralittoral rock	MA1211	▪ Increased SSC and turbidity are not relevant to this biotope ▪ Not sensitive to light smothering (<5cm) ▪ Not sensitive to heavy smothering (5-30cm)	Confidence is high for the light smothering and heavy smothering assessments, although the applicability and agreement between the evidence is low to medium.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Verrucaria maura on littoral fringe rock	MA1213	▪ Medium sensitivity to increased SSC and turbidity ▪ No evidence to assess the impact of light or heavy smothering on this biotope	Confidence in the SSC and turbidity assessment is low as it is based on expert judgement.
Semibalanus balanoides, *Fucus vesiculosus* and red seaweeds on exposed to moderately exposed eulittoral rock	MA12232	▪ Low sensitivity to increased SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the SSC and turbidity assessment is low as it is based on expert judgement. Confidence is high for the light smothering and heavy smothering assessments as they are based on peer reviewed literature.
Fucus vesiculosus and barnacle mosaics on moderately exposed mid eulittoral rock	MA1243	▪ Medium sensitivity to increased SSC and turbidity ▪ Medium sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in these assessments is medium as they are 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.
Coralline crusts and *Corallina officinalis* in shallow eulittoral rockpools	MA12621	▪ Not sensitive to increased SSC and turbidity ▪ Medium sensitivity light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	Confidence in the SSC and turbidity assessment is high as it is based on peer reviewed literature. Confidence is high for the light smothering and heavy smothering assessments, although the applicability and agreement between the evidence is low to medium.
Pelvetia canaliculata and barnacles on moderately exposed littoral fringe rock	MA1241	▪ Not sensitive to increased SSC and turbidity	Confidence is medium for the SSC and turbidity assessment as it is based on some peer reviewed papers

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
		▪ Medium sensitivity to light smothering (<5cm) ▪ Medium sensitivity to heavy smothering (5-30cm)	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 smothering and heavy smothering assessments as they are based on expert judgement.
Barren littoral shingle	MA3211	▪ Not sensitive to increased SSC and turbidity ▪ Not sensitive to light smothering (<5cm) ▪ Not sensitive to heavy smothering (5-30cm)	Confidence in the quality of the evidence is high, although the applicability and agreement between the evidence is low to medium.

4.7.1.55 The intertidal habitats in the Stake Ness Landfall Site have been assessed to have a medium sensitivity at most to increases in SSC and turbidity, light deposition (0-5cm) and heavy deposition (5-30cm) (both according to the MarESA and MarLIN benchmarks), except MA12441 that had a high sensitivity to heavy deposition (Table 4–23). The sensitivity of the receptors is therefore considered to be in the range from not sensitive to high according to the EIA assessment values.

Significance of Effect

4.7.1.56 Overall, it is predicted that the sensitivity of the intertidal receptors located across the intertidal ecology study area is worst-case medium, as it is not anticipated that heavy smothering will be recorded across intertidal biotopes due to HDD works.

4.7.1.57 The impact of increased SSC and deposition on the intertidal biotopes is considered to be of **Low** magnitude (intertidal biotopes are not expected to be directly affected by trenching operations or bedform clearance due to the fact that the Landfall Site will be undertaken using HDD), and the sensitivity of receptors affected is predicted to be **Medium** for all intertidal habitats. The significance of the residual effect is therefore concluded to be **Minor and Not Significant in EIA terms**.

Impact 3: Direct and Indirect Seabed Disturbance Leading to Release of Sediment Contaminants

Magnitude of Impact

4.7.1.58 There is the potential for sediment bound contaminants, such as heavy metals, hydrocarbons and organic pollutants, to be released into the water column and affect benthic receptors, as a result of construction activities and associated sediment mobilisation.

4.7.1.59 The analysis of sediment samples that have been collected across the Caledonia North Site and Caledonia North OECC suggest that contaminants concentrations (metals, organotins, PCBs, PBDEs, PAHs and THC) are low, often below LOD and typically below relevant assessment thresholds (e.g., Action Levels). Further details of sediment contamination are provided in Volume 3, Chapter 3: Marine Water and Sediment Quality and associated baseline appendices.

4.7.1.60 The total area that is likely to be disturbed by construction activities, and therefore the potential volume of material disturbed, resulting in the potential release of sediment bound contaminants is small and localised in extent.

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

4.7.1.62 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**. Irrespective of the sensitivity of the receptor, the significance of the impact is **Not Significant in EIA terms** as defined in the assessment of significance matrix (Table 4–17) and is therefore not considered further in this assessment.

4.7.2 Operation

4.7.2.1 This section presents the assessment of impacts arising from the operational phase of Caledonia North. The effects of the operational phase on benthic subtidal and intertidal ecology have been assessed for benthic subtidal and intertidal ecology study area. The environmental impacts arising from the operational phase of Caledonia North are listed in the Worst-Case Design Scenario (Table 4–20) along with the design envelope against which each operational phase impact has been assessed.

Impact 4: Long-term Habitat Loss/Alteration due to the Addition of Infrastructure to the Area

Magnitude of Impact

4.7.2.2 The presence of the WTG and OSP foundations and the associated scour protection, along with cable protection measures used where cable burial is not possible, will lead to a change from a sedimentary habitat to one characterised by hard substrate. This will be a long-term habitat loss for the 35-year design life duration of Caledonia North and is therefore considered to be an impact associated with the operational phase of Caledonia North and potentially beyond. It is assessed here as habitat loss and a potential adverse effect due to the potential shift in the baseline condition and loss of soft sediment substrate. However, it is noted that this is also habitat change which could have associated potential beneficial effects, providing new habitats for different faunal assemblage to colonise, resulting in a likely increase in biodiversity and biomass.

4.7.2.3 Table 4–20 identifies the foundation, scour and cable protection footprint. The total habitat loss arising from these components would be 5.11km², which equates to approximately 0.81% of the subtidal habitat within the site boundary of Caledonia North.

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

4.7.2.5 The Caledonia North OECC crosses the Southern Trench MPA, where cable protection could be required. If cable protection is required for the portion of the export cable that overlaps with the MPA, it will represent an area less than 0.01% of the whole MPA. This disturbance will therefore only occur at highly localised scale and transport processes are expected to not be affected. The magnitude of this receptor has therefore also been assessed as low.

Sensitivity of Receptor

4.7.2.6 All benthic receptors identified within the site boundary have been assessed according to the MarESA criteria as having no resistance to long-term habitat loss/alteration, with recovery assessed as very low. The sensitivity of subtidal receptors is therefore considered to be at worst-case high according to the EIA assessment values.

Significance of Effect

4.7.2.7 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.

4.7.2.8 Overall, it is predicted that the sensitivity of the benthic subtidal receptors located across the benthic ecology study area to long-term habitat loss/alteration is at worst-case **High** according to the MarESA assessments, and the magnitude of the effect is **Low**. Therefore, the significance of the residual effect of temporary habitat disturbance is assessed to be **Minor and Not Significant in EIA terms**.

Impact 5: Temporary Habitat Disturbance

Magnitude of Impact

4.7.2.9 Temporary subtidal habitat loss will arise from the use of JUVs for operational activities as well as from cable maintenance and cable replacement. The total worst-case design scenario is presented in Table 4–20, which is predicted to arise over the design life of Caledonia North.

4.7.2.10 Cable replacement works will require de-burial and re-burial of cables or cable sections. These activities, along with cable preventative maintenance, will result in increased SSC and an increase in sediment deposition. However, the impacts from these operational works will be spread over the life span of Caledonia North with only a limited number of activities occurring within any single year.

4.7.2.11 The magnitude of temporary habitat disturbance from JUVs and cable maintenance activities relating to Caledonia North on benthic subtidal receptors is considered to be low, indicating that the disturbance of the habitat represents a minor loss/divergence from baseline conditions within the Caledonia North Site and Caledonia North OECC.

Sensitivity of Receptor

4.7.2.12 Given that the habitats are common and widespread throughout the wider region (as described in section 4.4), the temporary habitat disturbance occurring through operational activities would have an impact on a very limited footprint in relation to their overall extent in the Caledonia North Site and Caledonia North OECC. As detailed in paragraph 4.7.1.3 *et seq.*, the habitats directly affected by habitat loss or disturbance have a worse-case sensitivity of medium to a disturbance of this nature, with the MarESA assessment for different biotopes also presented in detail in this section.

Significance of Effect

4.7.2.13 Overall, the impact of temporary habitat disturbance is considered to be of **Low** magnitude. The sensitivity of receptors affected by this impact is predicted to be at worst-case **Medium**, according to the detailed MarESA assessments and published literature. Therefore, the significance of the residual effect of temporary habitat disturbance is assessed to be **Minor and Not Significant in EIA terms**.

Impact 6: Colonisation of hard substrates

Magnitude of Impact

4.7.2.14 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.

4.7.2.15 The long-term introduced hard substrate of Caledonia North is 5.41km^2 which will be present for the duration of the operational phase (35 years). The presence of up to 77 WTGs and two OSPs in the water column, and subsequent scour and cable protection (for offshore export and inter-array cables) on the seabed will introduce new hard structures with the potential for encrusting epifauna to colonise. However, all biofouling represent additional food supply within the local ecosystem.

4.7.2.16 To reduce the footprint of the cable protection, offshore export cables will be buried where possible. In instances where adequate burial cannot be achieved, an alternative form of cable protection will be deployed. The cable protection methods being considered include concrete mattresses, rock placement, grout bags, iron cast and an engineered Cable Protection System (CPS).

4.7.2.17 Hard substrate habitats are comparatively rare within Caledonia North benthic subtidal and intertidal ecology study area, which is predominantly dominated by sedimentary habitats. The introduction of hard substrate, and associated increased in biodiversity, will alter the biotopes that characterise the area. This will be long-term, lasting for the duration of Caledonia North. Any effects in the benthic subtidal and intertidal ecology arising from the introduction of hard substrates will likely be localised to the Caledonia North Site and Caledonia North OECC (where cable protection is laid).

4.7.2.18 Therefore, the impact is predicted to be of local spatial extent, long-term duration, but reversible 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 considered to be low, as the habitats and characterising biotopes/taxa are not geographically restricted and are typically common throughout the wider region. Therefore, there will be a minor loss of habitat or divergence from baseline conditions.

Sensitivity of Receptor

4.7.2.19 The introduction of new hard substrate could represent a potential shift in the baseline condition within a small proportion of the Caledonia North Site and Caledonia North OECC. Potential beneficial effects that may occur are associated within the likely increase in biodiversity and biomass, which has been observed at the Egmond aan Zee OWF (Lindeboom *et al*., 2011[99]). Species with the potential to benefit from the introduction of hard substrate are those which are typical of rocky habitats and intertidal environments.

4.7.2.20 The species that are potentially introduced to the study area may also have indirect, adverse effects on the existing habitats and/or species through increased predation on, or competition with, neighbouring soft sediment species (Table 4–24). Such effects are difficult to predict. The increased biodiversity associated with hard structure could provide benefits at higher trophic levels as they provide an additional food source. Studies at the Horns Rev OWF in Denmark provided evidence that OWF structures are used as successful nursery habitats for the commercial species Cancer pagurus (Vattenfall, 2006[100]). However, any direct benefits are only likely to occur on a very localised basis.

4.7.2.21 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 the Impact 7 section below.

4.7.2.22 Given the presence of bryozoans, encrusting algae and sponges within the Caledonia North Site and Caledonia North OECC, it is predicted that colonisation of hard substrates will occur.

Table 4–24: MarESA for the benthic habitats to physical change (to another seabed type).

Biotope/Species name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers
Owenia fusiformis and *Amphiura filiformis* in deep circalittoral sand or muddy sand	MD5212	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in	MC3212	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers

Biotope/Species name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
circalittoral coarse sand or gravel			
Nephtys cirrosa and *Bathyporeia* spp. in Atlantic infralittoral sand	MB5233	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers
Sea pens and burrowing megafauna in Atlantic circalittoral fine mud	MC6216	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC5211	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers
Moerella spp. with venerid bivalves in infralittoral gravelly sand	MB3233	High (based on low resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers
Arctica islandica	N/A	High (based on no resistance and very low resilience)	Confidence is high as the assessment is based on peer reviewed papers

4.7.2.23 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 or low resistance, very low resilience and, therefore, sensitivity has been assessed to be high.

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

Significance of Effect

4.7.2.25 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. Any beneficial effects associated with an increase in biodiversity will be highly localised in nature and are not considered to represent mitigation for the loss of sedimentary habitat associated with the installation of these structures.

4.7.2.26 Overall, it is predicted that the sensitivity of the receptor is **High**, and the magnitude is **Low**. Therefore, the significance of the effect is **Minor and Not Significant in EIA terms**.

Impact 7: Increased Risk of Introduction and/or Spread of Marine INNS

Magnitude of Impact

4.7.2.27 There is a risk that the introduction of hard substrate into a predominantly sedimentary habitat will enable the colonisation of the introduced substrate by invasive species that might not otherwise have had a suitable habitat for colonisation, thereby enabling their spread. This, along within the movement of vessels in and out of the Caledonia North Site and Caledonia North OECC has the potential to impact upon benthic subtidal and intertidal ecology locally and in the broader region. Another potential pathway for INNS is the towing of infrastructure to Caledonia North.

4.7.2.28 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 ecology subtidal 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).

4.7.2.29 Table 4–20 presents the worst-case design scenario for new hard substrate that will be introduced into the Caledonia North Site and Caledonia North OECC. In addition, Table 4–20 details the round trips to port during the operational phase which will contribute to the risk of introduction or spread of marine INNS through ballast water discharge.

4.7.2.30 Table 4–19 presents the embedded environmental mitigation measures which includes an EMP with a biosecurity plan. This will ensure that the risk of potential introduction and spread of marine INNS from increased vessel activity is minimised.

4.7.2.31 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[101]).

4.7.2.32 Embedded mitigation measures, including an EMP with a marine biosecurity plan (Table 4–19) will ensure that the risk of potential introduction and spread of marine INNS will be minimised as far as practicable.

4.7.2.33 The introduction of hard structure may serve as 'stepping stones', extending the impact beyond a local scale. However, based on 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 the impact is predicted to affect the receptors indirectly. With the implementation of embedded mitigation measures for INNS impacts through the EMP, the magnitude of this impact is considered to be low.

Sensitivity of Receptor

4.7.2.34 As described in Table 4–25, benthic biotopes within the benthic subtidal study area and deemed to be not sensitive to having a high sensitivity of the introduction or spread of marine INNS, according the MarESA.

Table 4–25: MarESA for the benthic habitats to introduction or spread of invasive non-indigenous species.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	High (based on low resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement
Owenia fusiformis and *Amphiura filiformis* in deep circalittoral sand or muddy sand	MD5212	Not relevant	Not relevant
Mediomastus fragilis, Lumbrineris spp. and venerid bivalves in 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
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
Sea pens and burrowing megafauna in Atlantic circalittoral fine mud	MC6216	No evidence	No evidence
Echinocyamus pusillus, *Ophelia borealis* and *Abra*	MC5211	High (based on no resistance and very low resilience)	Confidence is low as the assessment is based on expert judgement

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
prismatica in circalittoral fine sand			
Moerella spp. with venerid bivalves in infralittoral gravelly sand	MB3233	High (based on low resistance and very low resilience)	Not relevant
Arctica islandica	N/A	No evidence	No evidence

4.7.2.35 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 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (MB3233) is 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 graver or shells embedded in the substratum that can be used for larvae settlement (Tillin *et al*., 2020[102]).

4.7.2.36 The biotope '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233) has a high resistance to this pressure as the sediments characterising this biotope 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. This biotope also has high resilience in general and is assessed by MarESA to be not sensitive to the pressure of marine INNS (Tillin *et al*., 2023c[103]).

4.7.2.37 There are no records of the introduction or spread of marine INNS in '*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand' (MD5212), therefore this pressure is considered not relevant for this biotope.

4.7.2.38 There is no evidence found to suggest that the biotope 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud' (MC6216) or *A. islandica* are adversely affected by marine INNS.

Significance of Effect

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

4.7.2.40 A key consideration, however, is that an EMP with a biosecurity plan (Table 4–19) will be in place to minimise the risk of introduction and spread of INNS.

4.7.2.41 Overall, the increased risk of introduction and / or spread of marine INNS is considered to be **Low** magnitude, and the sensitivity of receptors is predicted to be at worst case **High**. The significance of the residual effect is therefore concluded to be **Minor and Not Significant in EIA terms**.

Impact 8: Changes in physical processes resulting from the presence of the OWF subsea infrastructure

Magnitude of Impact

4.7.2.42 The presence of foundations, scour protection and cable protection may introduce changes to the local hydrodynamic and wave regime, resulting in changes to 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.

4.7.2.43 The use of correctly designed scour protection at foundations and sufficiently buried cables (Table 4–19) will prevent scour occurring where it is installed. Therefore, scour will only occur if and where scour and cable protection has not been applied appropriately.

4.7.2.44 The cable protection methods being considered include concrete mattresses, rock placement, grout bags, iron cast and an engineered 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.

4.7.2.45 Volume 3, Chapter 2: Marine and Coastal Processes has determined that the impacts on hydrodynamic and wave regimes will be not significant to coastal and physical processes and will therefore not result in any significant changes to sediment transport and consequently will not have any significant impacts on benthic subtidal and intertidal ecology. The magnitude of this impact is therefore considered to be negligible.

Sensitivity of Receptor

4.7.2.46 As detailed within paragraph 4.7.1.8 *et seq*., the habitats directly affected by habitat loss/disturbance have a worst-case sensitivity of medium to a disturbance of this nature. Paragraph 4.7.1.32 *et seq*., detail that the habitats indirectly affected by increased SSC and deposition have a worst-case medium sensitivity to the expected levels of SSC and deposition, with the MarESA assessment also presented in detail.

Significance of Effect

4.7.2.47 Overall, the impact from changes in physical processes is considered to be of **Negligible** magnitude, and the sensitivity of receptors affected is considered to be at worst-case **Medium** for all benthic subtidal and intertidal features. The significance of the effect is therefore concluded to be **Minor and Not Significant in EIA terms**.

Impact 9: EMF Effects Generated by Inter-array, Interconnector and Offshore Export Cables

Magnitude of the impact

4.7.2.48 EMFs are generated by the current that passes through an electrical cable. It is known that EMFs can be detected by fish and elasmobranchs, and it is thought that benthic invertebrates can also detect EMFs. 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 for Caledonia North are compliant with this approach (see Volume 1, Chapter 3: Proposed Development Description (Offshore)). 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 EMFs is limited to B-fields and associated iE-fields.

4.7.2.49 EMFs are likely to be generated by subsea cables and would be detectable above background levels near the cables. Although burial does not mask EMFs, it increases the distance between species that may be affected by EMFs and the source. As the cable will be buried or protected, as detailed within Table 4–19, any behavioural responses are likely to be mitigated.

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

Sensitivity of Receptor

4.7.2.51 The MarESA sensitivity assessments do not consider there to be sufficient evidence to support assessments of impacts of EMF on benthic 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 3, Chapter 5: Fish and Shellfish Ecology.

4.7.2.52 Typically, the impacts of EMF on marine organisms have focused on electrically sensitive fish and elasmobranchs. There has been sparse research focusing on benthic invertebrates, with the few studies for invertebrates focusing on crustaceans (e.g., Woodruff *et al*., 2012[104]). Furthermore, many studies contradict each other or provide inconclusive results (Switzer and Meggitt, 2010[105]), further reducing confidence in the available evidence.

4.7.2.53 Although there are requirements for further research, evidence of sensing, responding to, or orienting to natural magnetic field cues has been indicated for invertebrates including molluscs and arthropods (Boles and Lohmann, 2003[106]; Lohman and Willows, 1987[107]; Ugolini, 2006[108]; Ugolini and Pezzani, 1995[109]). Scott *et al*. (2021[110]) investigated the effects of EMFs (strengths 250μT, 500μT and 1000μT) from submarine power cables on edible crab and determined that there were limited physiological and behavioural effects on the crabs exposed to an EMF of 250μT. An EMF of 500μT or above indicated physiological stress in crabs, and changes to behavioural trends, specifically an attraction to the EMF. It is to be noted however, that these studies investigated EMF strengths which are 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[110]) was a factor of 10 higher than that expected for Caledonia North and effects were only noted in for studies using EMF strengths which were a factor of 20 - 1,000 higher than those expected from the cables for Caledonia North. Therefore, it is considered that it is unlikely that there would be any apparent impacts to crustaceans or other invertebrates from EMF. Taking this into consideration, any effects on marine invertebrates are anticipated to only occur in the immediate vicinity of the cable.

4.7.2.54 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[111]). The polychaetes did, however, exhibit enhanced burrowing activity when exposed to the B-field, with potential consequences for their metabolism; however, knowledge about the biological relevance of this response is currently limited (Jakubowska *et al*., 2019[111]).

4.7.2.55 One recent study examined the difference in invertebrate communities along an energised cable and nearby unenergised surface laid cables. 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[112]). The same study also identified that EMF levels reduced to background levels generally within one metre of the cable.

4.7.2.56 For invertebrate receptor species, it is difficult to translate the knowledge of individual-level EMF effects into assessments of biologically or ecologically significant impacts on populations (Boehlert and Gill, 2010[113]). Given the evidence presented, however, it is predicted that EMFs will likely have no significant impact on mobile or sessile benthic invertebrates, including if the cable is surface laid.

4.7.2.57 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 Caledonia North.

Significance of Effect

4.7.2.58 Caledonia North will include measures to bury or protect cables (Table 4–19), therefore any behavioural responses of benthic receptors are likely to be reduced due to distance between the cable and receptor. Overall, it is predicted that the sensitivity of the benthic subtidal and intertidal receptors found within the site boundary is **Low** and the magnitude of impact is **Negligible**. The residual effect significance is therefore **Negligible and Not Significant in EIA terms**.

Impact 10: Seabed Sediment Heating from Subsea Cables

Magnitude of Impact

4.7.2.59 When electric energy is transported, a certain amount dissipates as heat energy. As a result, subsea cables have the potential to cause an increase in temperature on the cable surface, potentially emitting heat and warming the surrounding ambient sediment (OSPAR, 2009a[114]). Therefore, it is possible that the buried inter-array and inter-connector cables within the Caledonia North Site, and the export cables within the Caledonia North OECC will emit heat energy into the surrounding sediment and result in sediment that is slightly warmer in the immediate vicinity (Worzyk, 2009[115]).

4.7.2.60 The thermal effect is a small increase in temperature within a few centimetres of the cable (Boehlert and Gill, 2010[113]). A field experiment on subsea cables from Nysted OWF found that the maximum temperature difference between cable sites and control sites was 2.5°C, with a mean difference of 0.8°C (Meißber *et al*., 2006[116]).

4.7.2.61 A substantial increase in the temperature of the sediment has the potential to alter the physical and chemical properties of the substratum. This can then have knock on effects that lead to alterations in the microorganism communities (OSPAR, 2008b[117]).

4.7.2.62 There is a significant lack of field data on the impact of heating from subsea cables on benthic habitat. However, it is clear that the impact is predicted to be highly localised, with a minor loss/divergence from baseline conditions. Therefore, the magnitude of this effect is low.

Sensitivity of Receptor

4.7.2.63 The only organisms likely to be affected by warming are burrowing species, as the water column will dissipate any surface temperature increase caused by subsea cable. However, it is thought that the majority of benthic burrowing infauna would be able to move away from any areas impacted by sediment heating from subsea cables. The MarESA for a local temperature increase on benthic receptors is detailed in Table 4–26.

Table 4–26: MarESA for the benthic habitats to local temperature increase.

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
Polychaete-rich deep *Venus* community in offshore circalittoral mixed sediment	MD4211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Owenia fusiformis and *Amphiura filiformis* in deep circalittoral sand or muddy sand	MD5212	Not sensitive (based on high resistance and high resilience)	Confidence is medium as the assessment 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
Mediomastus fragilis, *Lumbrineris* spp. and venerid bivalves in 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	Not sensitive (based on high resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Sea pens and burrowing megafauna in Atlantic circalittoral fine mud	MC6216	Medium (based on medium resistance and low resilience)	Confidence is low as the assessment is based on expert judgement
Echinocyamus pusillus, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand	MC5211	Low (based on medium resistance and high resilience)	Confidence is high as the assessment is based on peer reviewed papers
Moerella spp. with venerid bivalves in infralittoral gravelly sand	MB3233	Low (based on medium resistance and high resilience)	Confidence is medium as the assessment is based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature

Biotope/Species Name	Biotope Code (EUNIS, 2022)	Sensitivity Assessment	Assessment Confidence
			(habitat, its component species, or species of interest) or similar features
Arctica islandica	N/A	Medium (based on medium resistance and medium resilience)	Confidence is high as the assessment is based on peer reviewed papers

4.7.2.64 Three of the biotopes were classified as not sensitive to local temperature increase as both resistance and resilience were deemed to be high: '*Owenia fusiformis* and *Amphiura filiformis* in offshore circalittoral sand or muddy sand' (MD5212) and '*Nephtys cirrosa* and *Bathyporeia* spp. in Atlantic infralittoral sand' (MB5233). The species associated with MD5212 are likely to potentially benefit from an increase in temperature due to an increased distribution range, growth and fecundity.

4.7.2.65 The 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 '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (MB3233) have been assessed by MarESA as having a low sensitivity to local temperature increase. It is considered likely that a chronic change in temperature would be tolerated by species with a wide distribution.

4.7.2.66 The biotope 'Sea pens and burrowing megafauna in Atlantic circalittoral fine mud' (MC6216) and *A. islandica* have been assessed as having a medium sensitivity to local temperature increase. Sea pens associated with MC6216 are subtidal and occur at a depth where wide and rapid variations in temperature are not common and so may be less resistant to this pressure. *A. islandica* can burrow into the sediment to escape short-term temperature increases. However, a prolonged increase in temperature is likely to result in mortality.

Significance of Effect

4.7.2.67 Although there has been limited research into the impacts of seabed sediment heating from subsea cables, based on available evidence the benthic receptors are considered to have a worst-case sensitivity of **Medium**, based on the value of the presence of sea pens and *A. islandica*. However, any impacts are unlikely to affect the long-term functioning of the other benthic receptors within the benthic ecology subtidal study area. The impact is defined as being of **Low** magnitude and so the overall effect to benthic ecology receptors is considered to be **Minor and Not Significant in EIA terms**.

4.7.3 Decommissioning

4.7.3.1 The effects of the decommissioning of Caledonia North on benthic subtidal and intertidal ecology have been assessed for the benthic subtidal and intertidal ecology study area. The environmental impacts arising from the decommissioning phase of Caledonia North are listed in Table 4–20 (worst-case design scenario) along with the design envelope against which decommissioning phase impact has been assessed.

4.7.3.2 A description of the significance of effect on benthic and intertidal receptors caused by each identified impact is provided below.

Impact 11: Temporary Habitat Disturbance

Magnitude of Impact

4.7.3.3 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 paragraph 4.7.1.3 *et seq*.).

4.7.3.4 Decommissioning has the potential to cause temporary disturbance to benthic habitats within Caledonia North, 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.

4.7.3.5 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 Receptor

4.7.3.6 The sensitivities of the species to temporary habitat disturbance are detailed in Table 4–21 and described in paragraph 4.7.1.10 *et seq*.

Significance of Effect

4.7.3.7 The magnitude of the effect has been assessed as **Low** and the maximum sensitivity of the receptors is **Medium** (Table 4–21). Therefore, the significance of the effect from temporary habitat disturbance occurring as a result of decommissioning activities is **Minor and Not Significant in EIA terms**.

Impact 12: Temporary Increases in SSCs and Changes to Seabed Levels

Magnitude of Effect

4.7.3.8 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 4.7.1.19 *et seq*.

Sensitivity of Receptor

4.7.3.9 The sensitivities of the species to temporary habitat disturbance are detailed in Table 4–22 and described in paragraph 4.7.1.32 *et seq*. for subtidal receptors, and in Table 4–23 and paragraph 4.7.1.51 *et seq*. for intertidal receptors.

Significance of Effect

4.7.3.10 Based on the assessment undertaken for construction, which would be considered to be a very precautionary worst-case scenario for the decommissioning process, it is predicted that the maximum sensitivity of the receptors is **High** (Table 4–22 and Table 4–23) and the magnitude is **Low**. Therefore, the significance of effect from changes in SSC or sediment deposition occurring as a result of decommissioning activities in the subtidal and intertidal area is assessed to be **Minor and Not Significant in EIA terms**.

Impact 13: Direct and Indirect Seabed Disturbance Leading to Release of Sediment Contaminants

Magnitude of Impact

4.7.3.11 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 4.7.1.58 *et seq*.

Significance of Effect

4.7.3.12 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**. Irrespective of the sensitivity of the receptor, the significance of the impact is **Not Significant in EIA terms** as defined in the assessment of significance matrix (Table 4–17) and is therefore not considered further in this assessment.

Impact 14: Long-term Habitat Loss/Alteration due to the Removal of Infrastructure

Magnitude of Impact

4.7.3.13 As detailed in paragraph 4.7.2.14 *et seq*., hard substrate introduced from Caledonia North will become colonised by epifauna. If hard substrate such as foundations, scour protection and cable protection are removed during decommissioning, it would result in removal of these species and any associated habitats they create.

4.7.3.14 The removal of the foundations, scour protection and cable protection will result in a permanent loss of 5.10km² of hard substrate (and correspondingly the recovery of sedimentary habitats lost at the time of construction as the infrastructure is removed).

4.7.3.15 The impact will be permanent (i.e., the colonising species will be permanently lost) and irreversible but it will be of highly localised extent. It is predicted that the impact will directly affect the receptors. The magnitude is therefore considered to be low.

Sensitivity of Receptor

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

Significance of Effect

4.7.3.17 The loss of species colonising the hard substrate will be highly localised, there will be a typically high recoverability of the subsequently exposed substrate and communities back to their pre-construction state (see Section 4.4). Overall, the maximum sensitivity of the receptors is considered to be **Medium**, and the magnitude of the impact is considered to be **Low**. Therefore, the significance of effects from the removal of the hard substrate during decommissioning activities is **Minor and Not Significant in EIA terms**.

4.8 Cumulative Effects

4.8.1 Overview

4.8.1.1 The list of developments identified for assessing cumulative effects is presented in Volume 7A, Appendix 7-1: Cumulative Impact Assessment Methodology. In Table 4–27, the potential for cumulative effects with each of these developments is examined, and an assessment of the cumulative effects presented where appropriate.

4.8.1.2 The projects, plans and activities considered to be relevant to the assessment of impacts to benthic subtidal and intertidal ecology are based upon an initial screening exercise undertaken on a long list. Each project, plan or activity has been considered and scoped in or out based on effect-receptor pathway, data confidence and the temporal and spatial scales involved. For the purposes of assessing the impact of Caledonia North on benthic subtidal and intertidal ecology in the region, the CIA of this EIA screened in projects and plans as presented in Table 4–27.

Table 4–27: Benthic subtidal and intertidal ecology included in CIA.

Development	Status	Potential for Significant Cumulative Effects
Shetland HVDC Link	Under construction	Yes
Moray West OWF OECC[ii]	Under construction	Yes
Stromar OWF OECC	Concept/early planning	Yes

4.8.1.3 Certain impacts assessed for Caledonia North alone are not considered in the cumulative assessment due to:

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

4.8.1.4 Therefore, the CIA has only considered the temporary increase in SSC and sediment deposition during construction. The cumulative scenario described in Table 4–27 has been selected as 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 the project description for Caledonia North, 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.

Impact 15: Cumulative Temporary Increase in SSC and Sediment Deposition

4.8.1.5 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.

[ii] Moray West OWF OECC was commissioned after the CIA was undertaken, and therefore has been included as part of the longlist.

4.8.1.6 Sediment plumes from operational and maintenance activities are generally short-lived, with major maintenance works infrequent. Any impacts from operational OWF export cables (and other subsea cables) activities are therefore likely to be short-lived and of localised extent, with limited opportunity to overlap with Caledonia North-related activities. The Moray West OWF ECC and Shetland HVDC Link are both currently under construction and are expected to be in service by the end of 2024. Therefore maintenance-related impacts are similarly considered to be primarily short-lived and localised. Accordingly, the potential for cumulative interaction with these sites is limited and therefore has not been assessed further.

4.8.1.7 As detailed by the numerical modelling within Volume 3, Chapter 2: Marine and Coastal Processes, impacts for all construction activities (both in terms of SSCs and sedimentation) were predicted to mainly be confined to occur within the Caledonia North Site and/or along the Caledonia North OECC. Given the short-lived nature of the sediment plumes, alongside the location of other infrastructure, there is not anticipated to be a notable overlap with concentrated sediment plumes created from other industry activities.

4.8.1.8 Full discussion of the sensitivity of benthic subtidal and intertidal ecology receptors to increased SSC and sediment deposition is discussed in 4.7.1.19 *et seq*., which conclude that the habitats that have the potential to be indirectly affected by increased SSC and deposition within the benthic subtidal and intertidal ecology study area have a worst case medium sensitivity to the expected levels of SSC and deposition.

4.8.1.9 The impact of increased SSC and deposition is considered to be **Low**, and the sensitivity of receptors affected is considered to be a worst-case **Medium** for benthic subtidal receptors. The significance of the effect is therefore concluded to be **Minor and Not Significant in EIA terms**.

4.9 In-combination Effects

4.9.1.1 The in-combination effects assessment considers likely significant effects from multiple impacts and activities from the construction, operation and maintenance and decommissioning phases of Caledonia North on the same receptor, or group of receptors.

4.9.1.2 In-combination effects could potentially arise in one of two ways. The first type of in-combination effect is a Caledonia North lifetime effect, where multiple phases interact to create a potentially more significant effect on a receptor than in one phase alone. The phases for Caledonia North are construction, operation and decommissioning.

4.9.1.3 The second type of in-combination effect is receptor-led effects. Receptor-led effects are where effects from different environmental aspects combine spatially and temporally on a receptor. These effects may be short-term, temporary, transient, or longer-term.

4.9.1.4 Receptor-led effects have been considered, where relevant, in this chapter for potential interactions between benthic subtidal and intertidal ecology and the following environmental aspects:

- Volume 3, Chapter 2: Marine and Coastal Processes; and
- Volume 3, Chapter 5: Fish and Shellfish Ecology.

4.10 Transboundary Effects

4.10.1.1 Transboundary effects related to the benthic subtidal and intertidal ecology are not anticipated to arise from the construction, operation or decommissioning stages of Caledonia North. Any impacts on benthic subtidal or intertidal ecology receptors will be localised in nature and any indirect effects will likely be limited to one tidal excursion from the impact source. Caledonia North is a significant distance to the nearest adjacent exclusive economic zone (EEZ) of another state and, therefore, it is considered that transboundary impacts will not occur and are therefore not considered in this EIA.

4.11 Mitigation Measures and Monitoring

4.11.1 Construction

4.11.1.1 No additional mitigation measures beyond those outlined in Table 4–19 are proposed for the construction phase.

4.11.2 Operation

4.11.2.1 No additional mitigation measures beyond those outlined in Table 4–19 are proposed for the operation phase.

4.11.3 Decommissioning

4.11.3.1 No additional mitigation measures beyond those outlined in Table 4–19 are proposed for the decommissioning phase.

4.12 Residual Effects

4.12.1 Construction Effects

4.12.1.1 All identified construction effects were assessed as not significant in EIA terms following the implementation of embedded mitigation. The residual effects during construction are therefore also considered to be **Not Significant in EIA terms**.

4.12.2 Operation Effects

4.12.2.1 All identified operational effects were assessed as not significant in EIA terms following the implementation of embedded mitigation. The residual effects during operation are therefore also considered to be **Not Significant in EIA terms**.

4.12.3 Decommissioning Effects

4.12.3.1 All identified decommissioning effects were assessed as not significant in EIA terms following the implementation of embedded mitigation. The residual effects during decommissioning are therefore also considered to be **Not Significant in EIA terms**.

4.13 Summary of Effects

4.13.1.1 Table 4–28 presents a summary of the effects assessed for benthic subtidal and intertidal ecology within this EIAR, any mitigation measures required, and the residual effects are provided.

Table 4–28: Summary of effects for Benthic Subtidal and Intertidal Ecology.

Potential Impact	Magnitude	Sensitivity of Receptor	Significance	Mitigation Measure	Residual Effect
Construction					
Impact 1: Temporary habitat disturbance	Low	Medium	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 2: Temporary increases in SSCs and changes to seabed levels	Low	High	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 3: Direct and indirect seabed disturbance leading to release of sediment contaminants	Negligible	Low	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Operation and Maintenance					
Impact 4: Long-term habitat loss/alteration due to the addition of infrastructure to the area	Low	High	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)

Potential Impact	Magnitude	Sensitivity of Receptor	Significance	Mitigation Measure	Residual Effect
Impact 5: Temporary habitat disturbance	Low	Medium	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 6: Colonisation of hard substrates	Low	High	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 7: Increased risk of introduction and/or spread of INNS	Low	High	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 8: Changes in physical processes resulting from the presence of the OWF subsea infrastructure	Negligible	Medium	Low	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 9: EMF effects generated by inter-array, interconnector and offshore export cables	Negligible	Low	Negligible	No mitigation required above and beyond embedded mitigation measures	Negligible (not significant)

Potential Impact	Magnitude	Sensitivity of Receptor	Significance	Mitigation Measure	Residual Effect
				outlined in Table 4–19.	
Impact 10: Seabed sediment heating from subsea cables	Low	Medium	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Decommissioning					
Impact 11: Temporary habitat disturbance	Low	Medium	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 12: Temporary increases in SSCs and changes to seabed levels	Low	High	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Impact 13: Direct and indirect seabed disturbance leading to release of sediment contaminants	Low	Low	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)

Potential Impact	Magnitude	Sensitivity of Receptor	Significance	Mitigation Measure	Residual Effect
Impact 14: Long-term habitat loss/alteration due to the removal of infrastructure	Low	Medium	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)
Cumulative					
Impact 15: Cumulative temporary increase in SSC and sediment deposition	Low	Medium	Minor	No mitigation required above and beyond embedded mitigation measures outlined in Table 4–19.	Minor (not significant)

4.14 References

[1] The Council of the European Committees (1992) 'Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora'. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31992L0043 (Accessed 28/05/2024)

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[12] Scottish Government (2020) 'Sectoral Marine Plan for Offshore Wind Energy'. Available at: https://www.gov.scot/publications/sectoral-marine-plan-offshore-wind-energy/ (Accessed 31/10/2024)

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