Environmental Impact Assessment Report
Volume 1, Chapter 7: Marine Water and Sediment Quality

MarramWind Offshore Wind Farm

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MarramWind

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7. Marine Water and Sediment Quality

7.1 Introduction

7.1.1.1 This marine water and sediment quality chapter of the Environmental Impact Assessment (EIA) Report presents the results of the assessment of the likely significant effects on water quality and sediment quality that may arise from the construction, operation and maintenance (O&M) and decommissioning stages the offshore Project seaward of Mean High Water Springs (MHWS). It should be read in conjunction with the project description provided in **Chapter 4: Project Description** and the relevant parts of the following chapters and appendices.

- **Chapter 6: Marine Geology, Oceanography and Physical Processes**. A potential source of changes in water quality will be sediment mobilisation and the magnitude and extent of effects of such mobilisation on marine water and sediment quality will depend on physical processes. Floating substructures could influence water column mixing, altering water quality. These aspects are assessed in the marine geology, oceanography and physical processes chapter and this information has been used to inform the marine water quality assessment.
- **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**. Changes in marine water and sediment quality have the potential to result in adverse effects on benthic and epibenthic biota through toxicity and other mechanisms. While an assessment against established water quality and sediment quality standards, which are designed to be protective of biota, is included in this Chapter, further specific assessment of effects of changes in water quality, particularly where no environmental quality standard (EQS) is available, are also included in the benthic, epibenthic and intertidal ecology chapter.
- **Chapter 11: Marine mammals:** Marine mammal receptor species are sensitive to accidental pollution, increased concentrations of suspended solids and the leaching of toxins. This Chapter therefore informs the marine mammals chapter.
- **Chapter 13: Fish Ecology**: While assessment against EQS is included in this Chapter, further assessment of effects of specific water quality changes where relevant to fish marine and diadromous fish are addressed in the fish ecology chapter.
- **Chapter 20**: **Water Resources and Flood Risk:** The water resources and flood risk chapter addresses the potential impacts on onshore water resources and flood risk from onshore activities landward of Mean Low Water Springs. The water resources and flood risk assessment also addresses potential impacts on surface water and groundwater Water Framework Directive (WFD) water bodies, which is considered within a standalone WFD assessment in **Volume 3, Appendix 6.2: Water Framework Directive Assessment**.
- **Chapter 30: Socio-Economics:** Changes to water quality due to disturbance of the seabed sediment have the potential to affect recreational users of the marine environment. The information from this Chapter thus informs the socio-economics chapter where these effects are considered.

7.1.1.2 This Chapter describes:

- the legislation, planning policy, guidance and other documentation that has informed the assessment (**Section 7.2: Relevant legislative and policy context and technical guidance**);
- the outcome of consultation and engagement that has been undertaken to date, including how matters relating to marine water and sediment quality have been addressed (**Section 7.3: Consultation and engagement**);
- the scope of the assessment for marine water and sediment quality (**Section 7.4: Scope of the assessment)**;
- the data sources and methods used for gathering baseline data including surveys where appropriate (**Section 7.5: Methodology for baseline data gathering**);
- the overall environmental baseline (**Section 7.6: Baseline conditions**);
- the basis for the EIA Report (**Section 7.7: Basis for EIA Report**);
- methodology for EIA Report (**Section 7.8: Methodology for EIA Report**);
- the assessment of marine water and sediment quality effects (**Section 7.9**: **Assessment of effects: construction**; **Section 7.10: Assessment of effects: O&M stage** and **Section 7.11: Assessment of effects: decommissioning**);
- summary of effects (**Section 7.12: Summary of effects**);
- consideration of transboundary effects (**Section 7.13: Transboundary effects**);
- consideration of inter-related effects and cumulative effects (**Section 7.14: Inter-related effects** and **Section 7.15: cumulative effects assessment**);
- a summary of residual effects for marine water and sediment quality (**Section 7.16: Summary of residual likely significant effects**);
- a reference list is provided (**Section 7.17: References**); and
- a glossary of terms and abbreviations is provided (**Section 7.18: Glossary and abbreviations**).

7.1.1.3 This Chapter is also supported by the following appendices in:

- **Volume 3, Appendix 6.2**. The WFD includes physical, water quality and biological quality elements. Thus, although this appendix is attached to **Chapter 6: Marine Geology, Oceanography and Physical Processes**, it is also relevant as an appendix to this Chapter and to **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**, **Chapter 13: Fish Ecology**, and **Chapter 20: Water resources and Flood Risk** and **Chapter 23: Terrestrial Ecology and Ornithology**.
- **Volume 3, Appendix 7.1: Geophysical and Environmental Offshore Windfarm Survey Volume 4 of 11 Contaminants Report**.
- **Volume 3: Appendix 7.2: Geophysical and Environmental Export Cable Corridor Survey Volume 4 of 8 Contaminants Report**.
- **Volume 3, Appendix 7.3: Environmental Intertidal Survey- Contaminants Report**.

7.2 Relevant legislative and policy context and technical guidance

7.2.1 Legislative and policy context

7.2.1.1 This Section identifies the relevant legislation and policy context that has informed the scope of the marine water and sediment quality assessment. Further information on policies relevant to this EIA and their status is set out in **Chapter 2: Legislative and Policy Context**, which provides an overview of the relevant legislative and policy context for the Project. **Chapter 2: Legislative and Policy Context** is supported by **Volume 3, Appendix 2.1: Planning Policy Framework**, which provides a detailed summary of international, national, marine and local planning policies of relevance to this EIA. Individual policies of specific relevance to this assessment and associated appendices have been taken into account.

7.2.1.2 This summary provides a foundation for understanding the specific requirements that this Chapter must address in terms of assessing and mitigating impacts on receptors and relevant environmental issues.

7.2.1.3 The legislation and international agreements relevant to marine water and sediment quality includes:

- The Scotland River Basin District (Standards) Directions 2024 (Scottish Government, 2024);
- The Scotland River Basin District (Quality of Shellfish Water Protected Areas) (Scotland) Directions 2021 (Scottish Government, 2021);
- The Environment (EU Exit) (Scotland) (Amendment etc.) Regulations 2019;
- Marine Environment (Amendment) (EU Exit) Regulations 2018;
- The Scotland River Basin District (Standards) Amendment Directions 2015;
- The Water Environment (Shellfish Water Protected Areas: Environmental Objectives etc) (Scotland) Regulations 2013;
- The Water Environment (Shellfish Water Protected Areas: Designation) (Scotland) Order 2013;
- EU Directive 2013/39/EU amending Directives 2000/60/EC and 2008/105/EC (EQS amendment Directive);
- Water Environment (Controlled Activities) (Scotland) Regulations 2011;
- The Marine Strategy Regulations 2010;
- Marine (Scotland) Act 2010;
- Marine and Coastal Access Act 2009;
- EC Directive (2008/105/EC on EQS in the field of water policy, amending and subsequently repealing Council Directive 82/176/EEC, 83/513/ECC, 84/156/ECC, 84/491/ECC, 86/280/ECC and amending Directive 2000/60/EC (EQS Directive) (European Commission, 2008a);
- Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive (MSFD)) (European Commission, 2008b);

- Bathing Waters (Scotland) Regulations 2008;
- EC Directive (2006/7/EC) concerning the management of bathing water quality and repealing Directive 76/160/EEC (Bathing Water Directive) (European Commission, 2006);
- International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) (IMO, 2004);
- Water Environment and Water Services (Scotland) Act 2003;
- Convention for the Protection of the Marine Environment of the North East Atlantic (OSPAR, 1992); and
- International Convention for the Prevention of Pollution from Ships (MARPOL) (IMO, 1973).

7.2.1.4 The policies relevant to marine water and sediment quality includes:

- Draft Updated Sectoral Marine Plan (Scottish Government, 2025);
- Marine strategy part three: 2025 UK programme of measures. 2024 (HM Government, 2024);
- National Planning Framework 4 2023 (Scottish Government, 2023a);
- Aberdeenshire Council Local Development Plan 2023 (Aberdeenshire Council, 2023a);
- The River Basin Management Plan for Scotland 2021–2027 (SEPA, 2021);
- Sectoral Marine Plan for Offshore Wind 2020 (Scottish Government, 2020);
- Scottish National Marine Plan 2015 (Scottish Government, 2015); and
- UK Marine Policy Statement 2011 (HM Government, 2011).

7.2.2 Relevant technical guidance

7.2.2.1 Other information and technical guidance relevant to the assessment undertaken for marine water and sediment quality includes:

- Guidance for Pollution Prevention (SEPA, 2018);
- Action levels in dredged material assessments (Marine Scotland, 2017);
- RenewableUK and NERC guidelines on Cumulative Impact Assessment Guidelines – Guiding Principles for Cumulative Impact Assessment in Offshore Wind Farms (RenewableUK, 2013);
- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy project (Judd, 2012); and
- Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (Canadian Council of Ministers of the Environment, 2001).

7.3 Consultation and engagement

7.3.1 Overview

7.3.1.1 This Section describes the consultation and stakeholder engagement undertaken on the Project in relation to marine water and sediment quality. This includes early engagement, the outcome of and response to the Scoping Opinions (Scottish Government, 2023b; Aberdeenshire Council, 2023b) in relation to the marine water and sediment quality assessment, non-statutory consultation, and the findings of the Project's Statutory Consultation. An overview of engagement undertaken for the Project as a whole can be found in Section 5.5 of **Chapter 5: Approach to the EIA**.

7.3.2 Key issues

7.3.2.1 A summary of the key issues raised during statutory and non-statutory consultation, specific to marine water and sediment quality, is outlined below in **Table 7.1**, together with how these issues have been considered in the production of this EIA Report.

Table 7.1 Stakeholder issues responses – marine water and sediment quality

Stakeholder	Stakeholder issue ID	From, document, date	Stakeholder comment	How is this addressed in the EIA Report
Marine Directorate - Licencing Operations Team (MD-LOT)	299	MD-LOT Scoping Opinion, 12 May 2023 (Scottish Government, 2023b).	*“The Scottish Ministers are content with the baseline data sources regarding marine water and sediment quality used by the Developer in Table 5.2.6 of the Scoping Report. The Scottish Ministers advise in line with the NatureScot representation that consideration is given to impacts on blue carbon assessment and an assessment conducted for benthic ecology to focus on the potential impacts of the Proposed Development on marine sediments.”*	This has been addressed with the production of a blue carbon assessment, which feeds into the greenhouse gases (GHG) assessment which assesses GHG emissions from the construction and O&M of the Project. The blue carbon assessment is included in **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** but the assessment of carbon associated with mobilised sediment is estimated in this Chapter and feeds into the blue carbon assessment. Engagement with NatureScot on methods for blue carbon assessment elicited guidance that, as the fate of disturbed sedimentary organic carbon (OC) is currently unknown, as a precautionary approach, it should be assumed that 100% of the disturbed volume will result in CO^2 emissions to the atmosphere.
MD-LOT	300	MD-LOT Scoping Opinion, 12 May 2023 (Scottish Government, 2023b).	*“In Table 5.2.8 of the Scoping Report the Developer summaries the potential impacts on marine water and sediment quality during the different phases of the Proposed Development. The Scottish Ministers agree with this approach The Scottish Ministers agree with the impacts scoped in and out of the EIA Report and provide no further comments.”*	The potential impacts are considered in this Chapter (see **Sections 7.9**, **7.10** and **7.11**).

Stakeholder	Stakeholder issue ID	From, document, date	Stakeholder comment	How is this addressed in the EIA Report
MD-LOT	377	MD-LOT Scoping Opinion, 12 May 2023 (Scottish Government, 2023b).	*"The Scottish Ministers agree with the NatureScot representation and direct the Developer to section 5.3.1 of this Scoping Opinion which highlights that a blue carbon assessment should be undertaken in addition to the GHG assessment. The Scottish Ministers refer to section 5.25.1 of this Scoping Opinion which highlights the requirement for the EIA Report to include a GHG Assessment. The Developer must fully address the representation from NatureScot in the EIA Report."*	See response to stakeholder issue 299.
Dee District Salmon Fishery Board	405	MD-LOT Scoping Opinion, Appendix 1: Consultation Responses & Advice, 12 May 2023 (Scottish Government, 2023b).	*"Wild Salmon Strategy and Conservation regulations. In January 2022, the Scottish Government released its Wild Salmon Strategy which gave a clear message that there is sadly now unequivocal evidence that populations of Atlantic Salmon are at crisis point. The Strategy calls on government agencies, as well as the private sector, to prioritise the protection and recovery of Scotland's wild Atlantic salmon populations.* *One of the key pressures identified in the strategy is marine development, with marine renewables highlights as having the potential to impact salmon through noise, water quality and effects on electromagnetic fields (EMFs) used by salmon for migration."*	This is addressed in **Chapter 13: Fish Ecology**, taking account of changes in water quality presented in this Chapter.

7.4 Scope of the assessment

7.4.1 Overview

7.4.1.1 This Section sets out the scope of this EIA for marine water and sediment quality. This scope has been developed as the Project's design has evolved and responds to stakeholder feedback received to-date, as set out in **Section 7.3**.

7.4.2 Spatial scope and study area

7.4.2.1 The assessment considers the likely significant effects of the Project on marine water and sediment quality receptors within its Zone of Influence (ZOI).

7.4.2.2 The study area in this Chapter has been drawn to match the ZOI. The term study area has been used when describing the baseline, whereas ZOI has been used when discussing the potential extent of impacts of the Project.

7.4.2.3 The spatial scope of this marine assessment encompasses (as shown in **Volume 2, Figure 7.1: Marine water and sediment quality study area**):

- the Option Agreement Area (OAA), which covers an area of 684km^2;
- the offshore export cable corridor (including up to 5 offshore export cable trenches), which covers an area of 575km^2 located between the OAA and MHWS; and
- landfall(s) (up to MHWS), at which the offshore export cables come ashore and are connected to the onshore export cables (this includes possible options at Lunderton and Scotstown in the vicinity of Peterhead (see **Chapter 4: Project Description**)).

7.4.2.4 The study area for this Chapter is defined as the OAA, offshore export cable corridor and landfall(s) area together with a buffer zone extending one spring tidal excursion parallel to the coast outside these boundaries, as shown in **Volume 2, Figure 7.1.** The buffer zone has been informed by the tidal excursion extent to encompass the area over which suspended sediments may travel following disturbance as a result of the Project’s activities. It extends 15 kilometres (km) by sea in a direction parallel to the coast. Within 3 nautical mile (nm) (5.56km) of the shore, the study area has also been extended to include the whole of each WFD coastal water body intercepted by the buffer zone boundary, to ensure that all baseline water quality data relating to each of these water bodies is included in the study.

7.4.2.5 The spatial extent for likely significant effects for marine sediment and water quality include sea areas that are covered by different regulatory regimes, and therefore target standards, as outlined in **Table 7.2**.

Table 7.2 Different areas within the spatial scope for assessment for Marine Water and Sediment Quality

Receptor group	Receptors included within group	Regulatory regime
Offshore waters	Marine waters within a buffer zone of 15km in a direction parallel to the shore around the OAA and offshore export cable corridor and more than 3nm from the territorial waters baseline from which the 12nm territorial waters seaward boundary is measured.	Marine Strategy Framework Directive.
Inshore waters	Coastal areas within a buffer zone of 15km in a direction parallel to the shore around the OAA and offshore export cable corridor and within 3nm of the territorial waters baseline (WFD water bodies).	Water Framework Directive; Marine Strategy Framework Directive; and Water Environment and Water Services Act.
Protected areas	Designated sensitive and protected areas with specific water quality criteria, such as Bathing Waters, Shellfish Waters, National Site Network (Special Area of Conservation (SAC) and Special Protection Area (SPA)) and Nature Conservation Marine Protected Areas (NCMPA).	Habitats Directive; Wild Birds Directive; Bathing Water Regulations; and Water Environment and Water Services Act.

7.4.3 Temporal scope

7.4.3.1 The temporal scope of the assessment of marine water and sediment quality is the entire lifetime of the Project, which therefore covers the construction, O&M, and decommissioning stages.

7.4.3.2 It is anticipated that the construction of the Project will commence in 2030, with the first phase becoming fully operational by 2037. It is anticipated that the second phase of the Project would become fully operational by 2040 and the third phase by 2043. The operational lifetime of the Project for each phase is expected to be 35 years.

7.4.4 Identified receptors

7.4.4.1 Within the defined spatial and temporal scope of the assessment the key receptors addressed in this Chapter are:

- marine sediment quality; and
- marine water quality.

7.4.4.2 The spatial and temporal scope of the assessment enables the identification of receptors that may experience a change as a result of the Project. The receptors identified that may experience likely significantly effects for marine water and sediment quality are outlined in. **Table 7.3**

7.4.4.3 Similarly to changes in physical characteristics of the marine environment, changes in water or sediment quality predicted by the EIA can only be assessed directly for significance of effect where there is a water or sediment EQS established for protection of the aquatic environment. In this case, significance of effects on compliance of the receptor with the EQS is assessed in this Chapter.

7.4.4.4 Where no EQS is available, changes to sediment or water quality may, nevertheless, have indirect effects on receptors considered in other chapters, for example effects on a biological receptor such as benthic biota or fish, or on a marine user (for example, human users of bathing waters). These indirect effects are assessed in the relevant other chapters as specified in **Section 7.1**.

7.4.5 Potential effects

7.4.5.1 Potential effects on marine water and sediment quality receptors that have been scoped in for assessment are summarised in **Table 7.3**.

Table 7.3 Potential effects for marine water and sediment quality

Receptor	Activity or impact	Potential effect
Construction and decommissioning stages		
Marine water quality	Direct seabed disturbance during construction (substrate preparation and installation of infrastructure) or decommissioning temporarily mobilises suspended sediment into the water column, which is transported and dispersed in suspension by currents and deposited over various distances (tidal excursion and sediment granulometry dependent).	Remobilisation of sediments causing increased suspended solids concentration (SSC) in the water column leading to deterioration of water quality in offshore and inshore waters and, potentially, protected areas.
Marine water quality	Direct seabed disturbance during construction (substrate preparation and installation of infrastructure) may release potentially contaminated sediments into the water column causing deterioration of water quality due to increased concentrations of contaminants in the water column.	Mobilisation of sediments causing potential mobilisation of contaminants into the water column, leading to deterioration of water quality in offshore and inshore waters and, potentially, protected areas.
Marine sediment quality	Sediment mobilised by construction activities will settle back to the seabed in locations determined by tidal currents, potentially changing existing sediment quality where resettlement occurs.	Resettlement of mobilised sediment causing changes in the quality of sediment in areas where resettlement occurs.
Marine water and sediment quality	Trenchless techniques are a method of installation for the export cable, such as horizontal directional drilling (HDD) (or similar trenchless techniques), to transition the export cable to the onshore grid at the landfall(s) area during the construction stage. This activity can release drilling fluids (muds), containing bentonite, polymer additives and drill cuttings, increasing fine sediment in suspension in the water column, which may impact water and sediment quality. In relation to trenchless cable burial techniques, HDD has been presented in the EIA. Whilst other trenchless methods are available, HDD is presented herein as it its likely to have the largest footprint.	Release of drilling fluids into the water column causing changes in water quality in inshore waters and, potentially, protected areas. Resettlement of released material may cause changes in sediment quality in inshore waters and, potentially, protected areas.

Receptor	Activity or impact	Potential effect
Marine water and sediment quality	Deposit of material into the sea may result in leaching of toxicants into the sea water from metallic components or coatings.	Leaching of contaminants from wind turbine generator (WTG) floating units mooring components or cable armouring leading to deterioration of water quality in offshore and inshore waters.
Marine sediment quality	Construction of the Project could lead to a change in the blue carbon resource in the study area, which is present in the vicinity mainly as carbon in sediments.	This will be addressed mainly in **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** but is considered in this Chapter in terms of blue carbon resource held in sediments.
O&M stage		
Marine water quality	Direct seabed disturbance during maintenance and remedial work temporarily increases suspended sediment into the water column, which is transported and dispersed in suspension by currents and deposited over various distances (tidal excursion and sediment granulometry dependent).	Remobilisation of sediments causing increased SSC on the water column leading to deterioration of water quality in inshore and offshore waters and, potentially, protected areas.
Marine water quality	Direct seabed disturbance during maintenance and remedial work may release potentially contaminated sediments into the water column causing deterioration of water quality due to increased concentrations of contaminants in the water column.	Mobilisation of sediments leading to potential mobilisation of contaminants into the water column, with potential resettlement, leading to deterioration of water in inshore and offshore waters and, potentially, protected areas.
Marine sediment quality	Sediment mobilised by maintenance and remedial works will settle back to the seabed in locations determined by tidal currents, potentially changing existing sediment quality where resettlement occurs.	Resettlement of mobilised sediment may cause changes in the quality of sediment in areas where resettlement occurs.
Marine water and sediment quality	Material deposited into the sea as part of the Project may result in ongoing leaching of toxicants into the sea water from metallic components or coatings.	Leaching of contaminants from WTG mooring components or cable armouring leading to deterioration of water quality in offshore and inshore waters.
Marine water quality	Thermal emissions from electricity cables on or below the sea bed may warm the lower water layer in areas where the sea water is stratified, with potential for disruption of the stratification.	Breakdown of thermal stratification, causing changes in marine water quality.

7.4.6 Effects scoped out of assessment

7.4.6.1 A number of potential effects were scoped out from further assessment in the Scoping Report (MarramWind, 2023), resulting from a conclusion of no likely significant effect. These conclusions have been made based on the knowledge of the baseline environment, the nature of planned works and the professional judgement on the potential for impact from such projects more widely. The conclusions follow (in a site-based context) existing best practice. Each scoped out activity or impact is considered in turn in **Table 7.4**.

Table 7.4 Activities or effects scoped out of assessment

Activity or impact	Rational for scoping out
Accidental release of pollutants from vessels leading to deterioration of water and sediment quality during the construction, O&M and decommissioning stages	The presence of vessels, and plant machinery operating during construction and decommissioning, introduces the risk of accidental release of pollutants from leaks or spills of fuels and lubricants. **Volume 4: Outline Environmental Management Plan** and its appendix **Outline Marine Pollution Contingency Plan** includes appropriate measures in accordance with the International Convention for the Prevention of Pollution from Ships (MARPOL) and Shipboard Oil Pollution Emergency Plans to ensure the risk of accidental pollution events is minimised. Therefore, this impact is scoped out of this EIA.
Any accommodation platform will have a requirement to dispose of sewage, most likely to sea via a treatment plant during the construction, O&M and decommissioning stages	At Scoping, a bespoke platform was considered for the provision of permanent welfare, housekeeping, and accommodation facilities for personnel working on-site offshore during the operation and maintenance stage of the Project. The accommodation platform has subsequently been excluded from the design envelope so is no longer considered in the EIA (see **Chapter 3: Site Selection and Consideration of Alternatives** for further detail).
Presence of marine infrastructure may cause mixing at the thermocline and consequent changes to the thermal stratification regime, with potential effects on water quality during the O&M stage	This has been examined in **Chapter 6: Marine Geology, Oceanography and Physical Processes**, which describes stratification in the study area as weak and concludes that the effect of the presence of the offshore wind farm on stratification will be negligible in magnitude. Therefore, changes in water quality due to interference with the natural stratification regime have been scoped-out of this EIA.

7.5 Methodology for baseline data gathering

7.5.1 Overview

7.5.1.1 Baseline data collection has been undertaken to obtain information over the study area described in **Section 7.4**. The current and future baseline conditions are presented in **Section 7.6**.

7.5.2 Desk study

7.5.2.1 The data sources that have been collected and used to inform this marine water and sediment quality assessment are summarised in **Table 7.5**.

Table 7.5 Data sources used to inform the marine water and sediment quality chapter

Source	Date	Summary	Coverage of study area
Scotland's Marine Atlas (Scottish Government, 2011)	Accessed 2025	Contains data collected to support development of Scotland's National Marine Plan. The "Clean and safe" assessment chapter includes data on contaminants in water, sediment and biota for the Moray Firth and North East Scottish Marine Regions and the Fladen and Moray Firth Offshore Marine Region.	Full coverage of study area.
Marine Scotland NMPi (2025)	Accessed 2025	Publicly available mapping showing monitoring points, administrative areas, WFD water body status etc.	Full coverage of study area.
SEPA- Bathing Waters (2025b)	Accessed 2025	Monitoring of coastal bathing waters during the bathing season.	Includes the seven coastal bathing waters in the study area.
SEPA- water body data sheets (2025c)	Accessed 2025	WFD water body descriptions and status in 2012.	Includes the seven WFD coastal water bodies and three WFD transitional water bodies within the study area.
British Geological Survey	Accessed 2025	Seabed morphology and bathymetry (INFORMAR), sediment types, Sediment Quality.	Full coverage of study area.
Centre for Environment, Fisheries and Aquaculture Science (Cefas) – Suspended sediment climatologies around the UK (Cefas, 2025b)	2016 Accessed 2025	Suspended sediments concentrations and distributions.	Full coverage of study area.
Cefas – Silva 2016. Monthly average non-algal Suspended Particulate Matter concentrations on the UK shelf waters (Cefas, 2016)	2016 Accessed 2025	Survey data on suspended solids around the UK.	Full coverage of study area.

Source	Date	Summary	Coverage of study area
ICES – Oceanographic data (ICES, 2025)	Accessed 2025	Temperature and salinity data.	Full coverage of study area.
JNCC – Coasts and sea of the United Kingdom. Region 3. North-east Scotland: Cape Wrath to St Cyrus (JNCC, 1996)	1997 Accessed 2025	Overview of environment, geology, and ecology.	Coastal area.
Green Volt (2023)	Surveys undertaken in 2021.	Grab sampling was deployed to collect sediment for physio-chemical substances analysis and macrofaunal identification. The survey covered Green Volt's wind farm area (which is south of the Project's OAA) and two export cable routes, one to Buzzard and the other to land towards Peterhead area (which is south of the Project's offshore export cable corridor).	Approximately 10km south from the Project's OAA.
NorthConnect (2018a, b)	Surveys undertaken in 2016 and 2017.	Grab sampling (biota, Particle Size Analysis (PSA) and chemical analysis), seabed photography and video systems were used across the selected sample locations as part of the baseline characterisation.	NorthConnect consenting corridor overlaps study area.
Hywind (2015)	Surveys undertaken in 2013	Grab sampling gear were deployed to collect sediment for analysis of particle size across the survey area and along the export cable corridor to determine levels of metals and hydrocarbons.	Hywind Offshore Wind Farm pre-construction geophysical and environmental baseline survey are covered overlaps study area.

7.5.3 Site surveys

7.5.3.1 The site surveys that have been conducted and used to inform this marine water and sediment quality assessment are summarised in **Table 7.6**.

Table 7.6 Site surveys undertaken

Survey type	Scope of survey	Coverage of study area
Volume 3, Appendix 7.1	Grab and vibrocore (VC) samples were collected during the Geophysical and Environmental Offshore Windfarm survey to assess sediment contamination across the OAA. A total of 30 grab stations and 10 VC locations were successfully sampled, with each grab yielding a full suite of sub-samples for faunal, particle size distribution, contaminants, and other environmental parameters. Each VC location provided sub-samples for contaminant testing. Sampling was conducted between 27 April and 25 August 2021, with stations micro-sited based on geophysical data to ensure representative coverage of sediment types and habitats, including areas of potential conservation interest.	Full coverage of the OAA.
Volume 3, Appendix 7.2	Grab and VC samples were collected along the offshore export cable corridor. Sampling was conducted between April and July, and again in November and December 2023. Of the 80 proposed grab sampling stations, 79 were attempted, with 74 yielding full suites of samples. Five stations were unsampled due to unsuitable seabed conditions, and one station (ST58) was excluded due to infrastructure constraints. Subsamples from 25 representative grab stations were selected post-survey for contaminant analysis, ensuring spatial coverage and representation of soft sediment habitats. Additionally, VC samples were successfully collected at 25 stations, with cores subsampled at 0.1 metres (m) and every 0.5m to a depth of 6m for laboratory analysis.	Offshore export cable corridor.
Volume 3, Appendix 7.3	Contaminant sampling was conducted between the 16 July 2023 and 19 July 2023 across proposed landfalls of the offshore export cable corridor. Each landfall was surveyed using transects spaced at 500m intervals, with one contaminant sample collected from the midshore station of each transect. In total, 11 contaminant samples were collected.	Intertidal area.

7.5.4 Data limitations

7.5.4.1 There are no known data limitations at the time of this study relating to marine water and sediment quality that affect the robustness of the assessment of this EIA Report.

7.6 Baseline conditions

7.6.1 Current baseline

7.6.1.1 The OAA is located in the northeastern sector of the UK Continental Shelf, approximately 75km at its nearest point to shore and 110km at its furthest point, off the coast of Rattray Head in north-east Scotland. The Offshore Red Line Boundary lies within the North East marine region and is influenced by the North Sea currents and wider Atlantic waters. The circulation around the Project is shaped by a combination of tidal forces, wind-driven currents, and Atlantic inflows. Most Atlantic water enters the North Sea between Orkney and Shetland and through the Norwegian Trench, influencing the hydrography of the northeastern shelf. Tidal currents are generally stronger than non-tidal flows and play a key role in mixing the water column, although they contribute little to net water transport. The residual (non-tidal) circulation is predominantly anti-clockwise, with the Scottish Coastal Current typically flowing northward along the east coast, including through the Offshore Red Line Boundary. However, this pattern is highly variable and can be temporarily reversed by wind and density-driven coastal jets. These dynamic processes influence stratification, sediment transport, and water quality across the project area (Scottish Government, 2011b).

7.6.1.2 The shelf sea waters at the North Sea are particularly dynamic. They are often well mixed by tidal currents and wind-driven turbulence, though they can become seasonally stratified in deeper areas. Wave monitoring offshore around the OAA, has measured mean wave heights between 2.01m to 2.25m, in 100m water depths and winds of 8.8m/s (ABPmer, 2025).

7.6.1.3 Tides in the North Sea are predominantly semidiurnal, meaning there are two high tides and two low tides each day. These tidal currents are generally stronger than non-tidal flows and play a key role in mixing the water column, particularly in areas where the flow is constrained by topography, such as straits and headlands (Scottish Government, 2011). The mean tidal range around the OAA is typically around 2m (ABPmer, 2025).

7.6.1.4 The North Sea experiences a range of sea temperatures and salinities depending on location and season. Surface temperatures typically range from 5 to 9°C in winter to 12 to 17°C in summer. Salinity varies, with values between 15 to 25 Practical Salinity Unit (PSU) in areas with high river input and 32 to >35 PSU in the open North Sea (BSH, 2025).

Water quality

7.6.1.5 The hydrodynamic character of the water column across the Offshore Red Line Boundary has been assessed using long-term model outputs from the coupled GETM-ERSEM-BFM ecosystem model, which simulates physical and biogeochemical processes over a 51-year period (1958 to 2008). This model, as applied by Van Leeuwen *et al.* (2015), classifies the North Sea into five distinct stratification regimes: permanently stratified, seasonally stratified, intermittently stratified, permanently mixed, and regions of freshwater influence.

7.6.1.6 Model outputs indicate that the OAA and wider study area is located within the seasonally stratified regime. This classification is based on the persistence of thermal stratification during the warmer months, typically beginning in spring as surface waters warm and continuing through summer until autumnal mixing processes re-establish vertical homogeneity. During winter, the water column is generally well mixed due to increased wind and wave activity.

7.6.1.7 The seasonally stratified regime is a dominant feature of the northern and central North Sea, accounting for approximately 27 per cent of the basin's area over the modelled period. Although some inter-annual variability in the extent of this regime is observed, its spatial footprint remains relatively stable. The OAA, with water depths ranging from 87.8m to 133.7m, is well within the depth range conducive to seasonal stratification. These depths support the development of a thermocline, resulting in a measurable temperature gradient between surface and bottom waters during spring and summer, which may persist into early autumn.

7.6.1.8 A Cefas assessment (Cefas - Silva, 2016) presents an 18-year satellite-derived climatology (1998 to 2015) of non-algal Suspended Particulate Matter (SPM) across UK shelf waters. Commissioned under the UK Department for Business, Energy and Industrial Strategy's Offshore Energy Strategic Environmental Assessment programme, the study provides a robust spatial and temporal dataset to support environmental planning for offshore energy developments, including windfarms.

7.6.1.9 The OAA is located in the northern North Sea, a region explicitly covered in the Cefas study. According to the analysis, this area is characterised by relatively low to moderate concentrations of non-algal SPM, with a clear seasonal cycle. SPM levels tend to be lower in spring and summer, and higher in autumn and winter, reflecting natural variability driven by wind, wave action, and stratification dynamics.

7.6.1.10 Importantly, the study identified a statistically significant increasing trend in annual mean SPM concentrations in the northern North Sea over the 18-year period. This trend was most pronounced during the summer and autumn seasons, suggesting a potential shift in sediment dynamics that may be relevant to the planning and monitoring of offshore infrastructure. While the causes of this trend are not definitively attributed, the report notes that both natural variability and anthropogenic influences—such as seabed disturbance from offshore activities—could be contributing factors.

Water Framework Directive

7.6.1.11 Marine surface waters are classified under the Scotland River Basin Management Plan (RBMP) under the Water Environment and Water Services (Scotland) Act 2003. The key objectives of the WFD are to employ the RBMP to protect and, where necessary, restore water bodies to reach good status, and to prevent deterioration. There are five classifications of water status as defined under the WFD: High, Good, Moderate, Poor, and Bad. Good status means both good chemical and good ecological status (SEPA, 2023).

7.6.1.12 The landfall options at Scotstown and Lunderton, and the ZOI are located within two WFD designated transitional water bodies, as shown in Figure 1 of **Volume 3, Appendix 6.2**. The transitional water bodies, from north to south of the landfall(s) area, are:

- Strathbeg Estuary (ID 200137) is approximately 9km north of Scotstown landfall and has a water classification status of 'High'; and
- Ugie Estuary (ID 200129) is approximately 500m south of Lunderton South landfall and has a water classification status of 'High'.

7.6.1.13 Also, the landfall options at Scotstown and Lunderton, and the ZOI are located within four WFD designated coastal water bodies, as shown in Figure 2 of **Volume 3, Appendix 6.2**. The coastal water bodies, from north to south of the landfall(s) area, are:

- Rosehearty to Cairnbulg Point (ID 200500) is approximately 12km north of Scotstown landfall and has a water classification status of 'Good';
- Cairnbulg Point to the Ugie Estuary (ID 200142) includes all of the landfall options and has a water classification status of 'High';
- Ugie Estuary to Buchan Ness (Peterhead) (ID 200131) is within Lunderton South landfall option and has a water classification status of 'Good'; and

- Buchan Ness to Cruden Bay (ID 200125) is approximately 5km south from Lunderton South landfall and has a water classification status of 'High'.

7.6.1.14 There is one designated bathing water within the study area at Peterhead Lido (see Figure 2 of **Volume 3, Appendix 6.2**), which is approximately 3km south from Lunderton landfall. Peterhead Lido bathing water is situated within the outer harbour of Peterhead on Scotland's east coast, forming the shoreline of a boating marina. The sandy beach stretches approximately 300 metres and slopes gently toward the sea, with the distance to the water's edge varying between 80 and 150m depending on the tide. This bathing water is vulnerable to short-term pollution after heavy rainfall, particularly from sewer overflows.

7.6.1.15 Water quality monitoring at this site measures concentrations of microbiological parameters and the site has been classified as having 'Excellent' water quality in 2024.

7.6.1.16 Further details of WFD water bodies are contained in **Volume 3, Appendix 6.2**.

7.6.1.17 In the nearshore zone, water quality is potentially affected by several treated sewage outfalls, and an outfall at Peterhead discharging power station cooling water. There are also several combined sewer overflow outfalls within the study area. The effects of these discharges on baseline water quality will need to be established during the planned water quality monitoring programme and further desk study.

Sediment quality

Physical characteristics

7.6.1.18 Sediment grain size plays a key role in assessing contamination risk, as finer materials such as silts and clays tend to act as sinks for contaminants, making them more likely to retain pollutants than coarser sediments (Cefas, 2001). For instance, fine particles, particularly those in the silt / clay fraction can absorb petroleum hydrocarbons from seawater, facilitating their incorporation into the sediment system. Additionally, organic matter within the sediment matrix can bind with hydrocarbons and heavy metals, aiding their transport and retention. Grain size also helps predict the potential spread of sediment plumes if the seabed is disturbed.

7.6.1.19 The online British Geological Survey (BGS) GeoIndex Offshore data for seabed sediments, shown in Figure 3 of **Volume 3, Appendix 6.3: Marine Geology, Oceanography and Physical Processes Baseline Report** indicates that the seabed in the OAA is muddy sand, sand and slightly gravelly sand. The offshore export cable corridor consists of gravelly sand and slightly gravelly sand with gravel close to the shore.

7.6.1.20 The Particle Size Analysis (PSA) data for the OAA (see Figure 3 of **Volume 3, Appendix 6.3**) shows that sediments were predominantly composed of sand, with varying proportions of fines (silt and clay) and minimal gravel content. Stations A15_a, A20_a, and B19 had the highest sand content (over 94 per cent), with low fines and trace gravel, and were classified as 'sand'. In contrast, stations such as A14, A10, and B13 exhibited higher proportions of fines (up to 42.48 per cent) and were classified as 'muddy sand'. Gravel was largely absent across the survey area, with only minor occurrences (up to 2.17 per cent at station A9). The majority of stations (68 out of 79) were classified as 'muddy sand' under the BGS modified Folk classification, with the remaining 11 classified as 'sand'.

7.6.1.21 The PSA data for offshore export cable corridor shows that sand was the dominant sediment fraction across all stations, with sand content ranging from 33.89 per cent at station ST51 to 99.98 per cent at station ST44_a. Stations ST44_a, ST13_a, and ST15 exhibited the highest sand proportions (≥98 per cent), with minimal gravel and fines. In contrast, stations such as ST51, ST47_a, and ST52 showed elevated gravel content (36% to 65%), classifying them as sandy gravel or gravelly sand. Fines were generally low but reached up to 35.09 per cent at station STA2_05, where silt was more prevalent than clay. According to the Folk (BGS modified) classification, the sediments were predominantly described as 'sand' (31 stations), followed by 'muddy sand' (22 stations), 'gravelly sand' (16 stations), 'sandy gravel' (7 stations), and 'gravelly muddy sand' (1 station).

7.6.1.22 The PSA data for the intertidal area at landfall shows that all samples were composed predominantly of sand, with minimal gravel and negligible mud content. Stations D1U, D1M, D1L, and D3M exhibited the highest sand proportions (99.24 to 100 per cent), with only trace amounts of gravel (0.07 to 0.48 per cent) and mud (0.00 to 0.30 per cent). Stations D2M, D2L, and D3L also showed similar sand dominance (99.18 to 99.68 per cent) but with slightly elevated gravel content (0.31 to 0.34 per cent). Notably, D2U and D3U were classified as pure sand with 100 per cent sand and no gravel or mud detected. All samples were moderately well sorted, except D3U which was well sorted, indicating consistent sediment characteristics across the site.

Contaminants

Option Agreement Area

7.6.1.23 A site-specific survey was undertaken at the OAA in 2021 at which 40 sites were sampled for sediment chemistry as shown in Figure 4.1 of **Volume 3, Appendix 7.1**. Chemical analysis of the sediment samples focused on metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and organotins.

7.6.1.24 **Table 7.7** summarises the concentrations of the extractable metals in the sediment samples from the grabs within the OAA.

Table 7.7 Summary of surface sediment metals analysis for the grab samples within the OAA

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
A2	2.75	0.04	12.9	2.2	<0.03	6.0	4.0	11.6
A3	2.31	0.03	9.81	1.7	<0.03	4.4	3.2	9.2
A7	2.48	0.04	12.3	2.0	<0.03	6.2	3.7	11.8
A12	2.78	0.03	11.1	1.6	<0.03	5.1	3.1	10.0
A13	2.84	0.05	15.8	2.7	<0.03	8.4	4.9	15.2
A17	2.73	0.03	11.9	2.1	<0.03	6.2	3.9	12.0
A19	1.94	0.03	9.41	1.7	<0.03	4.2	2.8	8.7
A20_a	9.72	0.03	11.3	0.9	<0.03	2.4	5.9	7.1
A21	2.87	0.02	8.86	1.3	<0.03	3.4	3.0	7.7
A22	2.53	0.03	10.2	1.9	<0.03	5.5	3.8	10.6
A25	2.51	0.03	11.0	2.0	<0.03	5.9	3.6	11.1

Station	As	Cd	Cr	Cu	Hg	Ni	Pb	Zn
A26	2.37	0.04	13.9	2.3	<0.03	6.9	4.2	13.2
A30	2.62	0.04	13.8	2.8	<0.03	7.3	4.4	13.5
A33	2.80	0.03	13.7	2.2	<0.03	6.9	4.8	12.9
A36	2.65	0.04	16.7	2.8	<0.03	8.3	5.0	15.9
A40_a	2.98	0.06	19.1	3.3	<0.03	9.7	5.8	17.7
B2	2.92	0.03	11.5	1.8	<0.03	5.2	3.8	10.6
B5	2.70	0.04	10.5	1.6	<0.03	5.2	3.8	10.6
B9	2.58	0.03	11.1	1.5	<0.03	4.8	3.4	9.5
B10	2.86	0.04	16.3	2.6	<0.03	8.0	4.8	15.1
B12	2.58	0.03	11.4	1.6	<0.03	5.2	3.4	10.1
B14	2.73	0.03	13.1	2.0	<0.03	5.8	3.9	11.6
B17	2.61	0.04	14.6	2.3	<0.03	7.2	4.6	13.8
B23	2.41	0.04	13.6	2.0	<0.03	6.3	4.0	12.0
B25	2.66	0.02	9.54	1.2	<0.03	3.9	3.2	8.0
B26	3.34	0.04	15.3	2.5	<0.03	7.4	4.8	14.4
B28	2.23	0.02	8.84	1.2	<0.03	3.7	2.9	7.5
B30	2.58	0.03	12.0	1.8	<0.03	5.7	3.7	11.4
B35	3.09	0.04	13.9	2.0	<0.03	6.2	4.2	12.4
B39_a	2.81	0.04	16.3	2.6	<0.03	7.7	4.9	15.1
Min	1.94	0.02	8.84	0.9	<0.03	2.4	2.8	7.1
Max	9.72	0.06	19.1	3.3	<0.03	9.7	5.9	17.7
Mean	2.90	0.03	12.7	2.0	<0.03	6.0	4.0	11.7
AL1	20	0.4	50	30	0.25	30	50	130
AL2	70	4	370	300	1.5	150	400	600
Canadian marine ISQG	7.24	0.7	52.3	18.7	0.13	-	30.2	124

Notes to **Table 7.7**: Concentrations expressed in µg/g dry sediment;
As=Arsenic; Cd=Cadmium; Cr=Chromium; Cu=Copper; Hg=Mercury; Ni=Nickel; Pb=Lead; Zn=Zinc
AL1 = Marine Scotland Action level 1 AL2 = Marine Scotland Action level 2
Canadian ISQG = Canadian interim sediment quality guidelines (CCME, 2001)

7.6.1.25 Results of the sediment metals analysis for the vibrocore samples within the OAA can be seen in the survey report from the surveys carried out during 2021 (see **Volume 3, Appendix 7.1**).

7.6.1.26 Across the survey area, PAH concentrations were below Marine Scotland's Action Level 1 (AL1), indicating no ecological concern. Metal concentrations in grab samples were also below AL1 and AL2 thresholds, while core samples showed isolated exceedances of AL1 for arsenic and chromium, though all remained below AL2. PCBs and organotins (dibutyltin and tributyltin (TBT)) were consistently below detection limits or AL1 values, suggesting minimal contamination risk throughout the OAA.

Offshore export cable corridor

7.6.1.27 A site-specific survey was undertaken at the offshore export cable corridor in 2023, at which 25 were sampled for sediment chemistry as shown in Figure 4.1 of (**Volume 3, Appendix 7.2**). Sediment chemistry analysis included PAHs, metals, PCBs, and organotins.

7.6.1.28 **Table 7.8** summarises the concentrations of the extractable metals in the sediment samples from the grabs within the offshore export cable corridor.

Table 7.8 Summary of surface sediment metals analysis for the grab samples within the offshore export cable corridor

Station	Al	As	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
Nearshore										
ST73	4330	5.02	0.02	5.82	0.8	2240	<0.03	2.1	2.6	7.3
Offshore										
ST01	5130	4.75	0.02	6.28	1.3	1740	<0.03	2.3	3.4	6.7
ST04	5580	5.90	0.02	9.17	1.3	2540	<0.03	3.0	4.9	9.2
ST07	7060	5.61	0.02	12.1	1.3	2830	<0.03	3.3	5.3	11.8
ST10	7150	4.59	0.01	13.2	1.2	3050	<0.03	3.4	4.2	12.7
ST12	5850	4.52	0.01	12.0	1.2	2690	<0.03	3.2	4.6	11.6
ST13_a	5740	9.27	<0.01	7.98	0.6	1520	<0.03	2.0	4.3	6.0
ST17_a	6640	3.45	0.01	7.87	0.9	2320	<0.03	2.5	3.4	6.9
ST20	5430	2.83	0.01	9.10	1.4	2800	<0.03	3.2	3.9	8.8
ST23_a	4690	2.00	0.02	8.97	1.2	3350	<0.03	3.5	2.8	7.8
ST26_a	5000	2.49	0.02	9.25	1.2	3420	<0.03	3.4	3.2	7.5
ST28	4880	2.75	0.03	11.1	1.8	3900	<0.03	4.6	3.5	9.8
ST31	6090	3.24	0.04	14.0	2.0	5430	<0.03	6.2	3.9	12.1

Station	Al	As	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
ST36_a	7860	2.90	0.05	16.8	2.6	7450	<0.03	7.9	4.7	15.8
ST39_a	7440	3.13	0.05	17.1	2.7	6850	<0.03	8.8	5.0	15.9
ST42_a	7040	2.73	0.05	16.3	2.6	6520	<0.03	8.2	4.7	15.2
ST44_a	3380	8.59	0.02	3.85	0.6	1350	<0.03	1.3	2.5	5.1
ST50_a	8390	16.4	0.07	6.47	1.4	2520	<0.03	3.4	8.4	12.4
ST53	8410	10.8	0.04	8.18	1.3	2290	<0.03	3.5	6.8	11.2
ST56	6990	6.65	0.04	8.22	1.3	2230	<0.03	2.9	6.3	12.4
ST64	6570	7.40	0.05	6.23	1.2	1710	<0.03	3.7	4.8	9.4
ST67	6970	6.76	0.04	7.85	1.5	2130	<0.03	3.0	6.1	12.5
ST2_01	7000	2.66	0.04	12.1	2.1	4790	<0.03	6.4	4.4	13.0
STA2_05	7790	2.78	0.05	14.2	2.4	5630	<0.03	7.8	4.9	14.6
STC2_04	7880	13.7	0.02	5.78	1.1	1520	<0.03	2.6	5.1	6.5
Minimum	3380	2.00	<0.01	3.85	0.6	1350	<0.03	1.3	2.5	5.1
Maximum	8410	16.4	0.07	17.1	2.7	7450	<0.03	8.8	8.8	15.9
Mean	6370	5.64	0.03	10.0	1.5	3310	<0.03	4.1	4.5	10.5
AL1		20	0.4	50	30		0.25	30	50	130
AL2		70	4	370	300		1.5	150	400	600
Canadian marine ISQG	-	7.24	0.7	52.3	18.7	-	0.13	-	30.2	124

Notes to **Table 7.8**:

Concentrations expressed in μg/g dry sediment

Al=aluminium; As=arsenic; Cd=cadmium; Cr=chromium; Cu=copper; FE=iron: Hg=mercury; Ni=nickel; Pb=lead; Zn=Zinc

AL1 = Marine Scotland Action level 1 AL2 = Marine Scotland Action level 2

Canadian ISQG = Canadian interim sediment quality guidelines (CCME, 2023)

7.6.1.29 Results of the sediment metals analysis for the vibrocore samples within the offshore export cable corridor can be seen in the survey report from the surveys carried out during 2023 (Fugro, 2022).

7.6.1.30 Within the offshore export cable corridor, there are two oil and gas fields: Atlantic and Golden Eagle; samples collected within these 2 fields were: ST42_a, ST39_a, STA2_05, ST36_a (see **Volume 3, Appendix 7.2**). These showed no differences from the rest of the samples except that iron concentrations in the sediment were the highest among the offshore export cable corridor samples.

7.6.1.31 All PAH concentrations in grab samples were below Marine Scotland Action Level 1 (AL1), indicating no ecological concern. One core sample (MRW_ECC_47-3) exceeded AL1 for multiple PAHs, though adjacent layers did not, suggesting a localised anomaly. Metal concentrations in grab samples were also below AL1 and AL2 thresholds, while some core samples exceeded AL1 for arsenic, cadmium, chromium, copper, and nickel, but remained below AL2. PCB and TBT concentrations were consistently below AL1 across all samples, indicating minimal contamination risk.

Landfall(s) area

7.6.1.32 A site-specific survey was undertaken at the landfalls area in 2023 at which 11 stations were sampled for sediment chemistry as shown in Figures 3, 4 and 5 of **Volume 3, Appendix 7.3**). **Table 7.9** summarises the normalised metal concentrations recorded at the sites within the landfall areas.

Table 7.9 Normalised concentration of heavy and trace metals at the landfalls

Station	Al	As	Ba	Cd	Cr	Cu	Fe	Hg	Ni	Pb	Zn
D1	1150	11.4	13.0	0.04	2.9	1.2	6360	0.02	2.3	2.3	7.1
D2	871	11.7	11.8	0.07	2.9	1.0	5300	0.01	2.3	2.4	7.8
D3	838	10.4	10.4	0.07	2.8	0.7	4870	0.01	1.8	2.1	6.2
D4	737	7.6	8.98	<0.04	2.5	0.8	3980	<0.01	1.7	1.6	7.3
E1	780	6.1	8.35	0.05	2.8	1.4	3450	<0.01	2.1	1.8	7.6
E2	928	6.7	9.35	<0.04	2.5	1.1	4260	<0.01	2.2	1.7	6.3
E3	864	7.6	9.38	<0.04	2.3	1.1	4320	<0.01	1.8	1.8	6.8
E4	812	8.3	10.1	0.05	2.5	0.8	4440	<0.01	1.6	2.0	5.6
Min	737	2	8.35	0.04	2.3	0.7	3450	0.01	1.6	1.6	5.6
Max	1150	11.7	13.0	0.23	28.2	12.9	6360	0.04	30.8	16.3	114
Mean	1024	8.27	10.17	0.084	5.2	2.31	4590	0.02	4.86	3.48	17.82
AL1	-	20	-	0.4	50	30	-	0.25	30	50	130
AL2	-	70	-	4	370	300	-	1.5	150	400	600
Canadian marine ISQG		7.24	-	0.7	52.3	18.7	-	0.13	-	30.2	124

Notes to **Table 7.9**:

Concentrations expressed in µg/g dry sediment

Al=aluminium; As=arsenic; Ba=barium; Cd=cadmium; Cr=chromium; Cu=copper; FE=iron: Hg=mercury; Ni=nickel; Pb=lead; Zn=Zinc

AL1 = Marine Scotland Action level 1 AL2 = Marine Scotland Action level 2

Canadian ISQG = Canadian interim sediment quality guidelines (CCME, 2023)

7.6.1.33 All PAH concentrations in core samples were below Marine Scotland Action Level 1 (AL1), indicating no ecological concern.

Blue carbon

7.6.1.34 Blue carbon refers to coastal and marine ecosystem's ability to absorb and store carbon dioxide from the atmosphere. Plants calcifying organisms and sediment all play a role in capturing and storing carbon, both in the short-term (for example, plants) and long-term (for example, reefs and deep-sea sediments). A major threat to long-term carbon storage is any activity that disrupts the surface layers of sediment such as the installation of subsea cables and infrastructure.

7.6.1.35 There are various blue carbon habitats and these fall into two categories: seabed sediments and coastal vegetated habitats. Blue carbon stored within coastal vegetated habitats is assessed within **Chapter 10: Benthic, Epibenthic and Intertidal Ecology.** This Section provides a qualitative overview of the blue carbon potentially stored within seabed sediments.

7.6.1.36 Both OC and inorganic carbon (IC)[1] are stored within seabed sediments. Within the UK Economic Exclusion Zone, for example, Smeaton *et al.* (2021) estimated that the top 10cm of seabed sediments contain 524 ± 68 Mt of OC and 2,582 ± 168 Mt of IC. Globally, seabed sediments are estimated to contain 3,117,000 Mt OC within the top 1m, but no equivalent estimate for IC exists (Atwood *et al.* 2020). Much of this stored carbon has been accumulating over millennia and represents a considerable store that needs to be protected. Disturbance of seabed sediments could result in a reduction or changes to sequestration processes and associated carbon stores. Given the irreversibility of any potential impacts, a cautious approach to disturbance of seabed carbon stores is prudent (Laffoley, 2020).

7.6.2 Future baseline

7.6.2.1 In the absence of the Project, the future baseline for marine water and sediment quality within the OAA and offshore export cable corridor is expected to remain broadly consistent with current conditions. Natural variability in sediment dynamics and water quality parameters will continue to be influenced by seasonal cycles, regional hydrodynamics, and climatic factors. No significant changes to existing anthropogenic pressures, such as commercial shipping, fisheries activity, or terrestrial runoff, are anticipated in the near term. However, broader-scale environmental changes linked to climate change such as rising sea temperatures, increased storm intensity, and altered precipitation patterns, may influence water column stratification, sediment transport, and contaminant fluxes over time.

7.7 Basis for EIA Report

7.7.1 Maximum design scenario

7.7.1.1 The process of assessing using a parameter-based design envelope approach means that the assessment considers a maximum design scenario whilst allowing the flexibility to make improvements in the future in ways that cannot be predicted at the time of submission of the planning application, marine licences applications and Section 36 (s.36) consent.

[1] OC is the main building block of all living tissue, and IC largely takes the form of calcium carbonate found in the shells and skeletons of animals and plants.

7.7.1.2 The assessment of the maximum adverse scenario for each receptor establishes the maximum potential adverse effect and as a result effects of greater adverse significance would not arise should any other scenario (as described in **Chapter 4: Project Description**) to that assessed within this Chapter be taken forward in the final Project design.

7.7.1.3 The maximum design scenario parameters that have been identified to be relevant to marine water and sediment quality are outlined in **Table 7.10** and are in line with the project design envelope (**Chapter 4: Project Description**).

Table 7.10 Maximum design scenario for impacts on marine water and sediment quality

Impact / activity	Maximum design scenario parameter	Justification
Construction		
Impact C1: Mobilisation of sediment into the water column, increasing SSC and turbidity	**Seabed preparation for wind turbine anchors** • 225 WTGs each with 8 anchors, total of 1,800 anchors; • anchor type: driven pile anchor; and • bedform clearance (for example sandwaves). **Seabed preparation for array cables** • Bedform clearance (or example sandwaves). **Installation activities for array cables** • Jet trenching up to 530km of array cables with trench dimensions of 30m wide, 2m deep. **SDCs** • 45 SDCs; and • bedform clearance (or example sandwaves). **Seabed preparation for subsea substation** • 4 subsea substations; and • bedform clearance (or example sandwaves). **Seabed preparation for offshore substations** • 4 offshore substations; and • bedform clearance (or example sandwaves). **Piling for substation foundation installation** • 56 drilled piles (12 driven piles per offshore substation and 4 driven piles per reactive compensation platform (RCP)) with 94.5m drill penetration depth and 3m drill diameter, creating 667.7m^3 of drill arisings per pile.	The maximum design scenario corresponds to (a combination of) the greatest amount of material disturbed and the greatest geographical extent of the impact. **Seabed preparation** Seabed preparation, specifically sandwave clearance / levelling, may be undertaken using a range of techniques – mass flow excavator and suction hopper dredging are considered the worst case. Dredge spoil release is assumed to be an instantaneous release at the water surface, with 10% of the hopper volume (typically 11,000m^3) assumed to form the passive phase of the sediment plume. Other seabed preparation such as boulder clearance does not represent the maximum design scenario in terms of potential increases in SSC and associated changes to seabed substrate. **Installation activities for cables** Pre-lay trenching may be undertaken using a range of techniques – jetting, ploughing and trenching. Jetting will give maximum design scenario for sediment disturbance. 100% fluidisation of material expelled from trench is conservatively assumed. In reality, pre-lay jetting will move a proportion of material rather than bringing it fully into suspension.

Impact / activity	Maximum design scenario parameter	Justification
	Seabed preparation for offshore export cables • bedform clearance (or example sandwaves); and • 35,000m^3 of sandwave clearance from the offshore export cable. **Installation activities for export cables** • Jet trenching up to 5 offshore export cable trenches, with trench dimensions of 30m wide, 2m deep, along 140km offshore export cable corridor length. **Landfall installation activities** • 8 horizontal directional drill (HDD) cable bore exit pits and ducts with sub-tidal location for punch-out; and • 1,000 HDD duct length.	**Piling** Based on the greatest amount of material disturbed in a drilling event, considering the largest driven pile dimension and largest driven pile penetration depth. **Landfall installation activities** Other stages of drilling (pilot hole drilling and stages of reaming) may result in smaller release events separated in time. But the maximum design scenario is considered as a release of drilling mud (Bentonite) from a single conduit. The parameters are supported by modelling within **Volume 3, Appendix 6.1: Physical Processes Modelling**, which simulates sediment dispersion, deposition and SSC levels. Figure 3 within **Volume 3, Appendix 6.2** further illustrates the spatial footprint of the construction activities.
Impact C2: Mobilisation of sediment into the water column, increasing contaminant concentrations	Refer to impact C1.	Refer to impact C1.
Impact C3: Resettlement of mobilised sediment, potentially changing existing sediment quality	Refer to impact C1.	Refer to impact C1.
Impact C4: Release of drilling muds from HDD at landfall(s), impacting water and sediment quality	**Landfall(s) installation activities** • 8 cable bore sub-tidal exit points and ducts.	The risks to water quality from drilling fluids will be directly related to the number of HDD bores breaking out into the sea. The maximum

Impact / activity	Maximum design scenario parameter	Justification
		design scenario is considered as a release of drilling mud (Bentonite) from a single conduit.
Impact C5: Leaching of toxicants from material deposited into the sea	To be considered when details of materials to be placed in the sea and coatings to be applied are available.	Nature of materials to be placed in the sea will be regulated through the marine licence.
Impact C6: Change in the blue carbon resource in sediments	Refer to Impact C1.	The loss of sediment-associated blue carbon (Impact C6) will be related to the quantity of sediment mobilised as assessed in **Chapter 6: Marine Geology, Oceanography and Physical Processes**, so maximum design corresponds to the assumptions in that chapter.
O&M		
Impact O1: Mobilisation of sediment into the water column, increasing SSC and turbidity	The maximum design scenario will be the presence of infrastructure, comprising: • anchorage systems for 225 WTGs; • 680km of array cables; • up to five export cable trenches each 140km long.	Sediment mobilisation during the O&M stage will arise if any maintenance is required to buried assets, thus the magnitude of potential impact will relate to the extent of these assets. This the maximum design scenario relates to the presence of infrastructure.
Impact O2: Mobilisation of sediment into the water column, increasing contaminant concentrations	Refer to Impact O1.	Refer to Impact O1.
Impact O3: Resettlement of mobilised sediment, potentially changing existing sediment quality	Refer to Impact O1.	Refer to Impact O1.

Impact / activity	Maximum design scenario parameter	Justification
Impact O4: Ongoing leaching of toxicants from material deposited into the sea	To be considered when details of materials to be placed in the sea and coatings to be applied are available.	Nature of materials to be placed in the sea will be regulated through the marine licence.
Impact O5: Changes to thermal stratification resulting from thermal emissions from seabed electricity cables	The maximum design scenario will be the presence of, comprising: • 680km of array cables; and • up to five export cable trenches each 140km long.	The magnitude of Impact O6 will relate to the total cable length present on or buried in the seabed.
Decommissioning		
Impact D1: mobilisation of sediment into the water column, increasing SSC and turbidity	The approach for decommissioning is yet to be determined, however, for the purposes of this maximum design scenario total removal of all infrastructure including buried cables and cable protection has been assumed.	Maximum magnitude of Impact D1 assumed to be no more than for Impact C1.
Impact D2: Mobilisation of sediment into the water column, increasing contaminant concentrations	Refer to Impact D1	Refer to Impact D1
Impact D3: Resettlement of mobilised sediment, potentially changing existing sediment quality	Refer to Impact D1	Refer to Impact D1

7.7.2 Embedded environmental measures

7.7.2.1 As part of the Project design process, a number of embedded environmental measures have been adopted to reduce the potential for adverse impacts on marine water and sediment quality. These embedded environmental measures have evolved over the development process as the EIA has progressed and in response to consultation.

7.7.2.2 These measures also include those that have been identified as good or standard practice and include actions that would be undertaken to meet existing legislation requirements. As there is a commitment to implementing these embedded environmental measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of the Project and are set out in this EIA Report.

7.7.2.3 **Table 7.11** sets out the relevant embedded environmental measures within the design and how these affect the marine water and sediment quality assessment.

7.7.2.4 Further detail on the embedded environmental measures in **Table 7.11** is provided in the **Volume 3, Appendix 5.2: Commitments Register**, which sets out how and where particular embedded environmental measures will be implemented and secured.

Table 7.11 Relevant marine water and sediment quality embedded environmental measures

ID	Environmental measure proposed	Project stage	How the environmental measures will be secured	Relevance to water and sediment quality
M-033	An **Outline Marine Pollution Contingency Plan** (MPCP) (Appendix to the **Environmental Management Plan** (EMP)) has been submitted with this Application (**Volume 4**). This Outline MPCP outlines details of procedures to protect personnel working and to safeguard the marine environment and mitigation measures in the event of an accidental pollution event arising from offshore operations relating to the Project. The Final MPCP will be completed prior to construction commencing and submitted to MD-LOT for approval and will include relevant key emergency contact details.	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	Avoidance of adverse effects on marine water quality due to accidental pollution.
M-049	An **Outline Project Environmental Monitoring Programme** (PEMP) has been submitted with this Application (**Volume 4**). The Final PEMP will be completed prior to construction commencing and submitted to MD-LOT for approval. The Final PEMP will set out commitments to environmental monitoring in pre-, during and post-construction stages of the Project.	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	Monitoring of marine water quality will allow prompt action in case of adverse effects on marine water quality.
M-054	A detailed Cable Burial Risk Assessment (CBRA) will be undertaken to enable informed judgements about burial depth. This should reduce the risk of buried cables reemerging whilst also limiting the amount of sediment disturbance to that which is necessary. The array and export cables will typically be buried at a target burial depth between 1 to 2m below the seabed surface. The final depth of the cable will be dependent on the seabed mobility and CBRA. The CBRA will manage and mitigate risks from loading and sediment transport across the seabed. The CBRA will be included within the Final Cable Plan.	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	Minimising effects on marine water and sediment quality by limiting resuspension of sediment.

ID	Environmental measure proposed	Project stage	How the environmental measures will be secured	Relevance to water and sediment quality
M-059	Micro-siting will be applied to proposed offshore Project infrastructure such as cables (trenched or ploughed in), or WTG anchor structures, to minimise mobilisation of contaminants from any areas of significantly contaminated sediment detected during pre-construction surveys.	Scoping	s.36 conditions and marine licences conditions.	Minimising effects on marine water quality by limiting resuspension of contaminants.
M-060	Turbidity in the water column caused by sediment mobilisation during construction will be controlled by selection of best practice construction methods.	Scoping	s.36 conditions, marine licences conditions.	Minimising effects on marine water quality by limiting resuspension of sediment.
M-061	Minimise potential for creation of a temporary barrier to fish migration in any river adjacent to cable landfall due to a plume of mobilised sediment or released drilling fluid obstructing the river entrance by appropriate timing of operations close to the shore regarding tidal flows and fish migration seasons.	Scoping	s.36 conditions, marine licences conditions and EMP	Minimising effects on marine water quality that may affect migratory fish by limiting creation of turbidity in fish migration pathways.
M-062	Minimise adverse effects on water and sediment quality from loss of drilling muds when using HDD across the littoral zone by employment of a site-specific best practice protocol, including drilling, reaming and cleaning the majority of the hole from the land before drilling the final few metres to breakout using non-polluting drill fluid containing the least toxic drilling fluid additives.	Scoping Amended at EIA Report.	s.36 conditions, marine licences conditions and EMP	Minimising effects on marine water quality by limiting release of drilling muds.
M-064	The Project will ensure that any material to be deposited in the sea (metal components, rock for armour, concrete mattresses) does not contain toxic materials that could leach into the sea water and result in toxic effects.	Scoping	s.36 conditions, marine licences conditions and EMP.	Minimising effects on marine water quality by limiting potential for leaching of contaminants.
M-106	The development of and adherence to a Decommissioning Programme. The Decommissioning Programme will outline measures for the decommissioning of the Project. The Decommissioning Programme would be submitted prior to construction commencing to MD-LOT and approved by Scottish Ministers prior to construction.	Scoping Amended at EIA Report.	Required under Section 105 (Energy Act 2004) and Marine Licence consent conditions.	Minimising effects on marine water and sediment quality by requirements to M-121

ID	Environmental measure proposed	Project stage	How the environmental measures will be secured	Relevance to water and sediment quality
M-121	An **Outline Environmental Management Plan** (EMP) has been submitted with this Application (**Volume 4**) and includes the following Appendix: - **Outline Marine Pollution Contingency Plan**. The Final EMP will be completed prior to construction commencing and submitted to MD-LOT for approval. The Final EMP will be implemented by the contractor(s). The contractor(s) will ensure that the relevant environmental measures within the EMP and health and safety procedures are implemented. The Final EMP will identify the project management structure roles and responsibilities with regard to managing and reporting on the environmental impact of the construction and O&M stages. Other measures that feed into the EMP include: - A Waste Management Plan (WMP) will be developed as an Appendix of the EMP post-submission to manage all waste generated during the construction and operation stages of the Project. The WMP will be appended to the Environmental Management Plan. The WMP will follow the principles of the waste hierarchy (Department for Environment, Food & Rural Affairs, 2001) which consists of: prevention, re-use, recycle, other recovery and disposal. - The Final EMP will include a Chemical Risk Assessment to identify, evaluate and mitigate potential environmental and health risks associated with the use, storage and disposal of hazardous substances during O&M and decommissioning stages of the Project. The EMP will be the securing mechanism for many measures.	EIA Report.	s.36 conditions, marine licences conditions	Minimising effects on marine water and sediment quality by requirements to employ best practice throughout construction and O&M activities.
M-122	Development of and adherence to a Offshore Operations and Maintenance Plan, which will confirm the Project's operations and maintenance activities. This will be submitted to MD-LOT for approval post-consent.	EIA Report	s.36 conditions, marine licences conditions.	Minimising effects on marine water and sediment quality by requirements to employ best practice throughout O&M activities.

7.8 Methodology for EIA Report

7.8.1 Introduction

7.8.1.1 The project-wide approach to assessment is set out in **Chapter 5: Approach to EIA.** Whilst this has informed the approach that has been used in this marine water and sediment quality assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of the marine water and sediment quality assessment.

7.8.2 Significance evaluation methodology

Overview

7.8.2.1 The significance level attributed to each effect has been assessed based on the value of the affected receptor and the magnitude of change resulting from the Project. The level of significance has then been determined by the combination of value and magnitude.

Value of receptor

7.8.2.2 The criteria for defining the value (or sensitivity) in this Chapter are outlined in **Table 7.12**. The value / sensitivity of each receptor has been assessed using expert judgement on a standard semantic scale and is closely guided by the conceptual understanding of regional-scale physical and chemical processes in the North Sea.

Table 7.12 Definitions of sensitivity / value levels for marine water and sediment quality

Value	Definition
High	MSFD water body with 'Good' environmental status. WFD surface water body (or part thereof) with overall 'High' or 'Good' status / potential. Water or sediment quality conditions supporting a nature conservation site that is part of the national site network (SPA and SAC) or Ramsar sites or NCMPA, where water and / or sediment quality is an important factor in maintaining the site's conservation objectives. Water or sediment quality conditions supporting designated use, such as a designated bathing water or shellfish water.
Medium	MSFD water body with 'Moderate' environmental status. WFD surface water body (or part thereof) with overall 'Moderate' status / potential. Water or sediment quality conditions supporting a site of special scientific interest (SSSI), where water and / or sediment quality is an important factor in maintaining the site's conservation objectives. Water or sediment quality conditions supporting designated use, such as cooling water abstraction or general amenity use.

Value	Definition
Low	MSFD water body with 'Poor' environmental status. WFD surface water body (or part thereof) with overall 'Poor' or lower status / potential. Non-reportable[2] WFD surface water body (or part thereof), or non-WFD water body. Water or sediment quality conditions supporting a site with a local conservation designation (for example, Local Nature Reserve, where water and / or sediment quality is an important factor in maintaining the site's conservation objectives.
Very low	Non-reportable WFD surface water or groundwater body (or part thereof), or non-WFD water body. Water or sediment quality conditions supporting undesignated ecosystems or those with low sensitivity to water quality.

7.8.2.3 It should be noted that high value and high sensitivity are not necessarily linked within a particular impact. Where these differ, professional judgement is used to define the sensitivity / value score.

Magnitude of changes

7.8.2.4 The magnitude of impact describes the extent or degree of change that is predicted to occur to a receptor, in terms of the spatial extent, duration, frequency and reversibility of change. It has been assessed using expert judgement and described qualitatively with a standard semantic scale. Definitions for each term are provided in **Table 7.13**.

Table 7.13 Magnitude of impact for marine water and sediment quality

Value	Definition
High	Wide spatial extent with large magnitude compared to the natural variability and with a continuous signal extending into the long-term. Long-term or permanent and irreversible breaches of EQS values for water quality, which leads to a downgrading of WFD / MSFD status / potential. Large, long-term and permanent change to parameters defining chemical status and / or change to physico-chemical elements supporting the biological elements, which leads to a downgrading of WFD / MSFD status / potential.
Medium	Regional spatial extent with moderate magnitude compared to the natural variability, frequently occurring in the short- or medium-term. Local spatial extent with moderate magnitude compared to natural variability, occurring frequently over a long-term timescale. Measurable long-term change in water quality that uses much of the available headroom to the EQS, but without breaching EQS values; or medium-term and

[2] A non-reportable WFD water body refers to a water body that is not formally reported under RBMPs. These water bodies are still protected under the WFD, but they are not included in the official monitoring and classification system used for reporting to the European Commission or for public RBMP documentation.

Value	Definition
	reversible breaches of EQS values, which do not actually lead to a downgrading of WFD / MSFD status / potential. Measurable long-term change to parameters defining chemical status and / or change to physico-chemical elements supporting the biological elements, which does not actually lead to a downgrading of WFD / MSFD status / potential.
Low	Local or regional spatial extent with low magnitude, frequently occurring over a short or medium timescale. Measurable change in water quality, but with significant headroom to the EQS limit still available; or short-term and reversible breaches of EQS values, and no change to WFD / MSFD status. Measurable change to parameters defining chemical status and / or change to physico-chemical elements supporting the biological elements, which does not actually lead to a downgrading of WFD / MSFD status.
Very low	Local spatial extent, with magnitude comparable to natural variability, occurring infrequently over a short or medium timescale. No measurable change in water quality, and no breach of relevant EQS values, and no change to WFD / MSFD status. No measurable change to parameters defining chemical status and / or change to physico-chemical elements supporting the biological elements, and no change to WFD / MSFD status.

Significance evaluation

7.8.2.5 During the assessment of effects for each identified receptor, the value in **Table 7.12** will be combined with the magnitude of change from **Table 7.13** to produce an overall significance rating based on the evaluation matrix shown in **Table 7.14**. As a general rule, **Major** and **Moderate** effects are considered to be **Significant** and **Minor** and **Negligible** effects are considered to be **Not Significant**. However, professional judgement is applied, where appropriate, to determine significance of effect. Where effects are assessed, according to the matrix in **Table 7.14** to be **Potentially Significant** in EIA terms, professional judgement is applied to determine whether they are **Significant** or **Not Significant**.

7.8.2.6 Where water or sediment quality targets are available, changes in water sediment quality can be assessed for significance against these standards. Significance of indirect effects of changes in water or sediment quality on other receptors is assessed under the chapter dealing with that other receptor.

Table 7.14 Significance evaluation matrix

		Magnitude of change			
		High	Medium	Low	Very low
Value / Sensitivity	High	Major (Significant)	Major (Significant)	Moderate (Potentially significant)	Minor (Not significant)
	Medium	Major (Significant)	Moderate (Potentially significant)	Minor (Not significant)	Minor (Not significant)
	Low	Moderate (Potentially significant)	Minor (Not significant)	Minor (Not significant)	Negligible (Not significant)
	Very low	Minor (Not significant)	Minor (Not significant)	Negligible (Not significant)	Negligible (Not significant)

7.9 Assessment of effects: construction stage

7.9.1 Introduction

7.9.1.1 This Section provides an assessment of the changes in and effects on marine water and sediment quality arising from the construction of the offshore and inshore elements of the Project.

7.9.1.2 The assessment methodology set out in **Section 7.8** has been applied to assess effects on marine water and sediment quality from the Project.

7.9.2 Impact C1: mobilisation of sediment into the water column, increasing SSC and turbidity

Overview

7.9.2.1 This Section provides a description of the realistically possible combinations of magnitude and extent of impact for local increases in SSC in the sea water column caused by construction activities that result in mobilisation of seabed sediments.

7.9.2.2 Activities are quantified in **Table 7.10**. Such activities include:

- seabed preparation and ground clearance activities;
- installation of drag embedment anchors;
- installation of the array cables;
- installation of the export cable corridor;
- cable crossings;
- deployment of stabilising legs of jack up barges;

- installation of jacket foundations secured with suction caisson for offshore substations and RCPs; and
- installation of gravity-based foundations for subsea distribution centres.

7.9.2.3 Breakout from HDD for cable ducts at the landfall sites will result in potential release of drilling fluids, which will also lead to local increases in SSC. This aspect is addressed under **Section 7.9.5**.

7.9.2.4 The maximum design scenario relating to mobilisation of sediment in the water column increasing SSC and turbidity during the construction stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.9.2.5 As there is no EQS established for SSCs in sea water and SSC vary naturally by orders of magnitude in shallow waters in response to meteorological conditions, the magnitude of change for this impact is considered simply as a 'pathway' to indirect effects described in other chapters, as opposed to a receptor and therefore sensitivity ratings have not been assigned.

Magnitude of impact

7.9.2.6 The magnitude of change in SSC is described in **Chapter 6: Marine Geology, Oceanography and Physical Processes**. The change is short-term in nature with SSC concentrations generated varying between thousands of mg/l within a few metres of the activity to an unmeasurably small increase at the boundary of the study area.

7.9.2.7 The actual magnitude and extent of SSC will depend in practice on a wide range of factors, such as the actual total volumes and rates of sediment disturbance, the local water depth and current speed at the time of the activity, the local sediment type and grain size distribution, the local seabed topography and slopes. Applying realistic and conservative combinations of these factors allowed a robust assessment over a range of conditions (see **Volume 3, Appendix 6.1**).

7.9.2.8 The range of impacts is described in detail in **Chapter 6: Marine Geology, Oceanography and Physical Processes** and illustrated in Figure 3 of **Volume 3, Appendix 6.1.** These can be summarised in terms of distance from the activity as follows.

- 0.5m from activity – very high SSC increase (tens to hundreds of thousands of mg/l), lasting during the activity and for up to 30 minutes afterwards, with no measurable increase in SSC after an hour; sands and gravels may deposit in local thicknesses of up to tens of centimetres to several metres; fine sediment is unlikely to deposit in measurable thickness.
- 25m to 250m from activity– measurable increase in SSC (hundreds to low thousands of mg/l) lasting during the activity and for up to 30 minutes afterwards, with no measurable increase in SSC after an hour; sands and gravels may deposit in local thicknesses of up to tens of centimetres; fine sediment is unlikely to deposit in measurable thickness.
- 250m to study area boundary – measurable increase in SSC (tens to low hundreds of mg/l) within a narrow plume, lasting during the activity and for up to one day afterwards, representing fine sediment remaining in suspension; decreasing to ambient SSC values

within a day of cessation of the activity, with sediment unlikely to be deposited in measurable thickness.

- Beyond the tidal excursion buffer distance – there is no expected impact or change to SSC.

7.9.2.9 It is important to understand that all activities described in **Table 7.10** will not take place simultaneously for each phase of the Project, at every WTG location, or along every metre of cable to be buried.

7.9.2.10 Simultaneous activity at more than one WTG location will only cause an additive effect (increased change in SSC) if the two locations are aligned along the direction of tidal streams (tidal ellipses in the OAA and along the export cable route are all narrow and aligned along a north-south axis).

7.9.2.11 Seabed preparation and cable burial will be a progressive process, with disturbance at any one time confined to a small area around the activity (for example, dredging, jet trenching or ploughing).

7.9.2.12 The range of results from the physical processes modelling demonstrates four main zones of effect based on the distance from the activity causing sediment disturbance (**paragraph 7.9.2.8**). Whilst elevations in SSC will be significant in the short term (hours), no measurable increase in SSC will be observed between 0.5m to 250m after an hour post activity. Whilst between 250m to the study are boundary measurable increases will only last for up to one day. Considering these parameters, the magnitude of change to the pathway will be **negligible**.

Significance of residual effect

7.9.2.13 The assessment set out in this Section has considered potential changes to a pathway, rather than impacts on receptors. Accordingly, no assessment of significance is provided. However, the potential for these changes in SSC to impact other EIA receptor groups is considered elsewhere within this EIA, in particular in:

- **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**; and
- **Chapter 13: Fish Ecology**.

7.9.3 Impact C2: mobilisation of sediment into the water column, increasing contaminant concentrations

Overview

7.9.3.1 Mobilisation of sediment into the water column will result in any contaminants present in the sediment also being mobilised. Concentrations of metal contaminants in sediments in the OAA, offshore export cable corridor and landfall area, and the corresponding concentration in the water column are set out in **Table 7.15, Table 7.16** and **Table 7.17** respectively. Introduction of contaminants into the water column could result in breaches of EQS values.

7.9.3.2 In some cases, EQS have been established, with the aim of providing general protection of the marine environment so that it can support aquatic life. Numerical EQS have been established under the WFD for coastal waters (Scottish Government, 2024) and descriptive standards under the MSFD for offshore waters (European Commission, 2008b).

7.9.3.3 The numerical EQS set by the WFD may be considered as receptors. Therefore, it is feasible in this context to evaluate the significance of anticipated changes.

7.9.3.4 In relation to PAHs, TBT and PCBs there are no EQS values and the concentrations in the water column have not been calculated. For these compounds the concentrations in the sediment have been compared with Marine Scotland's Action Level 1 (AL1) indicating no ecological concern (**paragraph 7.6.1.26**).

7.9.3.5 The maximum design scenario relating to mobilisation of sediment in the water column, increasing contaminant concentrations during the construction stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.9.3.6 The OAA and much of the offshore export cable corridor lie outside the coastal waters where numerical EQS set by the WFD apply (out to 3nm for all parameters and out to 12nm for 'chemical status'). The coastal water body through which the offshore export cable corridor passes (Cairnbulg Point to the Ugie Estuary, ID 200142) has a water classification status of 'High'. Given the High status of the water body, it is therefore of **high** sensitivity / value.

7.9.3.7 The OAA is located entirely within offshore marine waters and is of Good Environmental Status (GES) in relation to MSFD Descriptor 8 (i.e. "*Concentrations of contaminants are at levels not giving rise to pollution effects.*" (European Commission, 2008b) (see **Volume 3, Appendix 5.3: Marine Strategy Framework Directive Assessment**) and is therefore of **high** sensitivity / value.

Magnitude of impact

7.9.3.8 As described in **Chapter 6: Marine Geology, Oceanography and Physical Processes**, elevated suspended sediment concentration resulting from the Project will be temporary and short lived, Annual Average (AA) EQS values are unlikely to affected by short term changes in sediment mobilisation. Therefore, relevant EQS values against which to compare contaminant concentrations resulting from sediment mobilisation are those set as Maximum Allowable Concentrations (MAC). Where MAC EQS parameters are not established, comparison with the AA EQS has been made.

7.9.3.9 **Table 7.15**, **Table 7.16** and **Table 7.17** shows a comparison of established EQS with predicted concentrations of contaminants in the water column for a SSC concentration of 1000mg/l (1g/l) of surface sediment with contaminant concentrations as described in **Table 7.7**, **Table 7.8** and **Table 7.9**.

Table 7.15 Sediment contaminant EQS and predicted water concentrations in OAA

Parameter	AA EQS	MAC EQS	Concentration in water – for mean concentration in sediment (µg/l)	Concentration in water – for max concentration in sediment (µg/l)
Arsenic (As)	25	-	2.90	9.72
Cadmium (Cd)	0.2	-	0.03	0.06
Chromium (Cr)	-	-	12.66	19.1

Parameter	AA EQS	MAC EQS	Concentration in water – for mean concentration in sediment (µg/l)	Concentration in water – for max concentration in sediment (µg/l)
Copper (Cu)	3.76	-	2.0	3.3
Mercury (Hg)	0.05	0.07	<0.03	<0.03
Nickel (Ni)	8.6	34	6.0	9.7
Lead (Pb)	1.3	14	4.1	5.9
Zinc (Zn)	7.9	-	11.7	17.7

7.9.3.10 **Table 7.15** shows that mean contaminant concentrations in water in the OAA are below the AA EQS, with the exception of lead which exceeds the EQS by 2.8µg/l. However, the maximum concentration (5.9µg/l), is well below the MAC EQS of 14µg/l. The MAC is considered to be the more appropriate standard given dilution and the short-term nature of sediment mobilisation (**paragraph 7.9.3.8**).

Table 7.16 Sediment contaminant EQS and predicted water concentrations along offshore export cable corridor

Parameter	AA EQS	MAC EQS	Concentration in water – for mean concentration in sediment (µg/l)	Concentration in water – for max concentration in sediment (µg/l)
Arsenic (As)	25	-	5.64	16.4
Cadmium (Cd)	0.2	-	<0.03	0.07
Chromium (Cr)	-	-	10.0	17.1
Copper (Cu)	3.76	-	1.5	2.7
Mercury (Hg)	0.05	0.07	<0.03	<0.03
Nickel (Ni)	8.6	34	4.1	8.8
Lead (Pb)	1.3	14	4.5	8.4
Zinc (Zn)	7.9	-	10.5	15.9

7.9.3.11 **Table 7.16** shows that two parameters, lead and zinc, exceeded the AA AQS (4.5µg/l, and 10.5µg/l respectively) for samples collected within the offshore export cable corridor. The maximum concentration of lead is well below the MAC EQS value (14µg/l), whilst no MAC EQS are established for zinc. As above, due to the short-term nature of sediment mobilisation, the MAC EQS, have been assessed as a more appropriate metric of magnitude.

Table 7.17 Sediment contaminant EQS and predicted water concentrations in landfall(s) area (intertidal)

Parameter	AA EQS	MAC EQS	Concentration in water – for mean concentration in sediment (µg/l)	Concentration in water – for max concentration in sediment (µg/l)
Arsenic (As)	25	-	8.7	11.7
Cadmium (Cd)	0.2	-	<0.05	0.07
Chromium (Cr)	-	-	2.7	2.9
Copper (Cu)	3.76	-	1.0	1.4
Mercury (Hg)	0.05	0.07	<0.011	0.02
Nickel (Ni)	8.6	34	2.0	2.3
Lead (Pb)	1.3	14	2.0	2.4
Zinc (Zn)	7.9	-	6.8	7.8

7.9.3.12 There was a slight exceedance of the AA EQS for lead (2 µg/l compared with 1.3 µg/l) in samples collected within the intertidal landfall(s) area (**Table 7.17**). The maximum concentration of lead for samples within the landfall(s) area is well below the MAC EQS value. All other parameters are below the AA and MAC EQS.

7.9.3.13 In sediments in both the OAA and landfall(s) area, PAH concentrations were below Marine Scotland's AL1 Action Level 1 (AL1) indicating minimal contamination risk, PCBs and organotin (dibutyltin and TBT) were consistently below detection limits or AL1 values, suggesting negligible risk to marine water quality from remobilisation.

7.9.3.14 In the offshore export cable corridor PAH concentrations in sediment grab samples were generally below Marine Scotland's AL1. However, one core sample exceeded AL1 for multiple PAHs, though adjacent layers did not, suggesting a localised anomaly. PCB and TBT concentrations were consistently below AL1 across all samples, indicating minimal contamination risk.

7.9.3.15 Overall, there was no exceedance of water column MAC EQS in the OAA, offshore export cable corridor and landfall(s) area. PAH, PCB and TBT concentrations in sediments are predominantly within Marine Scotland AL1 thresholds. The impact from contaminated sediment on water is therefore considered to be **negligible**.

Significance of residual effect

7.9.3.16 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.9.4 Impact C3: resettlement of mobilised sediment, potentially changing existing sediment quality

Overview

7.9.4.1 Sediment mobilised by construction activity may be transported by wave and tidal action and subsequently resettle on the seabed in a new location. If the sediment supports elevated levels of contaminants, this could result in a change in sediment quality in the areas where resettlement occurs.

7.9.4.2 The maximum design scenario relating to resettlement of mobilised sediment, potentially changing existing sediment quality during the construction stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.9.4.3 As with impact C2, the value of sediment within the Red Line Boundary reflects the status classification of the waterbodies within which it is located. As previously described, this varies by location: High for the coastal waterbody (Cairnbulg Point to the Ugie Estuary, ID 200142) through which the offshore export cable corridor passes; and Good for the coastal waterbody in which the OAA is located. The offshore export cable corridor also passes through the Southern Trench Marine Protected Area. The coastal waterbodies in which the landfall(s) site is located Strathbeg Estuary (ID 200137) and Ugie Estuary (ID 200129) both have a water classification status of 'High'.

7.9.4.4 Taking a conservative approach, the receptor overall is considered to be of **high** value.

Magnitude of impact

7.9.4.5 In general, mobilised sediment will resettle to the seabed as described in **paragraph 7.9.2.8**, with the coarse grain sizes (sands and gravels) depositing in layers between tens of centimetres to several metres within 0.5m of the activity, and up to tens of centimetres within 250m. Fine sediments are unlikely to settle in measurable deposits. The magnitude of impact is determined by the extent to which resettled sediment could change the existing sediment quality. According to the analysis of sediment samples from site-specific surveys across the OAA, offshore export cable corridor and intertidal area, there are no exceedances of MAC EQS' for metals and all samples comply with Marine Scotland AL1 and Canadian ISQG, with the exception of arsenic and chromium for which there were isolated exceedances (**paragraph 7.6.1.26**).

7.9.4.6 The magnitude of impact is therefore considered to be **negligible**, as the resettled sediment is not expected to introduce contaminant levels above guideline values.

Significance of residual effect

7.9.4.7 Given the **high** value of the receptor and the **negligible** impact magnitude the overall significance of effect is considered to be **Minor Adverse** (**Not Significant**) in EIA terms.

7.9.5 Impact C4: release of drilling muds from HDD at landfall(s), impacting water and sediment quality

Overview

7.9.5.1 The offshore export cable corridor will be connected at the landfall(s) area via trenchless techniques such as HDD below to shallow subtidal and intertidal sections of the landfall(s). Drilling fluid is used as part of the HDD process. It is typically an environmentally benign mixture of water and bentonite or polymer continuously pumped to the cutting head or drill bit to facilitate the removal of cuttings, stabilise the borehole, cool the cutting head, and lubricate the passage of the duct.

7.9.5.2 HDD can discharge drilling fluids (muds), increase fine sediment resuspension and release bentonite into the water column. Bentonite is a natural mineral that is chemically inert and non-toxic to marine life. The only impacts from its release into the water column are from increased suspended sediment. The quantity of drilling fluid released at the sub-sea breakout will be directly related to the number of holes drilled. The maximum design scenario is that 8 cable bore exit pits and ducts with subtidal exit locations will be required.

7.9.5.3 The maximum design scenario relating to release of drilling muds from HDD at landfall(s), impacting water and sediment quality during the construction stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.9.5.4 The coastal water body through which the offshore export cable corridor passes (Cairnbulg Point to the Ugie Estuary, ID 200142) has a water classification status of ‘High’. Given the High status of the water body, it is therefore of **high** sensitivity / value.

Magnitude of impact

7.9.5.5 Whilst the loss of drilling fluid is possible at the subtidal cable bore exit point, this will be minimised by good practice as in embedded environmental measure M-062 (see **Table** 7.11). The materials that could be released are not harmful and contain no chemicals that are regulated by EQS. **Chapter 6: Marine Geology, Oceanography and Physical Processes** assesses the spatial and spatial distribution of SSC, including those caused by the release of drilling fluids. This concluded that within one hour of the source, there would be no change to SSC and no measurable ongoing deposition within 0 to 5m from the source. In combination with the implementation of M-062, the magnitude of impact is considered to be **negligible**.

Significance of residual effect

7.9.5.6 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.9.6 Impact C5: leaching of toxicants from material deposited into the sea

Overview

7.9.6.1 There is a risk that toxicants may leach from materials such as mooring components or cable armouring associated with WTGs and export cables, leading to deterioration of water quality in offshore and inshore waters. At the time of writing, these toxicants are currently unknown (see **Table 7.10**).

7.9.6.2 The maximum design scenario relating to leaching of toxicants from material deposited into the sea during the construction stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.9.6.3 The OAA and much of the offshore export cable corridor lie outside the coastal waters where numerical EQS set by the WFD apply (out to 3nm for all parameters and out to 12nm for ‘chemical status’). The coastal water body through which the offshore export cable corridor passes (Cairnbulg Point to the Ugie Estuary, ID 200142) has a water classification status of ‘High’. Given the High status of the water body, it is therefore of **high** sensitivity / value.

7.9.6.4 The OAA is located entirely within offshore marine waters and is of GES in relation to MSFD Descriptor 8 and is therefore of **high** sensitivity / value.

Magnitude of impact

7.9.6.5 The leaching of toxicants will be minimised by good practice, described as an embedded environmental measure (M-064). In addition, materials and coatings will be regulated by MD-LOT through the marine licencing system. As a result, the magnitude of impact is **negligible.**

Significance of residual effect

7.9.6.6 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.9.7 Impact C6: change in the blue carbon resource in sediments

Overview

7.9.7.1 The degree to which seabed habitats can trap organic carbon (OC) is dependent on grain size, long-term stability, and degree of shelter from waves and currents (Laffoley, 2020). Seabed sediments, if undisturbed can store carbon for thousands of years or more. This store is vulnerable to disturbance, and any disturbance could result in a reduction or changes to sequestration processes and associated carbon stores. Greater carbon storage is associated with fine sediments because their small particle size and low permeability create oxygen-poor conditions that slow the breakdown of organic matter. These sediments also have a high surface area, allowing more carbon to bind and be buried, making them effective long-term carbon sinks in marine environments, and as a result any potential impacts on sediment stores are effectively irreversible.

7.9.7.2 In highly dynamic shallow water sandy seabed ecosystems, waves and currents are a significant source of natural disturbance and may continually change seabed contours and mix sediments. Deep-sea sediment stores are likely to be more stable and thus hold a larger reservoir of carbon. However, blue carbon habitats can become carbon sources if damaged by human activities. For example, exposing deeply buried sediments to oxygen triggers the aerobic microbial breakdown of ancient, stored carbon.

7.9.7.3 The maximum design scenario relating to change in the blue carbon resource in sediments during the construction stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.9.7.4 Within the OAA, the sediments are predominantly composed of sand, with varying proportions of fines (silt and clay) and minimum gravel content. These sediments are considered to be of higher value as a blue carbon resource than those in the offshore export cable corridor and landfall(s) area where sand is dominant, with minimal or negligible silt content.

7.9.7.5 Despite the differences in the likely carbon storage potential of substrates within each of the Project areas, a precautionary approach to the valuation of seabed carbon stores has been adopted such that all sediments are considered to be of **high** sensitivity.

Magnitude of impact

7.9.7.6 Sediment may be mobilised or displaced directly through construction activities. The total volume of seabed sediment directly disturbed by the construction activities has been modelled and is displayed in **Table 7.18** (see **Chapter 6: Marine Geology, Oceanography and Physical Processes**).

Table 7.18 Total sediment mobilised directly through construction activities.

	Seabed preparation (dredge spoil)	Piling for substation foundations	Seabed preparation for export cables
	Volume of sediment (m^3) released		
OAA	1,100 (10% of 11,000)	37,391.2 (56 x 667.7)	-
Offshore export cable corridor / landfall	-		35,000

7.9.7.7 Sediment within the OAA were classified as ‘coarse silt’ to ‘medium sand’, with sand as the dominant fraction (mean 79.95%). Whilst within the ECC, sand was also the dominant fraction (mean 81.41%), with a very small percentage of fines. Given the particle size of the sediments, and the dominance of sand within the study area, the disturbance of sediments is not anticipated to release a substantial portion of carbon. They are, unlikely to be a significant carbon sink compared to deep sea mud habitats. The area of disturbance will be minimised as far as possible, as outlined within the embedded environmental measures (**Table 7.11**). As a result, the magnitude of impact is expected to be **negligible**.

Significance of residual effect

7.9.7.8 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.10 Assessment of effects: O&M stage

7.10.1 Introduction

7.10.1.1 This Section provides an assessment of the effects for marine water and sediment quality from the O&M of the offshore elements of the Project.

7.10.1.2 The assessment methodology set out in **Section 7.8** has been applied to assess effects to marine water and sediment quality from the Project.

7.10.2 Impact O1: mobilisation of sediment into the water column, increasing SSC and turbidity

Overview

7.10.2.1 Mobilisation of sediment into the water column may occur during the O&M stage due to direct seabed disturbance during maintenance and remedial work temporarily increasing suspended sediment into the water column. Increased turbulence in the vicinity of the WTG foundations will also result in the localised entrainment of sediment. This has the potential to reduce water quality in offshore and inshore waters.

7.10.2.2 The maximum design scenario relating to mobilisation of sediment into the water column, increasing SSC and turbidity during the O&M stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.10.2.3 As with mobilisation of sediment during the construction stage (C1), the magnitude of change for this impact is considered simply as a 'pathway' to indirect effects described in other chapters, since there is no EQS for suspended sediment.

Magnitude of impact

7.10.2.4 Sediment mobilisation during the O&M stage will be associated with seabed disturbance caused by maintenance to the buried assets including anchors, foundations, array and export cables and substations. Similarly, increases in SSC may occur due to turbulence in the vicinity of the anchors. Any sediment mobilisation as a result of maintenance activities during the O&M stage will be orders of magnitude below the impact of the construction activities on SSC. Therefore, increases in SSC due to maintenance activities and turbulence are anticipated to be small, localised in nature and short lived, and of **negligible** magnitude.

Significance of residual effect

7.10.2.5 As for C1, the assessment set out in this Section has considered potential changes to a pathway, rather than impacts on receptors. Accordingly, no assessment of significance is provided. However, given the negligible magnitude of impact, effects on relevant receptors are not anticipated to be significant. The potential for these changes in SSC to impact other EIA receptor groups is considered elsewhere within this EIA, in particular in:

- **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** and;
- **Chapter 13: Fish Ecology**.

7.10.3 Impact O2: mobilisation of sediment into the water column, increasing contaminant concentrations

Overview

7.10.3.1 Mobilisation of sediment into the water column due to maintenance activities and increased turbulence in the vicinity of structures will potentially result in the release of any contaminants present in the sediment. Concentrations of contaminants in sediments in the OAA, export corridor and landfall(s) area are set out in **Table 7.15, Table 7.16** and **Table** 7.17. Introduction of contaminants into the water column could result in breaches of EQS values. The EQS system is described in **paragraph 7.9.3.2**.

7.10.3.2 The maximum design scenario relating to mobilisation of sediment into the water column, increasing contaminant concentrations during the O&M stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.10.3.3 The OAA and much of the offshore export cable corridor lie outside the coastal waters where numerical EQS set by the WFD apply (out to 3nm for all parameters and out to 12nm for 'chemical status'). The coastal water body through which the offshore export cable corridor passes (Cairnbulg Point to the Ugie Estuary, ID 200142) has a water classification status of 'High'. Given the High status of the water body, it is therefore of **high** sensitivity / value.

7.10.3.4 The OAA is located entirely within offshore marine waters and is of GES in relation to MSFD Descriptor 8 and is therefore of **high** sensitivity / value.

Magnitude of impact

7.10.3.5 As described in **Chapter 6: Marine Geology, Oceanography and Physical Processes**, elevated suspended sediment concentration resulting from the Project will be temporary and short lived, and Annual Average (AA) EQS values are unlikely to be affected by short term changes in sediment mobilisation. Therefore, relevant EQS values against which to compare contaminant concentrations resulting from sediment mobilisation are those set as Maximum Allowable Concentrations (MAC).

7.10.3.6 Given that there were no exceedance of water column MAC EQS in the OAA, offshore export cable corridor and landfall(s) area, and only minor exceedances of Marine Scotland AL1 thresholds PAH, PCB and TBT concentrations in isolated samples the impact from contaminated sediment on water during construction was considered to be negligible.

During operation the volumes of SSC will be lower than construction and therefore the impact is also considered to be **negligible**.

Significance of residual effect

7.10.3.7 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.10.4 Impact O3: resettlement of mobilised sediment, potentially changing existing sediment quality

Overview

7.10.4.1 Sediment mobilised by O&M activities will resettle to the seabed. If this involves relocation of sediments with elevated levels of contaminants, this could result in a change in sediment quality in the areas where resettlement occurs.

7.10.4.2 The maximum design scenario relating to resettlement of mobilised sediment, potentially changing existing sediment quality during the O&M stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.10.4.3 As with impact O2 (**paragraph 7.10.3.3** and **7.10.3.4**) the receptor is considered to be **high** value reflecting the sensitivity of the waterbodies in which the Project is located.

Magnitude of impact

7.10.4.4 Sediment mobilised during maintenance activities and from turbulence will resettle to the seabed. The magnitude of impact is determined by the extent to which resettled sediment could change the existing sediment quality. According to the site-specific surveys across the OAA, offshore export cable corridor and landfall(s) area, all surface sediment samples comply with Marine Scotland AL1, and Canadian ISQG. Except for isolated arsenic and chromium exceedances in sediment samples. Therefore, the magnitude of impact is considered **negligible**, as the resettled sediment is not expected to introduce contaminant levels above guideline values.

Significance of residual effect

7.10.4.5 Given the **high** value of the receptor and the **negligible** impact magnitude the overall significance of effect is considered to be **Minor Adverse** (**Not Significant**) in EIA terms.

7.10.5 Impact O4: ongoing leaching of toxicants from material deposited into the sea

Overview

7.10.5.1 As in construction, there is a risk that toxicants may leach from materials such as mooring components or cable armouring associated with WTGs and export cables, leading to deterioration of water quality in offshore and inshore waters.

7.10.5.2 The maximum design scenario relating to ongoing leaching of toxicants from material deposited into the sea during the O&M stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.10.5.3 As for impact O2 (**paragraph 7.10.3.3** and **7.10.3.4**) and O3 (**paragraph 7.10.4.3**), the receptor is considered to be **high** value reflecting the sensitivity of the waterbodies in which the Project is located.

Magnitude of impact

7.10.5.4 The leaching of toxicants will be minimised by good practice, described as an embedded environmental measure (M-064). In addition, materials and coatings will be regulated by MD-LOT through the marine licencing system. As a result, the magnitude of impact is considered to be **negligible.**

Significance of residual effect

7.10.5.5 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.10.6 Impact O5: changes to thermal stratification resulting from thermal emissions from seabed electricity cables

Overview

7.10.6.1 By warming the lower, cooler sea water layer, the thermal emissions from subsea cables have the potential to cause changes to thermal stratification of the water column and / or increases in oxygen demand, potentially resulting in changes in water quality.

7.10.6.2 The maximum design scenario relating to changes to thermal stratification resulting from thermal emissions from seabed electricity cables during the O&M stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.10.6.3 The coastal water body through which the offshore export cable corridor passes (Cairnbulg Point to the Ugie Estuary, ID 200142) has a water classification status of 'High'. Given the High status of the water body, it is therefore of h**igh** sensitivity / value.

Magnitude of impact

7.10.6.4 Taking typical thermal losses of up to 164 W/m for each cable (Hughes *et al.,* 2015), near bed residual current of approximately 0.05m/s (Scottish Government, 2016) and a 'worst case' scenario of 350km of subsea cable, the estimated temperature rise in the lower layer of sea stratified at mid-depth is approximately 0.0012 °C. This is negligible and is unlikely to cause changes in water quality. The impact is therefore considered to be **negligible**.

Significance of residual effect

7.10.6.5 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.11 Assessment of effects: decommissioning stage

7.11.1 Introduction

7.11.1.1 This Section provides an assessment of the effects for marine water and sediment quality from the decommissioning of the offshore elements of the Project.

7.11.1.2 The assessment methodology set out in **Section 7.8** has been applied to assess effects to marine water and sediment quality from the Project.

7.11.2 Impact D1: mobilisation of sediment into the water column, increasing SSC and turbidity

Overview

7.11.2.1 The following decommissioning activities could potentially give rise to increases in SSC and associated deposition of material within the OAA and the offshore export cable:

- removal of foundation structures;
- cutting off of piles at foundation legs / anchors (for driven pile anchors); and
- removal of buried cables and protection.

7.11.2.2 The maximum design scenario relating to mobilisation of sediment into the water column, increasing SSC and turbidity during the decommissioning stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.11.2.3 As for the mobilisation of sediment during the construction and O&M stages stage (C1 and O1) the magnitude of change for this impact is considered simply as a 'pathway' to indirect effects described in other chapters, since there is no EQS for suspended sediment.

Magnitude of impact

7.11.2.4 The removal of offshore substation and RCP foundations is expected to result in some localised seabed disturbance accompanied by temporary increases in SSC. Foundations involving piled solutions would be cut off at or just below the seabed surface, potentially causing a localised disturbance of the bed and a temporary increase in SSC.

7.11.2.5 Based on the outputs from the physical processes modelling (**Chapter 6: Marine Geology, Oceanography and Physical Processes**) there may be an additive effect on SSC concentrations where activities are undertaken at more than one location, with the effect on SSC only additive in the area of overlap. The changes in SSC associated with decommissioning activities are expected to be less than that associated with construction, therefore **negligible** magnitude.

Significance of residual effect

7.11.2.6 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.11.3 Impact D2: mobilisation of sediment into the water column, increasing contaminant concentrations

Overview

7.11.3.1 Mobilisation of sediment into the water column due to decommissioning activities will potentially result in the release of any contaminants present in the sediment. Concentrations of contaminants in sediments in the OAA, export corridor and landfall(s) area are set out in **Table 7.15, Table 7.16** and **Table 7.17**. Introduction of contaminants into the water column could result in breaches of EQS values. The EQS system is described in **paragraph 7.9.3.2**.

7.11.3.2 The maximum design scenario relating to mobilisation of sediment into the water column, increasing contaminant concentrations during the decommissioning stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.11.3.3 As for impact C2 and O2, the value of the sediments within the Red Line Boundary reflect the status classification of the waterbodies within which they are located. These vary by location: High for the coastal waterbody (Cairnbulg Point to the Ugie Estuary, ID 200142) through which the offshore export cable corridor passes; and Good for the coastal waterbody in which the OAA is located. The offshore export cable corridor passes through the Southern Trench Marine Protected Area. The coastal waterbodies in which the landfall(s) site is located Strathbeg Estuary (ID 200137) and Ugie Estuary (ID 200129) both have a water classification status of 'High'.

7.11.3.4 Overall, the receptor is considered to be of **high** value.

Magnitude of impact

7.11.3.5 As for the O&M stage the Given that there were no exceedance of water column MAC EQS in the OAA, offshore export cable corridor and landfall(s) area, and only minor exceedances of Marine Scotland AL1 thresholds PAH, PCB and TBT concentrations in isolated samples. During operation the volumes of SSC will be lower than construction and therefore the impact is also considered to be **negligible**.

Significance of residual effect

7.11.3.6 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.11.4 Impact D3: resettlement of mobilised sediment, potentially changing existing sediment quality

Overview

7.11.4.1 Sediment mobilised by decommissioning activities may be transported by wave and tidal action and resettle on the seabed in a new location. As for construction and O&M, if the sediment supports elevated levels of contaminants, this could result in a change in sediment quality in the areas where resettlement occurs. Resettlement of mobilised sediment causing changes in the quality of sediment in areas where resettlement occurs.

7.11.4.2 The maximum design scenario relating to resettlement of mobilised sediment, potentially changing existing sediment quality during the decommissioning stage is presented in **Table 7.10**. Where predicted effects are identified, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 7.8**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded environmental measures from **Table 7.11** will be implemented as part of the Project.

Sensitivity or value of receptor

7.11.4.3 As for impact D2 (**paragraph 7.11.3.3**) the receptor is considered to be **high** value reflecting the sensitivity of the waterbodies in which the Project is located.

Magnitude of impact

7.11.4.4 Based on the physical processes modelling, measurable thicknesses of sediment deposition are only expected within relatively small distances (tens of metres) from the site of the activity, extending in the direction of tidal current at the time of the work. The impact is therefore considered to be **negligible**.

Significance of residual effect

7.11.4.5 With a **negligible** magnitude of change and **high** sensitivity receptors, significance is rated as **Minor Adverse** (**Not Significant**) in EIA terms.

7.12 Summary of effects

7.12.1.1 A summary of the effects arising from the construction, O&M and decommissioning stages of the Project in relation to marine water and sediment quality are summarised in **Table 7.19**.

Table 7.19 Summary of effects during the construction, O&M and decommissioning stages of the Project on marine water and sediment quality

Receptor	Sensitivity / value	Activity and potential effect	Embedded environmental measures	Magnitude of effect	Significance of effects
Construction					
Marine Sediment and Water Quality	**N/A** [Potential pathway of effect for other topics: • **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**; and • **Chapter 13: Fish Ecology**].	Impact C1: mobilisation of sediment into the water column, increasing SSC and turbidity	M-060 M-054	**N/A** [Potential pathway of effect for other topics: • **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**; and • **Chapter 13: Fish Ecology**].	Not applicable.
Marine coastal and offshore water quality	**High**	Impact C2: mobilisation of sediment into the water column, increasing contaminant concentrations.	M-059	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine Sediment and Water Quality	**High**	Impact C3: resettlement of mobilised sediment, potentially changing existing sediment quality.	M-060	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine coastal water quality.	**High**	Impact C4: release of drilling muds from HDD at landfall impacting water and sediment quality.	M-062	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine coastal and	**High**	Impact C5: leaching of toxicants from material deposited into the sea.	M-064	**Negligible**	**Minor Adverse** (**Not Significant**).

Receptor	Sensitivity / value	Activity and potential effect	Embedded environmental measures	Magnitude of effect	Significance of effects
offshore water quality					
Blue carbon stored in seabed sediments	**High**	Impact C6: change in the blue carbon resource in sediments.	N/A	**Negligible**	**Minor Adverse** (**Not Significant**).
O&M					
Marine sediment and water quality	**Not assessed**	Impact O1: mobilisation of sediment into the water column, increasing SSC and turbidity.	M-033 M-049	**Not applicable**	Not applicable
Marine coastal and offshore water quality	**High**	Impact O2: mobilisation of sediment into the water column, increasing contaminant concentrations.	M-033 M-049	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine sediment and water quality	**High**	Impact O3: resettlement of mobilised sediment, potentially changing existing sediment quality.	M-033 M-049	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine coastal and offshore water quality	**High**	Impact O4: ongoing leaching of toxicants from material deposited into the sea.	M-033 M-049	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine coastal and offshore water quality	**High**	Impact O5: changes to thermal stratification resulting from thermal emissions from seabed electricity cables.	M-033 M-049	**Negligible**	**Minor Adverse** (**Not Significant**).

Receptor	Sensitivity / value	Activity and potential effect	Embedded environmental measures	Magnitude of effect	Significance of effects
Decommissioning					
Marine sediment and water quality	**N/A** [Potential pathway of effect for other topics: • **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**; and • **Chapter 13: Fish Ecology**].	Impact D1: mobilisation of sediment into the water column, increasing SSC and turbidity.	M-106 M-121	**N/A** [Potential pathway of effect for other topics: • **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**; and • **Chapter 13: Fish Ecology**].	Not applicable
Marine coastal and offshore water quality	**High**	Impact D2: mobilisation of sediment into the water column, increasing contaminant concentrations.	M-106 M-121	**Negligible**	**Minor Adverse** (**Not Significant**).
Marine sediment quality	**High**	Impact D3: resettlement of mobilised sediment, potentially changing existing sediment quality	M-106 M-121	**Negligible**	**Minor Adverse** (**Not Significant**).

7.13 Transboundary effects

7.13.1.1 Transboundary effects arise when impacts from a development with one European Economic Area (EEA) State affects the environment of another EEA State(s). A screening of transboundary effects have been carried out and is presented in Appendix 4B of the Scoping Report (MarramWind Ltd., 2023).

7.13.1.2 Based on the knowledge of the baseline environment, the nature of planned works and the wealth of evidence on the potential for impact from such projects more widely, there are not considered to be any transboundary effects on marine water and sediment quality receptors from the Project.

7.14 Inter-related effects

7.14.1.1 A description and assessment of the likely inter-related effects arising from the Project on marine water and sediment quality is provided in **Chapter 32: Inter-Related Effects**.

7.15 Assessment of cumulative effects

- A description and assessment of the cumulative effects arising from the Project on marine water and sediment quality is provided in **Chapter 33: Cumulative Effects Assessment**.

7.16 Summary of residual likely significant effects

7.16.1.1 There are no residual likely significant effects on marine water and sediment quality receptors assessed in this Chapter have been identified.

7.17 References

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7.18 Glossary of terms and abbreviations

7.18.1 Abbreviations

Acronym	Definition
AA	Annual Average
AL	Action Level
BGS	British Geological Survey
BWM	International Convention for the Control and Management of Ships' Ballast Water and Sediments
CBRA	Cable Burial Risk Assessment
EIA	Environmental Impact Assessment
EMF	Electromagnetic fields
EMP	Environmental management plan (offshore)
EQS	Environmental quality standard
GES	Good Environmental Status
GHG	Greenhouse gases
HDD	Horizontal directional drilling
IC	Inorganic Carbon
km	kilometres
m	metres
MAC	Maximum Allowable Concentrations
MARPOL	International Convention for the Prevention of Pollution from Ships
MD-LOT	Marine Directorate – Licencing Operations Team
MHWS	Mean high water spring
MPCP	Marine pollution contingency plan
MSFD	Marne Strategy Framework Directive (2008/56/EC)
nm	nautical mile
O&M	Operation and maintenance
OAA	Option Agreement Area
OC	Organic Carbon

Acronym	Definition
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
PEMP	Project Environmental Monitoring Programme
PSA	Particle Size Analysis
PSU	Practical Salinity Unit
SAC	Special Area of Conservation
SDC	Subsea Distribution Centre
SPM	Suspended Particulate Matter
SSC	Suspended solids concentration
SSSI	Site of Special Scientific Interest
TBT	Tributyltin
VC	Vibrocore
WFD	Water Framework Directive
WMP	Waste Management Plan
WTG	Wind Turbine Generator
ZOI	Zone of Influence

7.18.2 Glossary of terms

Term	Definition
Blue carbon	Blue carbon refers to the carbon that is captured and stored by oceanic and coastal ecosystems, particularly vegetated coastal habitats.
Stratification	Stratification describes the layering of water in oceans due to differences in temperature and salinity (density).
Thermocline	A thermocline is a distinct layer in a body of water where the temperature changes rapidly with depth, it separates the warmer surface water from the colder deeper water.
Tidal excursion	Tidal excursion refers to the horizontal distance that a water parcel travels during a single tidal cycle due to tidal currents.
Vibrocore	A vibrocore is a coring system that uses vibration to help a core barrel penetrate into sediments, allowing for the extraction of a relatively undisturbed vertical sample.

MarramWind