Offshore Wind Power Limited

West of Orkney Windfarm Offshore EIA Report

Volume 1, Chapter 9 - Water and Sediment Quality

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XODUS

West of Orkney Windfarm

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CONTENTS

9 WATER AND SEDIMENT QUALITY

Chapter summary

This chapter of the Offshore Environmental Impact Assessment (EIA) Report assesses the potential effects from the offshore Project on water and sediment quality receptors. This includes direct, indirect, whole Project assessment, cumulative, inter-related effects, inter-relationships, and transboundary effects.

The water and sediment quality offshore study area encompasses a 10 kilometre (km) buffer around the Option Agreement Area (OAA) and a 15 km buffer around the offshore Export Cable Corridor (ECC). The baseline characterisation was informed by a combination of Project site-specific surveys and desk-based studies.

Under the Water Framework Directive (WFD), the Strathy Point to Dunnet Head and the Sule Skerry and Sule Stack coastal waterbodies are defined as being in 'high' or 'good' condition. The Strathy Point to Dunnet Head coastal waterbody overlaps the offshore ECC, and the Sule Skerry and Sule Stack coastal waterbody very slightly overlaps the OAA. There are an additional two designated coastal waterbodies and one designated bathing water located within the wider water and sediment quality offshore study area.

The site-specific sediment sampling and sediment chemistry and contaminant analyses identified limited contamination within samples obtained across the water and sediment quality offshore study area. The analysis undertaken included analysis of metals, organics, organotins, Polychlorinated Biphenyls (PCBs), pesticides and flame retardants. Overall, only arsenic, nickel and certain PCBs marginally exceeded sediment quality criteria at a limited number of sites.

Radiological contamination in the form of radioactive particles is known to be present in the marine environment at the Dounreay coast, due to historic practices of the coastal nuclear sites. There has been extensive remediation and monitoring efforts to reduce radioactive contamination in the region. The main area of concern is designated by a Food and Environment Protection Act (FEPA) Order Zone. There will be no Project infrastructure located within the FEPA Order Zone.

The following impacts during construction and decommissioning were identified as requiring assessment (impacts during operation and maintenance were scoped out of the assessment):

- Disturbance and release of contaminated sediments or radioactive particles; and
- Impacts on water quality status of designated waterbodies due to increased suspended sediment and potential release of contaminants or radioactive particles.

This assessment has taken account of embedded mitigation measures and is informed by the outputs of the marine physical and coastal processes assessment, including Project-specific numerical modelling. The assessment for water and sediment quality concluded that due to the low levels of contamination present within the water and sediment quality offshore study area and the highly localised and temporary nature of the impacts from the construction activities, as shown through the modelling results, no significant effects to any water and sediment quality receptors were predicted, either for the offshore Project or cumulatively with other plans or projects (developments). No secondary mitigation or monitoring requirements are proposed. There are also no inter-related effects or transboundary effects and the whole Project assessment concluded no overlap between the effects of the onshore and offshore Project on marine water and sediment quality receptors.

Seabed preparations ahead of construction may require dredging and excavated material disposed in designated/licensed disposal sites or within the offshore Project area. Disposal of such material could require a separate Marine Licence application to Marine Directorate – Licensing Operations Team (MD-LOT). Sediment samples would be collected and analysed as required in support of the application.

9.1 Introduction

This chapter of the Offshore Environmental Impact Assessment (EIA) Report presents the water and sediment quality receptors of relevance to the offshore Project and assesses the potential impacts from the pre-construction, construction, operation and maintenance and decommissioning of the offshore Project on these receptors. Where required, mitigation is proposed, and the residual impacts and their significance are assessed. Potential cumulative and transboundary impacts are also considered.

Table 9-1 below provides a list of all the supporting studies which relate to and should be read in conjunction with the water and sediment quality impact assessment. All supporting studies are appended to this Offshore EIA Report and issued on the accompanying Universal Serial Bus (USB) flash drive.

Table 9-1 Supporting studies

DETAILS OF STUDY	LOCATIONS OF SUPPORTING STUDY
Marine Physical and Coastal Processes Supporting Study	Offshore EIA Report, Supporting Study 3 (SS) 3: Marine physical and coastal processes supporting study.
Benthic Subtidal and Intertidal Ecology Baseline Report	Offshore EIA Report, Supporting Study (SS) 4: Benthic subtidal and intertidal baseline report.
West of Orkney Windfarm Benthic Environmental Baseline Report	Offshore EIA Report, Supporting Study (SS) 5: Benthic environmental baseline report.

The impact assessment presented herein draws upon information presented within other impact assessments within this Offshore EIA Report, including:

- Chapter 8: Marine physical and coastal processes – which assesses the impacts of the offshore Project on water and sediment through the interaction with physical and coastal processes; and
- Chapter 10: Benthic subtidal and intertidal ecology – which characterises the invasive non-native species in the offshore Project area and provides the context for assessment on water and sediment quality receptors.

Equally, the water and sediment quality impact assessment also informs other impact assessments. This interaction between the impacts assessed within different topic-specific chapters on a receptor is defined as an 'inter-relationship'. The chapters and impacts related to the assessment of potential effects on water and sediment quality are provided in Table 9-2.

Table 9-2 Water and sediment quality inter-relationships

CHAPTER	IMPACT	DESCRIPTION
Marine physical and coastal processes (chapter 8, Offshore EIA Report)	Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediments.	Changes in marine physical and coastal processes, including disturbance of sediment, can result in increases in Suspended Sediment Concentrations (SSC) and consequences on water and sediment quality. The development and spread of a sediment plume in addition to potential increases in SSC and associated deposition during construction are assessed in chapter 8: Marine physical and coastal processes and used to inform this chapter. The effects of the operation and maintenance of the offshore Project on marine physical and coastal processes may also have consequences on water column structure and changes in landfall morphology which may affect water and sediment quality.
Benthic subtidal and intertidal ecology (chapter 10, Offshore EIA Report)	Indirect impacts on benthic fauna and habitats associated with changes in water quality from suspended sediments, or due to disturbance of contaminants and radioactive particles in the sediment.	Changes in water and sediment quality can result in indirect impacts on benthic fauna and habitats which are sensitive to water quality, disturbance of sediment, and contamination. This is assessed in chapter 10: Benthic subtidal and intertidal ecology.
Fish and shellfish ecology (chapter 11, Offshore EIA Report)	Indirect impacts on fish and shellfish associated with changes in water quality from suspended sediments, or due to disturbance of contaminants and radioactive particles in the sediment.	Changes in water and sediment quality can result in indirect impacts on fish and shellfish (including spawning habitats) which are sensitive to water quality, disturbance of sediment, and contamination. The impact of increases in suspended sediment on fish and shellfish ecology was scoped out of the assessment (see chapter 11: Fish and shellfish ecology).
Marine mammals and megafauna (chapter 12, Offshore EIA Report)	Indirect impacts on marine mammal and megafauna species associated with changes in water quality from suspended sediments, or due to disturbance of contaminants and radioactive particles in the sediment.	Changes in water quality can result in indirect impacts to marine mammals and megafauna which are sensitive to water quality. This is assessed in chapter 12: Marine mammals and megafauna. The impact of decreased water quality on marine mammals and megafauna was scoped out of the assessment (see chapter 12: Marine mammals and megafauna).

CHAPTER	IMPACT	DESCRIPTION
Other sea users (chapter 18, Offshore EIA Report)	Indirect impacts on other sea users (e.g. other developments, recreation and tourism) associated with changes in water quality from suspended sediments, or due to disturbance of contaminants and radioactive particles in the sediment.	Changes in water and sediment quality can result in indirect impacts to other sea users such as nearby developments (e.g. aquaculture sites) and marine recreation and tourism activity along the Caithness coast which are sensitive to water quality and contamination. This is assessed in chapter 18: Other sea users.

The following specialists have contributed to the assessment:

- Xodus Group Limited (Xodus) – baseline description, impact assessment and Offshore EIA Report chapter write up.

There are additional Marine Licences that may be required for certain activities that have been assessed in this chapter:

- Dredging, and subsequent disposal, could entail a separate Marine Licence application to Marine Directorate Licensing Operations Team (MD-LOT). The exact need for dredging and disposal will be confirmed post-consent during detailed design. If dredging is required, sediment samples would be collected, analysed as required in support of the Marine Licence application; and
- Boulder clearance may also be subject to a separate Marine Licence application. Again, the requirements will be confirmed post-consent during detailed design, following this there will be consultation with MD-LOT to confirm any licensing requirements.

9.2 Legislation, policy and guidance

Over and above the legislation presented in chapter 3: Planning policy and legislative context, the following legislation, policy and guidance are relevant to the assessment of impacts from the offshore Project on water and sediment quality:

- Legislation:
  - Food and Environment Protection Act (FEPA) 1985;
  - Water Environment and Water Services (Scotland) Act 2003;
  - Action Programme for Nitrate Vulnerable Zones (Scotland) Regulations 2008;
  - The Bathing Waters (Scotland) Regulations 2008;
  - The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended);
  - The Marine Strategy Regulations 2010;
  - The Pollution Prevention and Control (Scotland) Regulations 2012;
  - The Water Environment (Shellfish Water Protected Areas: Designation) (Scotland) Order 2013; and
  - The Environmental Authorisations (Scotland) Regulations 2018.

- Policy:
  - The following policies of Scotland's National Marine Plan (Scottish Government, 2015), which was prepared in accordance with the United Kingdom (UK) Marine Policy Statement, apply to this water and sediment quality assessment:
    - GEN 1: General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan;
    - GEN 10: Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made;
    - GEN 12: Water quality and resource: Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD) or other related Directives apply; and
    - GEN 21: Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.
  - Pilot Pentland Firth and Orkney Waters Marine Spatial Plan (Scottish Government, 2016):
    - This non-statutory plan sets out an integrated planning policy framework to guide marine development, activities and management decisions, whilst ensuring the quality of the marine environment is protected.
  - Orkney Islands Regional Marine Plan: Consultation Draft (Orkney Islands Council, 2022):
    - The Plan sets out an integrated planning policy framework to guide marine development and activities, whilst ensuring the quality of the marine environment is protected, and where appropriate, enhanced. It supports the delivery of a vision for Orkney's coastal and marine environment, economy and communities.
  - National Islands Plan (Scottish Government, 2019):
    - The Plan sets out 13 objectives to address crucial sectors within island communities. Under Strategic Objective 8: To improve and promote environmental wellbeing and deal with biosecurity, there is a commitment to protect island biodiversity and to address biosecurity issues;
  - Highland-wide Local Development Plan (The Highland Council, 2012) Planning Policies:
    - Policy 63: Water Environment: The Council will support proposals for development that do not compromise the objectives of the WFD (2000/60/EC), aimed at the protection and improvement of Scotland's water environment. In assessing proposals, the Council will take into account the River Basin Management Plan for the Scotland River Basin District and associated Area Management Plans and supporting information on opportunities for improvements and constraints; and
    - Policy 72: Pollution: Proposals that may result in significant pollution such as noise (including aircraft noise), air, water and light will only be approved where a detailed assessment report on the levels, character and transmission and receiving environment of the potential pollution is provided by the applicant to show how the pollution can be appropriately avoided and if necessary mitigated. Where the Council applies conditions to any permission to deal with pollution matters these may include subsequent independent monitoring of pollution levels. Major Developments and developments that are subject of Environmental Impact Assessment will be expected to follow a robust project environmental management process, following the approach set out in the Council's Guidance Note "Construction Environmental Management Process for Large Scale Projects" or a similar approach.

- Guidance:
  - Scottish Environment Protection Agency (SEPA), Northern Ireland Environment Agency, and Department for Agriculture, Environment and Rural Affairs: Guidance for Pollution Prevention (GPPs) and Pollution Prevent Guidance (PPGs));
  - Land Use Planning System SEPA Guidance Note 17: Marine development and marine aquaculture planning guidance, Version 6 (SEPA, 2014)[1]; and
  - Supporting Guidance (WAT-SG-53) Environmental Quality Standards and Standards for Discharges to Surface Waters (SEPA, 2020a).

9.3 Scoping and consultation

Stakeholder consultation has been ongoing throughout the EIA and has played an important part in ensuring the scope of the baseline characterisation and impact assessment are appropriate with respect to the Project and the requirements of the regulators and their advisors.

The Scoping Report, which covered the onshore and offshore Project, was submitted to Scottish Ministers (via Marine Scotland - Licensing Operations Team (MS-LOT)[2]) and The Highland Council (THC) on 1st March 2022[3]. MS-LOT circulated the Scoping Report to consultees relevant to the offshore Project and a Scoping Opinion was received on 29th June 2022. The comments from the Scoping Opinion relevant to the water and sediment quality assessment, were specifically directed at the connection to the Flotta Hydrogen Hub, which is no longer part of the current consent application and will be subject to a separate later consent application. As such these comments have not been provided in this report as they do not relate to the current application.

The following comment was provided by Scottish Ministers (via MS-LOT) as part of the Scoping Opinion which is relevant to water quality:

> *"Should seabed preparation involve dredging, the EIA Report must identify the quantities of dredged material and identify the likely location for deposit. The Developer may also be required to submit pre-dredge sample analysis, this should include supporting characterisation of the new or existing deposit sites."*

Seabed preparation may include bedform clearance which can be performed using dredging techniques, jetting tools or Controlled Flow Excavation (CFE). CFE and dredging by Trailing Suction Hopper Dredger (TSHD) have been accounted for as the potential worst case activities in the assessment. Should TSHD be used, excavated material may be disposed of in designated/licensed disposal sites or within the offshore Project area. Dredging by TSHD includes disposal, which could entail a separate Marine Licence application to MD-LOT. The exact need for dredging and disposal will not be confirmed until a further stage of the Project. If dredging is required, OWPL understand that

[1] *The guidance is currently under review and being updated following the publication of Scotland's National Planning Framework 4. Any resulting changes to the guidance will be taken into consideration as applicable.*

[2] *MS-LOT have since been renamed Marine Directorate - Licensing Operations Team (MD-LOT).*

[3] *The Scoping Report was also submitted to the Orkney Islands Council (OIC), as the scoping exercise included consideration of power export to the Flotta Hydrogen Hub, however, this scope is not covered in the Offshore EIA Reports and will be subject to separate Marine Licence and onshore planning applications.*

sediment samples must be collect, analysed and provided to MD-LOT in support of the Marine Licence application. Please note, this disposal location has not yet been selected as part of the Project Design Envelope. For the purposes of this assessment and for ease of quantification of impacts, a nominal indicative disposal area has been chosen for some context.

Further consultation has been undertaken throughout the pre-application stage. Table 9-3 summarises the consultation activities carried out relevant to water and sediment quality.

Table 9-3 Consultation activities for water and sediment quality

CONSULTEE AND TYPE OF CONSULTATION	DATE	SUMMARY
NatureScot and OIC – meeting	29th June 2022	A meeting with NatureScot and OIC to discuss the approach to consultation and baseline characterisation as well as planned surveys for physical processes, water and sediment quality, benthic subtidal and intertidal ecology, and fish and shellfish ecology.
NatureScot, OIC and THC – meeting	4th October 2022	A meeting with NatureScot, OIC and THC to discuss offshore survey updates, assessment approach and modelling, and Habitats Regulations Appraisal (HRA) screening, for physical processes, water and sediment quality, and benthic subtidal and intertidal ecology.

9.4 Baseline characterisation

This section outlines the current baseline for water and sediment quality within the water and sediment quality offshore study area. A desk-based review of the publicly available data sources and literature in addition to the site-specific surveys was used to establish the baseline.

9.4.1 Study area

The water and sediment quality offshore study area is based on the marine physical and coastal processes offshore study area as detailed in chapter 8: Marine physical and coastal processes. The water and sediment quality offshore study area has been established using a 10 kilometre (km) buffer around the Option Agreement Area (OAA) and a 15 km buffer around the offshore Export Cable Corridor (ECC) as illustrated in Figure 9-1.

This is based on the mean spring tidal excursion distance from the UK Atlas of Marine Renewable Energy Resources meso-scale model (ABPmer, 2008). Different buffer distances are applied between the OAA and offshore ECC to account for the variation in excursion distance between the two Project elements. The proximity of the offshore ECC to faster and stronger flows through the Pentland Firth between the Scottish mainland and Orkney Islands account accounts for the larger excursion distance.

The applied buffer (10 km and 15 km for the OAA and offshore ECC, respectively) is considered to be appropriate on the basis of the flow characteristics from regional model data, to capture effects that extend beyond the offshore

Project area. This includes effects associated with pathways for tidal advection, net drift and dispersion of sediment plumes from seabed disturbance activities and the extent of wakes and water column mixing due to flows and waves passing individual foundations and the wider OAA.

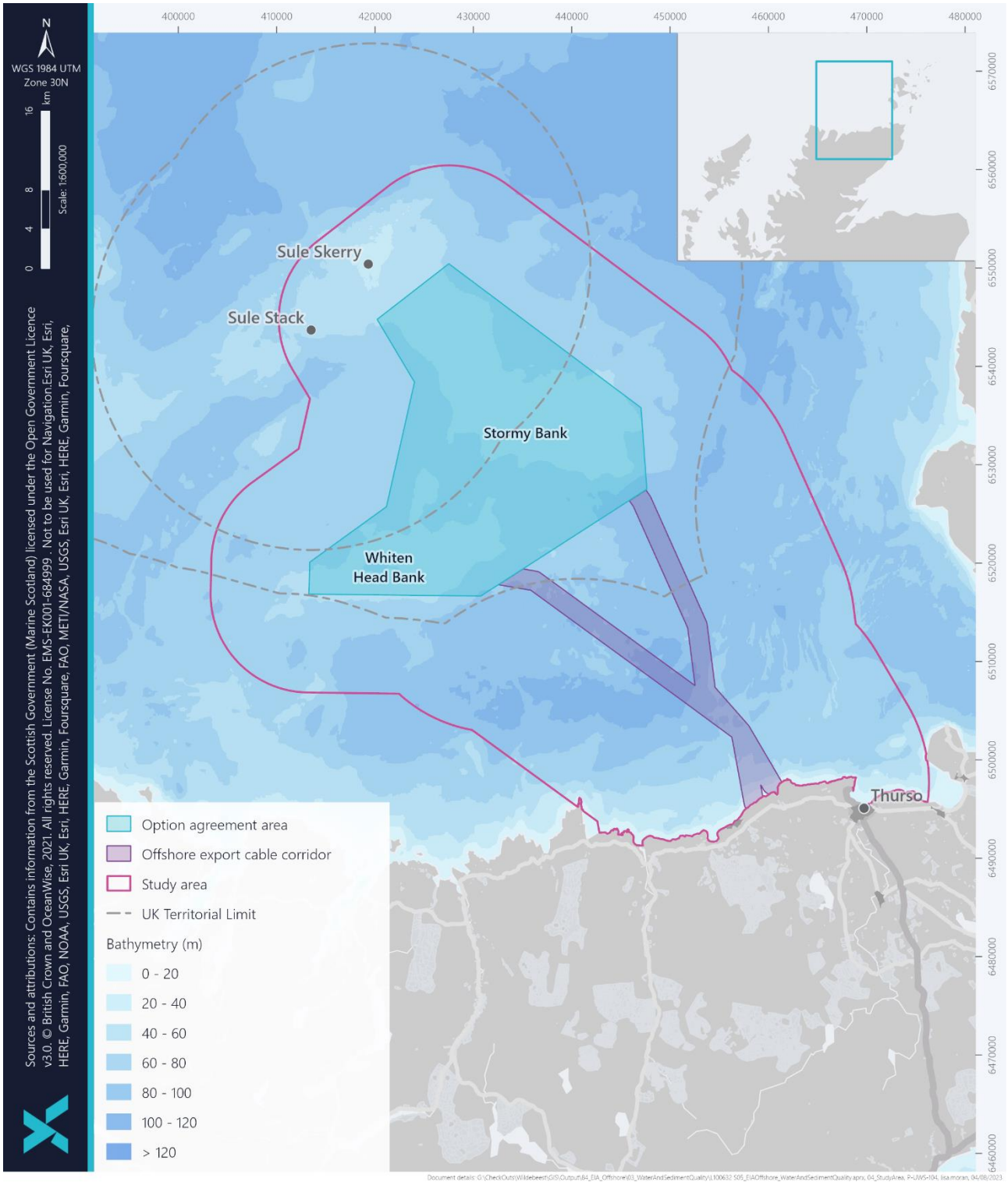


Figure 9-1 Water and sediment quality offshore study area

9.4.2 Data sources

The existing data sets and literature with relevant coverage to the offshore Project, which have been used to inform the baseline characterisation for water and sediment quality are outlined in Table 9-4. Project specific data obtained and used to inform this topic assessment are presented in section 9.4.3.

Table 9-4 Summary of key datasets and reports

TITLE	SOURCE	YEAR	AUTHOR
Waterbody Data Sheets	https://www2.sepa.org.uk/WaterBodyDataSheets/	2012	SEPA
Monthly Average Non-algal Suspended Particulate Matter (SPM) Concentrations on the UK Shelf Waters	https://www.cefas.co.uk/data-and-publications/dois/monthly-average-non-algal-supended-particulate-matter-concentrations/	2016a	Centre for Environment, Fisheries and Aquaculture Science (Cefas)
Suspended Sediment Climatologies Around the UK	https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/584621/CEFAS_2016_Suspended_Sediment_Climatologies_around_the_UK.pdf	2016b	Cefas
OSPAR Intermediate Assessment 2017 – Contaminant Assessments	https://oap.ospar.org/en/osparassessments/intermediate-assessment-2017/pressures-human-activities/contaminants	2017a	OSPAR[4]
Scotland's Water Environment 2019: A Summary and Progress report	https://www.sepa.org.uk/media/490771/191219_scotlands-water-environment-final.pdf	2019	SEPA
Clean Seas Environmental Monitoring Programme (CSEMP)	https://www.bodc.ac.uk/projects/data_management/uk/merman/assessments_and_data_access/csemp/	2020	National Oceanography Centre
Urban Waste Water Treatment Directive Sensitive Areas 2019	https://www.gov.scot/binaries/content/documents/govscot/publications/map/2016/01/urban-waste-water-treatment-sensitive-areas-map/documents/urban-waste-water-treatment-sensitive-areas-map-2019/urban-waste-water-treatment-sensitive-areas-map-	2020b	SEPA

[4] *Oslo and Paris Commissions 1992 Convention for the Protection of the Marine Environment of the North-east Atlantic known as the OSPAR Convention, which established the OSPAR Commission (OSPAR).*

TITLE	SOURCE	YEAR	AUTHOR
	2019/govscot%3Adocument/UWWTD%2Bdesignations%2B2019.pdf		
Dynamic Coast 2	https://www.crew.ac.uk/dynamic-coast	2021	Centre of Expertise for Waters (CREW)
Action Level Tool	https://rconnect.cefas.co.uk/action_levels_tool/	2023	Cefas
Scotland's National Marine Plan Interactive (NMPi)	https://marinescotland.atkinsgeospatial.com/nmpi/	2023	Marine Scotland
Annual Updates on the Condition of the Water Environment	https://www.sepa.org.uk/data-visualisation/water-classification-hub	2023a	SEPA
Water Framework Directive River Basin Management Plan Waterbody status	https://www.sepa.org.uk/data-visualisation/water-environment-hub/	2023b	SEPA
Scotland's Environment data tool for Bathing Waters	https://www2.sepa.org.uk/bathingwaters/	2023c	SEPA
Nitrates Monitoring	https://www.sepa.org.uk/environment/water/monitoring/nitrates-monitoring/	2023d	SEPA
Nitrate Vulnerable Zones (NVZs)	https://www.gov.scot/policies/agriculture-and-the-environment/nvz/	2023	Scottish Government

9.4.3 Project site-specific surveys

Site-specific surveys have been completed across the offshore Project area to inform the impact assessment. The surveys of specific relevance to this water and sediment quality topic are summarised here.

9.4.3.1 Geophysical survey

9.4.3.1.1 Offshore

Ocean Infinity were contracted by Offshore Wind Power Limited (OWPL) to conduct an offshore geophysical survey across the offshore Project area between April and September in 2022, in order to characterise the seabed, sediment and substrates. The geophysical data acquired during the survey consisted of:

- Multibeam Echo Sounder (MBES) bathymetry and backscatter;
- Side-Scan Sonar (SSS) between 300 kilohertz (kHz) and 600 kHz at 75 m range;
- Magnetometer;
- Sub-Bottom Profiler (SBP) to approximately 10 m below seabed; and
- Ultra High Resolution Seismic (UHRS) to approximately 100 m below seabed.

The findings of the geophysical survey have been detailed in three reports:

- Offshore Geophysical Site Investigation West of Orkney Windfarm: Volume 1 – OAA Results Report (Ocean Infinity, 2023a);
- Offshore Geophysical Site Investigation West of Orkney Windfarm: Volume 2a – Export Cable Corridor (ECC) Results Report (Whiten Head Bank to Crosskirk) (Ocean Infinity, 2023b); and
- Offshore Geophysical Site Investigation West of Orkney Windfarm: Volume 2b – ECC Results Report (Stormy Bank to Crosskirk) (Ocean Infinity, 2023c).

9.4.3.1.2 Nearshore

OWPL contracted Spectrum Geosurvey Limited ("Spectrum") between August and October 2022 to complete a marine geophysical survey across the nearshore area of the offshore ECC and proposed landfalls. The survey was completed to a similar specification as that described for the offshore (section 9.4.3.1.1) and included the acquisition of MBES, SSS, magnetometer and SBP data. Also associated with this survey is the completion of an intertidal survey which is described in chapter 8: Marine physical and coastal processes. The results of nearshore marine geophysical survey are detailed in Spectrum (2023).

9.4.3.2 Benthic and environmental survey

A benthic and environmental survey was completed by Ocean Infinity between August and September of 2022 within the OAA and along the offshore ECC areas. Additionally, a nearshore benthic and environmental survey was carried out in October 2022 by Spectrum Geosurvey Limited and Ocean Ecology Limited.

The offshore survey data acquisition included sediment sampling and imagery, with continuous video to establish a baseline for the habitats and faunal communities within the survey area. Water sampling for SSC, along with Conductivity, Temperature and Depth (CTD), turbidity and Dissolved Oxygen (DO) water column profiling was also completed to characterise the water column properties. The findings from the benthic and environmental surveys are fully detailed within Benthic Environmental Baseline Report (SS5: Benthic environmental baseline report) for both the offshore and nearshore. The relevant information gathered through these environmental surveys pertaining to the water and sediment quality baseline is summarised below.

9.4.3.2.1 Benthic characterisation and seabed sediments

Benthic sampling was completed for characterising the seabed habitats and sediment properties across the offshore Project area as summarised below, while the sampling and analyses processes are detailed in SS5: Benthic environmental baseline report and SS4: Benthic subtidal and intertidal baseline report. The benthic sampling locations are presented in SS5: Benthic environmental baseline report, and the locations where particle size and chemical contaminant samples were successfully acquired is illustrated in Figure 9-2.

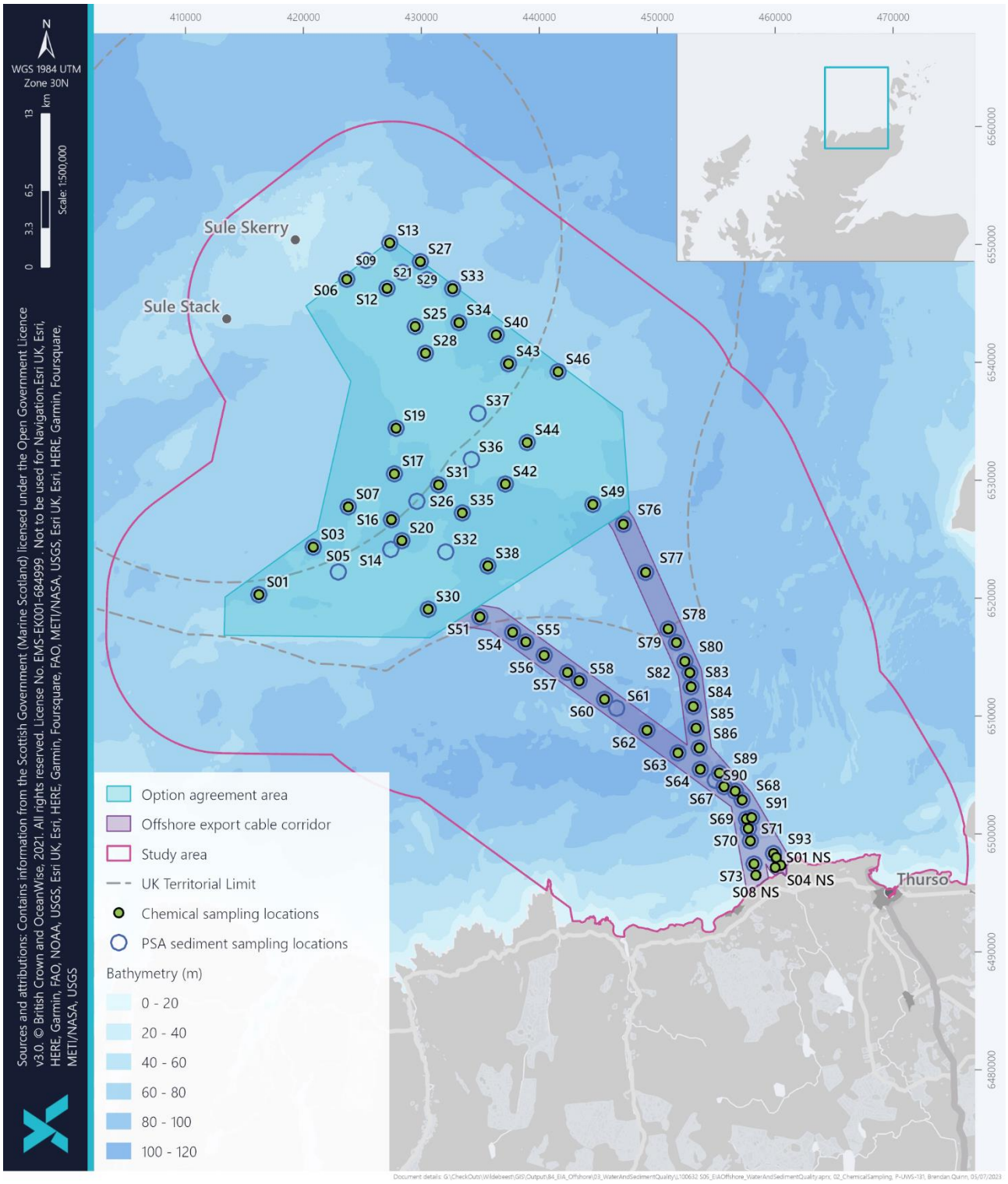


Figure 9-2 Particle size and chemical contaminant sampled locations in the OAA and offshore ECC (see SS5: Benthic environmental baseline report)

Offshore

As part of the benthic and environmental baseline survey conducted in the OAA and offshore ECC, grab sampling was planned at a total of 82 locations, and samples were successfully acquired from 73 of the 82 locations. At each sampling location, one sample was acquired for faunal analyses (SS5: Benthic environmental baseline report), one sample for Particle Size Analysis (PSA) (Figure 9-2), and one sample for sediment chemistry and contaminants analysis (Figure 9-2). Replicate grab samples for faunal, PSA and sediment chemistry and contaminants analyses were collected as a backup but not included in the analyses.

From the 73 grab sample locations, PSA samples were not acquired from six locations, resulting in 67 locations sampled for PSA. The sediment chemistry and contaminants analysis samples were not acquired from 16 of the 73 grab sample locations, resulting in 57 sampled locations for sediment chemistry and contaminants. Samples were taken of the following: metals, organics (Total Organic Matter (TOM) and Total Organic Carbon (TOC)), hydrocarbons (Total Hydrocarbon Content (THC) and Polycyclic Aromatic Hydrocarbon (PAH)), Polychlorinated Biphenyls (PCB), organotins (Monobutyltin (MBT), Dibutyltin (DBT) and Tributyltin (TBT)). It should be noted that the PSA and sediment chemistry and contaminants sample locations were not necessarily coincident (Figure 9-2). Samples for pesticides (Organochlorine Pesticides (OCP)) and flame retardants (Polybrominated Diphenyl Ethers (PBDE)) were planned at 32 locations, but due to the coarse sediment samples were not acquired at six locations, resulting in a total of 26 sampled locations.

Prior to grab sampling, a Drop Down Video (DDV) system was deployed which acquired still photos and continuous video recordings. Seabed imagery was obtained at all 82 planned sampling locations. For the faunal, particle size, and sediment chemistry and contaminant grab sampling, the primary grab sampler utilised was the Dual Van Veen (DVV) (DVV; 2 x 0.1 m^2) and the secondary grab sampler, e.g., in areas of coarse sediment, was the Hamon Grab (HG) (HG; 0.1 m^2). For sediment chemistry and contaminant sampling only the DVV was used. Sediment chemistry and contaminants samples were collected from an undisturbed surface using a plastic spoon for metals and a metal spoon for all other samples to reduce risk of contamination.

Nearshore

For the nearshore benthic and environmental survey, four grab sampling locations were selected based on geophysical data and nine DDV transects completed prior to grab sampling. Three out of four locations were successfully sampled for faunal, PSA, and sediment chemistry and contaminant analyses (Figure 9-2). Replicates were acquired as back-up and not analysed. The primary grab sampler utilised for nearshore faunal grab sampling was the HG (0.1 m^2), and for nearshore PSA and contaminants sampling, the Shipek grab sampler (0.05 m^2) was utilised.

9.4.3.2.2 Water column properties

Sampling for water column properties was completed at 25 locations across the offshore Project area, comprising 13 in the OAA, seven in the offshore ECC and five in the nearshore, with a total of 29 samples being acquired (including four replicate sample locations). The sampled locations used to inform the environmental baseline characterisation for water and sediment quality are illustrated in Figure 9-3, with further detail on the sampling approach described in the following sections. Sampling and analyses processes for water column are detailed in the Environmental Baseline Report (SS5: Benthic environmental baseline report).

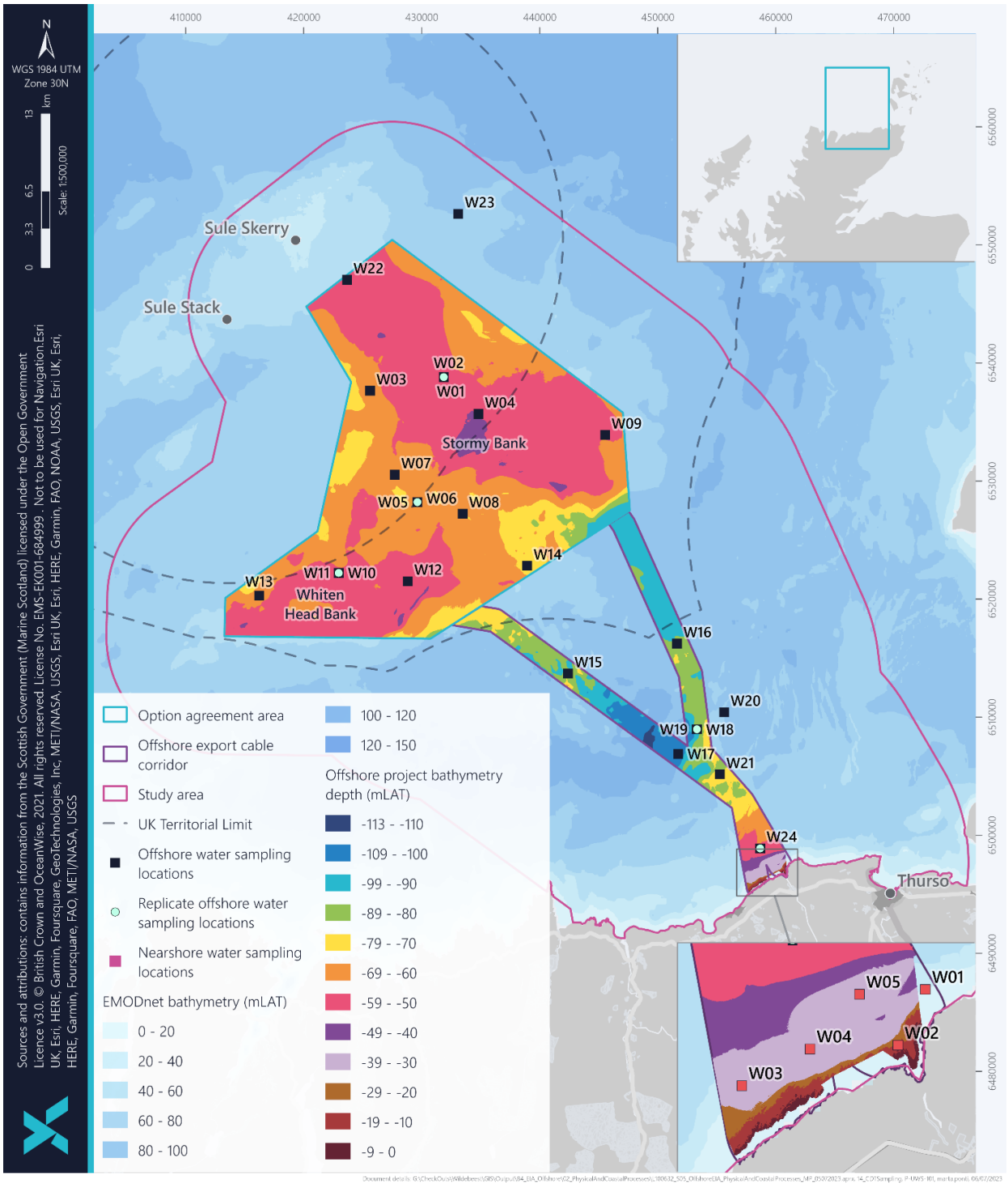


Figure 9-3 Water sampling locations (SS5: Benthic environmental baseline report)[5]

[5] *It is standard practice is present the EMODnet bathymetry data as positive numbers, while the Project specific bathymetry is provided as minus number. Regardless of the values sign both are presenting the water depth.*

Offshore

Water sampling for Total Suspended Solids (TSS) as an indication of SSC, together with CTD (comprising depth, conductivity, dissolved oxygen, pH and temperature) and turbidity profiling, was completed at 20 locations across the offshore Project area. Water sampling was completed between 23rd August and 11th September 2022, with samples collected at three depths (bottom, middle and top). All of the 20 planned water sample locations, including four locations selected for sampling during both spring and neap tides, were successfully completed, resulting in 24 samples.

Water sampling for TSS was performed using five-litre Niskin bottles attached to a Rosette sampler. The open bottles were lowered into the water and closed at pre-assigned depths. A CTD and external turbidity sensor was fitted to the Rosette sampler. The water sampling was acquired prior to the deployment of the DDV or grab sampler so that seabed sediment had not been disturbed. Water sampling was acquired as the sampler was lowered, with sensors (CTD, turbidity and DO) recording on both the drop and retrieval. However, post processing, an average was taken between the measurements between the lowering and recovery, to provide an indication of the water column profile for the different parameters.

Nearshore

For the nearshore surveys, water sampling and profiling was collected at five locations. Water samples were collected at three depths (bottom, middle and top). Water sampling was completed between 22nd and 25th October 2022. Similar to the offshore surveys, water sampling was performed using a five-litre Niskin bottle, with concurrent turbidity profiling.

9.4.4 Project specific supporting studies

To support the development of the EIA, technical supporting studies have been completed to inform EIA topic chapters, two of which are relevant to this topic and are summarised below.

9.4.4.1 Marine physical and coastal process supporting study

A supporting study has been completed for the marine physical and coastal processes topic (SS3: Marine physical and coastal processes supporting study). Of direct relevance to this topic is the consideration of SSC characteristics across the offshore Project area and the potential for changes to the SSC as a result of Project construction activities. To enable the assessment of construction impacts within the technical study, a Project specific numerical model was developed (the 'West of Orkney model') and applied to investigate the potential for sediment plumes associated with construction activities. In particular the modelling analysed the potential magnitude, extent and duration of the finer sediment fraction that could develop into a plume. The marine physical and coastal processes supporting study (SS3: Marine physical and coastal processes supporting study), and appendices within, detail further the completed assessment and modelling, with only the relevant information applied within this topic-specific chapter.

9.4.4.2 Benthic subtidal and intertidal ecology baseline study

The benthic subtidal and intertidal ecology baseline study (SS4: Benthic subtidal and intertidal baseline report) has been used to inform water and sediment quality baseline and assessment in relation to the presence of marine Invasive Non-Native Species (INNS) in the offshore Project area. The presence of INNS can result in changes to water quality status of designated waterbodies as one of the criteria is 'freedom from invasive species' (see section 9.4.6.2). Thus, the potential for changes in water quality status of designated waterbodies as a result of construction activities introducing INNS is addressed within the impact assessment. Detail on the non-native taxa present within the offshore Project area is provided in section 9.4.6.6. Further information on INNS is detailed within chapter 10: Benthic subtidal and intertidal ecology, with only the relevant information applied within this topic-specific chapter.

9.4.5 Assessment of sediment quality

Sediment quality standards are typically applied to evaluate the degree to which contaminants are present and to assess the potential impacts on water and sediment quality receptors. Although there are no Environmental Quality Standards (EQS) for *in situ* sediments in Scotland, EQS exist for selected WFD UK priority substances and specific pollutants in relation to water quality in surface waters, within the WAT-SG-53 guidance (SEPA, 2020b). In the absence of any defined EQSs for sediment, data from the Project specific surveys are compared with the Cefas Action Levels (AL) (developed for the disposal of dredged material). For comparison, data are also often assessed against more stringent quality standards through the Canadian Marine Sediment Quality Guidelines (Canadian Council of Ministers of the Environment (CCME), 1999) and Dutch Quality Standards (International Association of Dredging Companies (IADC)/Central Dredging Association (CEDA), 1997) particularly for hydrocarbons. Although the SEPA WAT-SG-53 guidance relates to surface waters, it is noted that contaminant threshold levels are within the range defined for sediment in the section below.

9.4.5.1 Cefas action levels

Cefas ALs are typically used as part of a 'weight of evidence' approach to demonstrate to decision-makers the suitability of dredged material for disposal at sea but are not themselves statutory standards. The Cefas ALs are presented in Table 9-5. These levels are used in this assessment to inform the potential risk to the environment from contaminants. Contaminants below Action Level 1 (AL1) are generally not considered to be of concern and are approved for disposal at sea. Contaminant levels above Action Level 2 (AL2) are not considered suitable for disposal at sea without further consideration.

Construction activities within the offshore Project area will result in the disturbance of seabed sediment. Therefore, consideration of the potential for sediment contaminants is applicable, which will be contextualised against the Cefas ALs to provide an indicative risk to the environment.

Table 9-5 Cefas action levels (mg/kg)

CONTAMINANT	CEFAS AL 1	CEFAS AL 2[6]
Arsenic	20	100
Mercury	0.3	3
Cadmium	0.4	5
Chromium	40	400
Copper	40	400
Nickel	20	200
Lead	50	500
Zinc	130	800
Organotins; TBT DBT MBT	0.1	1
PCBs, Sum of ICES 7[7] (∑PCB7)	0.01	
PCBs, Sum of 25 congeners[8] (∑PCB25)	0.02	0.2
Dichlorodiphenyltrichloroethane (DDT)	0.001	
Dieldrin	0.005	

9.4.5.2 Canadian marine sediment quality guidelines

The Canadian marine sediment quality guidelines were developed by the CCME as broadly protective tools to support the functioning of healthy aquatic ecosystems (CCME, 1999). They are based on field research programmes that have

[6] *A Cefas AL 2 threshold is not available for PCBs, sum of ICES 7, DDT, or Dieldrin, as these chemicals are monitored on a presence / absence basis rather than specific levels.*

[7] *PCBs, sum of ICES 7 refers to the sum of the seven International Council for the Exploration of the Sea (ICES) PCB congeners: PCB 28, PCB 52, PCB 101, PCB 118, PCB 138, PCB 153, and PCB 180 which are likely to be found in sediment samples.*

[8] *PCBs, sum of 25 congeners refers to the sum of a group of 25 chemical compounds that are monitored.*

demonstrated associations between chemicals and biological effects by establishing cause-and-effect relationships in particular organisms.

Comparison of measured concentrations of various contaminants within the sediments with these guideline values will, therefore, provide a basic indication of the degree of contamination and likely impact on ecology. The Canadian Sediment Quality Guidelines include two values as assessment criteria: the Interim Sediment Quality Guidelines (ISQG) or Threshold Effect Level (TEL) and Probable Effect Level (PEL). The ISQG/TELs and PELs are used to identify the following three ranges of chemical concentrations with regard to biological effects:

- Below the ISQG/TEL: The minimal effect range within which adverse effects rarely occur;
- Between the TEL and PEL: The possible effect range within which adverse effects occasionally occur; and
- Above the PEL: The probable effect range within which adverse effects frequently occur.

Table 9-6 below lists the existing sediment quality guidelines for relevant parameters that have been monitored, including the ISQG/TELs and PELs (dry weights).

Table 9-6 Canadian sediment quality guidelines (CCME, 1999)

SUBSTANCE	UNITS	ISQG/TEL	PEL
Arsenic	mg/kg	7.24	41.6
Cadmium	mg/kg	0.7	4.2
Chromium	mg/kg	52.3	160
Copper	mg/kg	18.7	108
Lead	mg/kg	30.2	112
Mercury	mg/kg	0.13	0.7
Zinc	mg/kg	124	271
PCBs: total PCBs	µg/kg	21.5	189
Acenaphthene	µg/kg	6.71	88.9
Acenaphthylene	µg/kg	5.87	128
Anthracene	µg/kg	46.9	245
Benz(a)anthracene	µg/kg	74.8	693
Benzo(a)pyrene	µg/kg	88.8	763
Chrysene	µg/kg	108	846
Dibenz(a,h)anthracene	µg/kg	6.22	135
Fluoranthene	µg/kg	113	1,494

SUBSTANCE	UNITS	ISQG/TEL	PEL
Fluorene	µg/kg	21.2	144
2-Methylnaphthalene	µg/kg	20.2	201
Naphthalene	µg/kg	34.6	391
Phenanthrene	µg/kg	86.7	544
Pyrene	µg/kg	153	1,398

9.4.5.3 Dutch quality standards

There are no UK contamination threshold values regarding total hydrocarbons for marine sediments. In the absence of such guidelines, the Dutch National Institute for Public Health and the Environment's (Rijksinstituut voor Volksgezondheid en Milieu (RIVM)) intervention levels for aquatic sediments can offer a useful comparison. Concentrations above the Dutch RIVM intervention values represent a serious level of contamination, where functional properties of the sediment are seriously impaired or threatened (Hin *et al.*, 2010). Dutch RIVM guidelines only provide single threshold values for metals and total hydrocarbons, which are summarised in Table 9-7.

Table 9-7 Dutch RIVM sediment quality guidelines (Hin et al., 2010)

SUBSTANCE	UNITS	INTERVENTION VALUE SEDIMENT
Metals		
Arsenic	mg/kg	85
Cadmium	mg/kg	14
Chromium	mg/kg	380
Copper	mg/kg	190
Lead	mg/kg	580
Mercury	mg/kg	10
Nickel	mg/kg	210
Zinc	mg/kg	2,000
Polychlorinated biphenyls		
PCBs: total (sum of 7)	µg/kg	1
Total hydrocarbons and polycyclic aromatic hydrocarbons		
Total hydrocarbons	µg/kg	5,000,000
PAHs: total (sum of 10)	µg/kg	40

9.4.6 Existing baseline

A review of literature and available data sources (Table 9-4) subsequent consultation, and Project specific surveys has been undertaken to describe the current baseline environment for water and sediment quality. The following sections provide information on the key water and sediment quality properties and receptors across the water and sediment quality offshore study area (Figure 9-1).

9.4.6.1 Water column properties

CTD, turbidity and DO profiling data were completed within the water and sediment quality offshore study area as part of the site-specific environmental sampling at 25 locations and 29 water samples were obtained for TSS analysis (section 9.4.3.2.2 and Figure 9-3) (SS5: Benthic environmental baseline report). Temperature and salinity profiles for the water column are described in section 9.4.6.1.1 and summarised in Figure 9-4 to Figure 9-6. Turbidity and DO profiles are described in section 9.4.6.1.2 and summarised in Figure 9-8 through Figure 9-10.

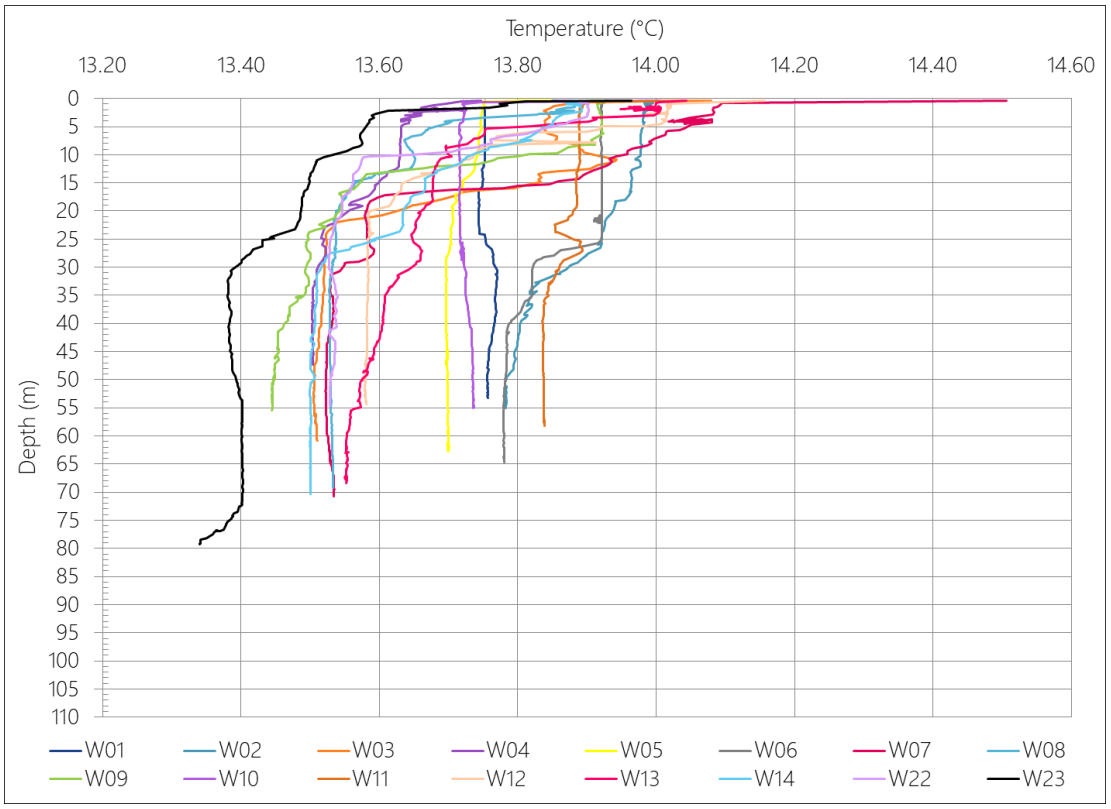
9.4.6.1.1 Temperature and salinity

According to data from the Marine Scotland's Pentland Firth Orkney Waters (PFOW) model (Marine Scotland, 2016), as presented in chapter 8: Marine physical and coastal processes and the supporting technical report (SS3: Marine physical and coastal processes supporting study), annual temperatures across the water and sediment quality offshore study area are relatively consistent, ranging approximately between 7°C and 15°C. Salinity values range between 33.7 Practical Salinity Units (psu) and 34.5 psu, which is slightly below the average salinity of sea water (35 psu), owing to the mixing of Atlantic water with low-salinity coastal waters (Barne *et al.*, 1996). The chemical composition of the water present in the offshore Project area would be expected to be similar to that recorded for typical unpolluted coastal/offshore Atlantic waters. Regional understanding from the PFOW model (Marine Scotland, 2016; 2023) suggests the presence of thermal and salinity stratification across the continental shelf off the north coast of Scotland, with seasonal stratification occurring in the surface waters. The information from the PFOW model (Marine Scotland, 2016) indicates the absence of stratification in offshore waters in the autumn, as characterised further in chapter 8: Marine physical and coastal processes.

Site-specific sampling across the OAA and offshore ECC, indicated stratification was generally observed to occur in the upper 30 m of the water column, with the surface waters being warmer and less saline (Figure 9-4; Figure 9-5). Through the water column across the offshore Project area, temperature ranged between 13.3°C and 14.5°C, and salinity was between 34.55 psu and 35.00 psu. Generally, stratification (mainly salinity, but also observed for temperature) appears to be more pronounced in the offshore ECC (Figure 9-5Figure 9-4), although three locations within the OAA (W02, W6, and W14) appear to exhibit a considerable level of stratification (Figure 9-4). Based on the survey within the nearshore area, completed in October 2022, stratification of temperature and salinity is breaking down or no longer present in the nearshore (Figure 9-6). No stratification is observed in temperature at the nearshore locations, i.e. NS_W01 to NS_W05 (top graph in Figure 9-6), with temperatures being nearly 2 °C colder compared samples from elsewhere in the offshore ECC (Figure 9-5). Potential stratification is observed in salinity at two samples NS_W02 and NS_W04, with no stratification present in the remaining three samples (bottom graph in Figure 9-6). In samples NS_W02 and NS_W04, the stratification differs considerably from that which occurs elsewhere in the offshore ECC (Figure 9-5), in that the stratification occurs in the first 5 to 10 m water depth and exhibits higher concentrations of salinity in a water column of more consistent temperature (Figure 9-6). The season (at the time of the survey) and

the proximity to the coast, with more freshwater input from fluvial sources and potentially more mixing within the shallower depths, are likely to be the main reasons why no or less stratification is observed in the nearshore, compared to the offshore areas, with respect to both temperature and salinity (Figure 9-6).

With respect to the temperature and salinity stratification, it should be noted that there is no apparent connection where stratification occurs within the OAA, as stratification is present throughout the OAA at different depths (Figure 9-4). Within the offshore ECC, the sample locations are generally in deeper water depths and these points appear to correspond to areas with stronger stratification (based on the greater variance in temperature and salinity through the water column), whereas the rate of change in salinity within the OAA appears to be more gradual (Figure 9-4). Additionally, the potential variation in stratification between tidal conditions was analysed across the OAA and offshore ECC. For both temperature and salinity and based on replicate samples, stratification was more apparent on neap tides (as evidenced by neap tide samples W02, W06, W11 and W19), which had greater variation in salinity and temperature compared to spring tide samples. Further detail on thermal and salinity stratification throughout the offshore Project area is available in chapter 8: Marine physical and coastal processes and the supporting technical report (SS3: Marine physical and coastal processes supporting study).



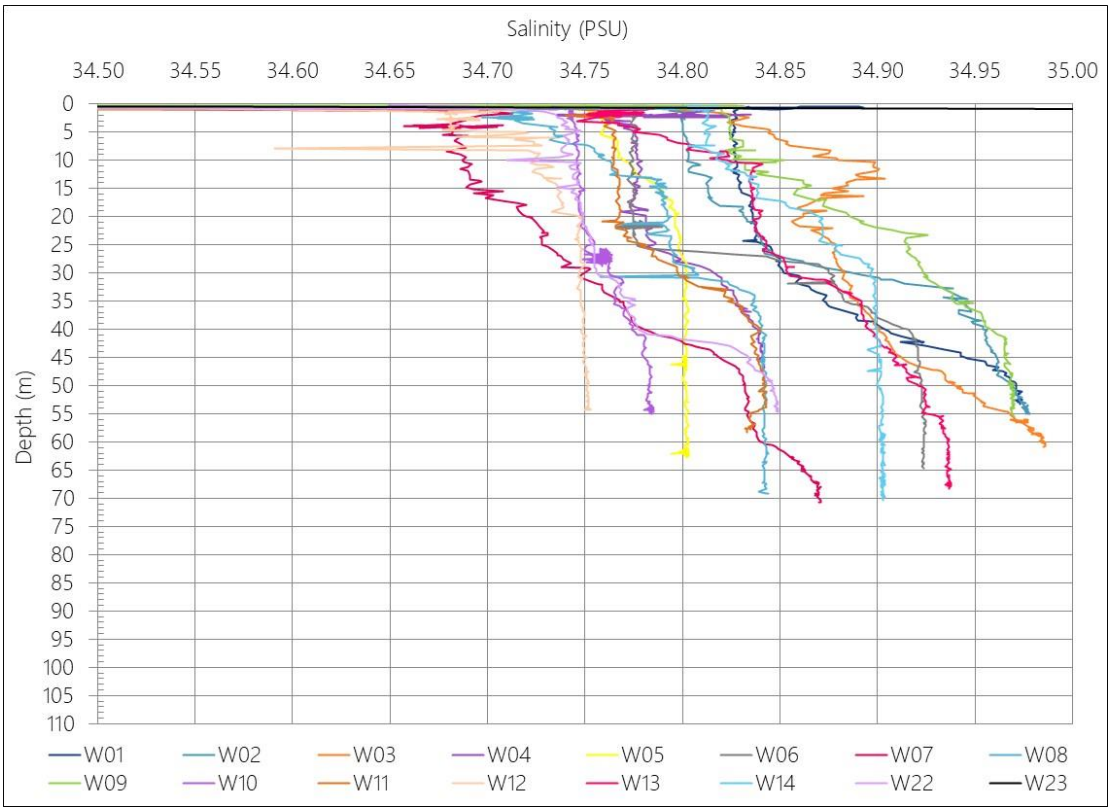


Figure 9-4 Temperature (top) and salinity (bottom) throughout the water column within the OAA (corresponding to locations in Figure 9-3)

Figure 9-5 Temperature (top) and salinity (bottom) throughout the water column within the offshore ECC (corresponding to locations in Figure 9-3)

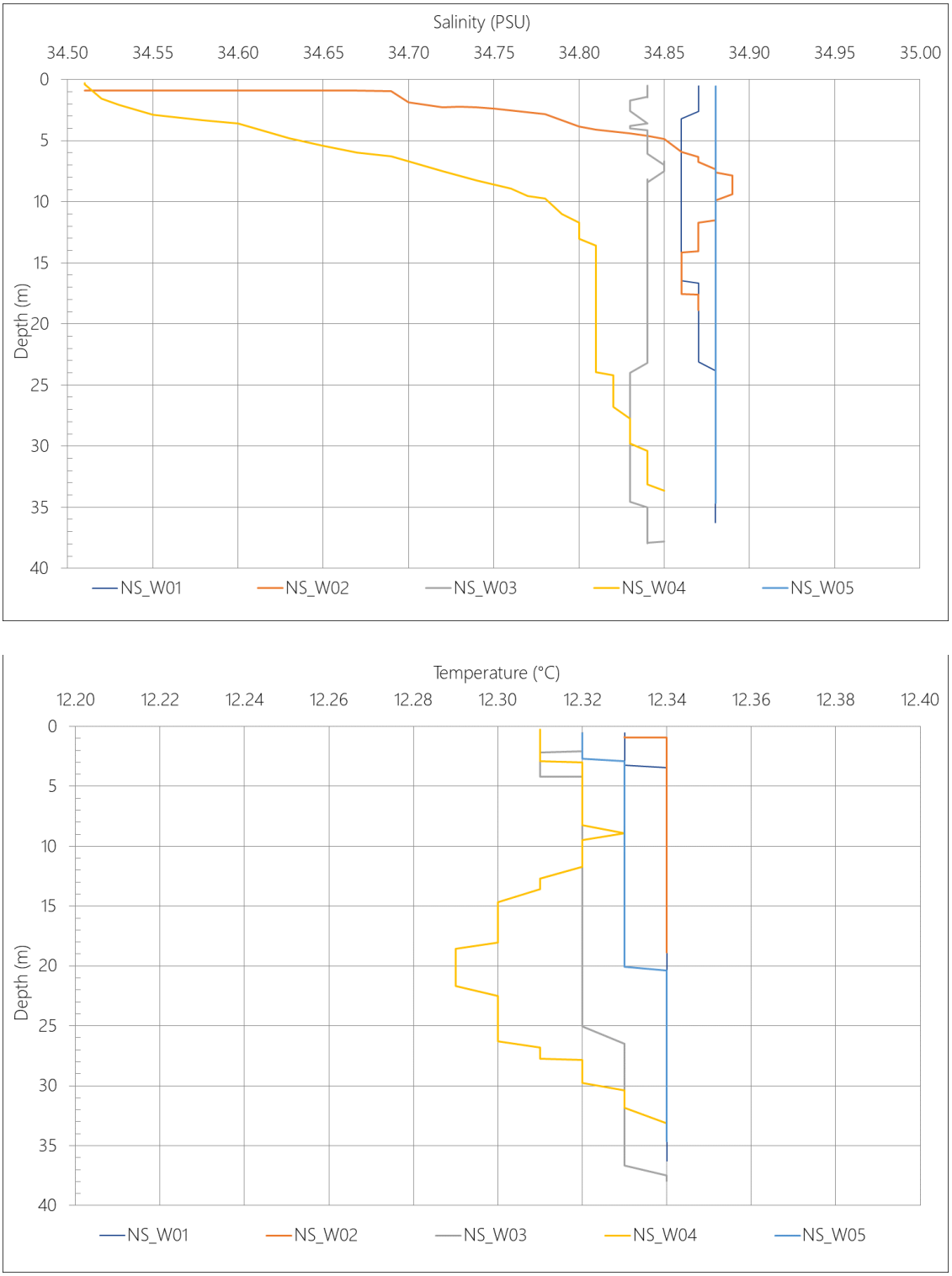


Figure 9-6 Temperature (top) and salinity (bottom) throughout the water column within the nearshore (corresponding to locations in Figure 9-3)

9.4.6.1.2 Suspended sediment concentration and dissolved oxygen

Baseline SSC across the study area have been established regionally based on long-term (1998 to 2015) satellite-derived monthly average non-algal SPM concentrations (Cefas, 2016a; Figure 9-7), as a proxy for SSC. The modelled SPM concentrations were greatest to the east of the OAA, which can be attributed to the proximity to the rocky coastline of Orkney and thus coastal erosion releasing sediment into the sea. Within the OAA, SPM concentrations can be considered relatively low, ranging from 0.7 to 1.0 g/l (Figure 9-7). Along the offshore ECC, SPM concentrations were lower, at 0.08 – 0.8 mg/l (Cefas, 2016a).

To further characterise SSC in the offshore Project area, water sampling for TSS analysis was undertaken as part of the site-specific survey, and turbidity was recorded throughout the water column profile (SS5: Benthic environmental baseline report). Water samples were collected from 29 samples from 25 locations across the offshore Project area (Figure 9-3). Seven were taken within the offshore ECC, 17 within the OAA and five across the nearshore. Eight samples (W01/W02, W05/W06, W10/W11, W18/W19) are replicates at four locations (across the OAA and offshore ECC) in order to capture different tidal conditions (spring/neap respectively).

A detailed characterisation of TSS concentrations throughout the water column is provided in Chapter 8: Marine physical and coastal processes and has informed the following description of TSS concentrations. The TSS concentrations throughout the water column, as recorded by the samples, is presented in Table 9-8. TSS is colour coded in accordance with the concentration; from <5 mg/l (darkest green) to 35 mg/l (darkest red) (Table 9-8).

Overall, most samples showed a TSS of <5 mg/l, which is in line with the general understanding of the region. There are no obvious differences in the TSS between spring and neap or flood and ebb conditions. Additionally, there were generally low background levels of SSC at typically <5 mg/l throughout the water column regardless of water depth. The TSS data show that, generally, higher concentrations are more common along the offshore ECC; however, the nearshore samples had lower TSS concentrations. Overall, as the majority of samples were taken on a spring tide, slightly higher TSS levels appear to be associated with spring tides (Table 9-8). Point W21 in a water depth of 79 m below Lowest Astronomical Tide (mLAT) is the only exception to this. The highest concentration occurred within the surface sample at W15 (35 mg/l), taken from the offshore ECC and associated with a spring flood tide. The increased levels in the offshore ECC are more likely in relation to the larger degree of finer sediment as described in section 9.4.6.3.

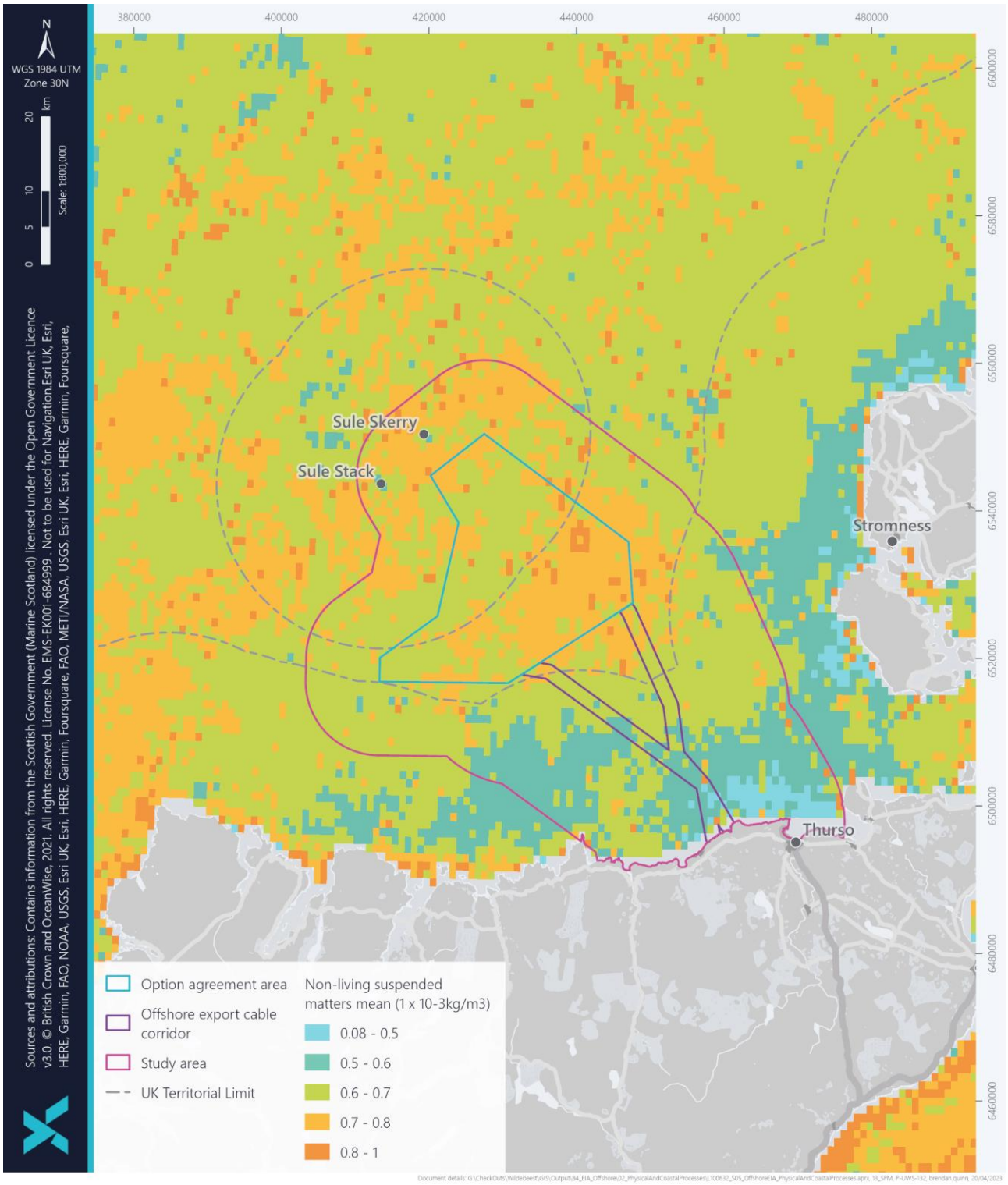


Figure 9-7 Monthly average SPM concentrations (Cefas, 2016a)

For two pairs of the replicate sample locations (i.e., W01/W02 and W04/W05), TSS concentrations were <5 mg/l. From the remaining two pairs of replicates (W10/W11 within the OAA and W18/W19 within the ECC), the measured TSS would seem to suggest, concentrations are higher on a neap tide, i.e., W11 and W19. However, as the number of

replicates is limited, it is not possible to conclude this with certainty, because based on the results from across the offshore ECC in general (irrespective) of replicates, higher concentrations occur, which may be a result of both the tidal flow and seabed sediment. Changes in TSS throughout the water column, of the samples taken, appear to indicate the highest concentration at the mid-point in the water depth.

Table 9-8 TSS concentrations throughout the water column (surface, mid, bottom) within the water and sediment quality offshore study area (corresponding to locations in Figure 9-3)

SAMPLE POINT		WATER DEPTH (MLAT)	SURFACE WATER DEPTH (MLAT)	MID WATER DEPTH (MLAT)	BOTTOM WATER DEPTH (MLAT)	SURFACE TOTAL SUSPENDED SOLIDS** (MG/L)	MID TOTAL SUSPENDED SOLIDS** (MG/L)	BOTTOM TOTAL SUSPENDED SOLIDS** (MG/L)
OAA	W01*	56	2	29	52	<5	<5	<5
	W02*	56	2	28	55	<5	<5	<5
	W03	61	2	31	56	<5	<5	<5
	W04	50	2	25	45	<5	<5	<5
	W05*	64	2	30	54	<5	<5	<5
	W06*	64	2	33	63	<5	<5	<5
	W07	69	2	35	66	<5	<5	<5
	W08	68	2	35	66	<5	<5	<5
	W09	57	2	30	54	24	<5	<5
	W10*	56	2	37	55	<5	<5	<5
	W11*	56	2	30	54	<5	19	<5
	W12	52	2	25	50	<5	6	<5
	W13	67	2	33	65	<5	<5	<5
	W14	72	2	37	69	<5	<5	<5
	W22	55	5	25	49	<5	<5	<5
	W23	81	5	40	76	<5	<5	<5
Offshore ECC	W15	85	2	40.5	82	35	11	23
	W16	84	2	44	83	<5	26	9
	W17	108	2	55	105	8	10	13
	W18*	88	2	44	83	<5	10	8
	W19*	88	2	46	87	7	23	10
	W20	83	2	40	81	7	31	<5
	W21	79	2	42	78	<5	<5	<5
	W24	57	2	30	56	<5	10	18

SAMPLE POINT		WATER DEPTH (MLAT)	SURFACE WATER DEPTH (MLAT)	MID WATER DEPTH (MLAT)	BOTTOM WATER DEPTH (MLAT)	SURFACE TOTAL SUSPENDED SOLIDS** (MG/L)	MID TOTAL SUSPENDED SOLIDS** (MG/L)	BOTTOM TOTAL SUSPENDED SOLIDS** (MG/L)
Nearshore	NS_W01	36	<2	19	36	<5	<5	<5
	NS_W02	19	<2	10	19	<5	<5	<5
	NS_W03	37	-	-	-	No Data		
	NS_W04	33	<2	15	33	<5	<5	<5
	NS_W05	34	<2	17	34	<5	<5	<5

*** Samples W01/W02, W05/W06, W10/W11, W18/W19 are replicates, taken during spring/neap tide respectively.**
**** TSS is colour coded in accordance with the concentration; from <5 mg/l (darkest green) to 35 mg/l (darkest red).**

DO was recorded throughout the water column for the 25 locations across the offshore Project area (section 9.4.3.2.2, Figure 9-3) associated with the CTD profiling. As a result, measured DO concentrations are available as profiles through the water column as illustrated in Figure 9-8 and Figure 9-9, with a statistical summary for each sampled location presented in Table 9-9. In the OSPAR Intermediate Assessment (2017b), a DO concentration of >6 mg/l near the seafloor is used as an indicator of a healthy marine environment. DO concentrations were >6 mg/l throughout the water column for each sampled location within the offshore Project area, based on the minimum and maximum levels (Table 9-9) and water column profiles (Figure 9-8; Figure 9-9). DO was also highest within the nearshore samples, which is attributed to its proximity to the coast and the additional mixing that occurs with waves and faster flows.

Stratification was also observed within the DO sampled from across the OAA and offshore ECC, with no stratification considered to be present in the nearshore samples (Figure 9-8; Figure 9-9). The extent of stratification differed between the OAA and offshore ECC, with the range of DO concentration being much broader within the offshore ECC, ranging between 7.1 mg/l and 8.4 mg/l, compared to the OAA where concentrations mostly ranged between 7.4 mg/l and 8.2 mg/l. Although isolated occurrences were measured at up to 9.3 mg/l at the very surface of -1 mLAT (Table 9-9). The lowest DO concentration was observed in the offshore ECC at W16 (7.1 mg/l) associated with an ebb tide. In the nearshore DO ranged between 8.1 mg/l and 8.3 mg/l, with the gradient reflecting natural variance due to water depth (Figure 9-9). With respect to the sampled replicate pairs across the OAA and offshore ECC, the mean DO concentrations ranged between 7.3 mg/l and 6.0 mg/l (Table 9-9).

As for thermal and salinity stratification (section 9.4.6.1.1), stratification also occurs with the recorded DO within the upper 30 m of the water column for samples across the OAA and offshore ECC, as surface waters are more oxygenated (Figure 9-8; Figure 9-9). No stratification was considered to exist for the samples acquired from the nearshore, instead the variation is considered to be a natural gradient with depth. The absence of stratification in the nearshore DO samples may be associated with various factors including the season when sampling, the shallower water depth, the proximity to the coast and increased mixing due to waves and faster flows. For the replicate pairs, DO stratification was more apparent on a neap tide as evidenced by all neap tide samples W02, W06, W11, W19 which had greater variation in DO than their respective spring tide samples (Figure 9-10). For the samples taken on the spring tide (W01, W05, W10 and W18), at W18_ the stratification occurs higher up in the water column at a water depth of -15 mLAT (Figure 9-10), while in the other spring samples from the OAA the stratification does not appear

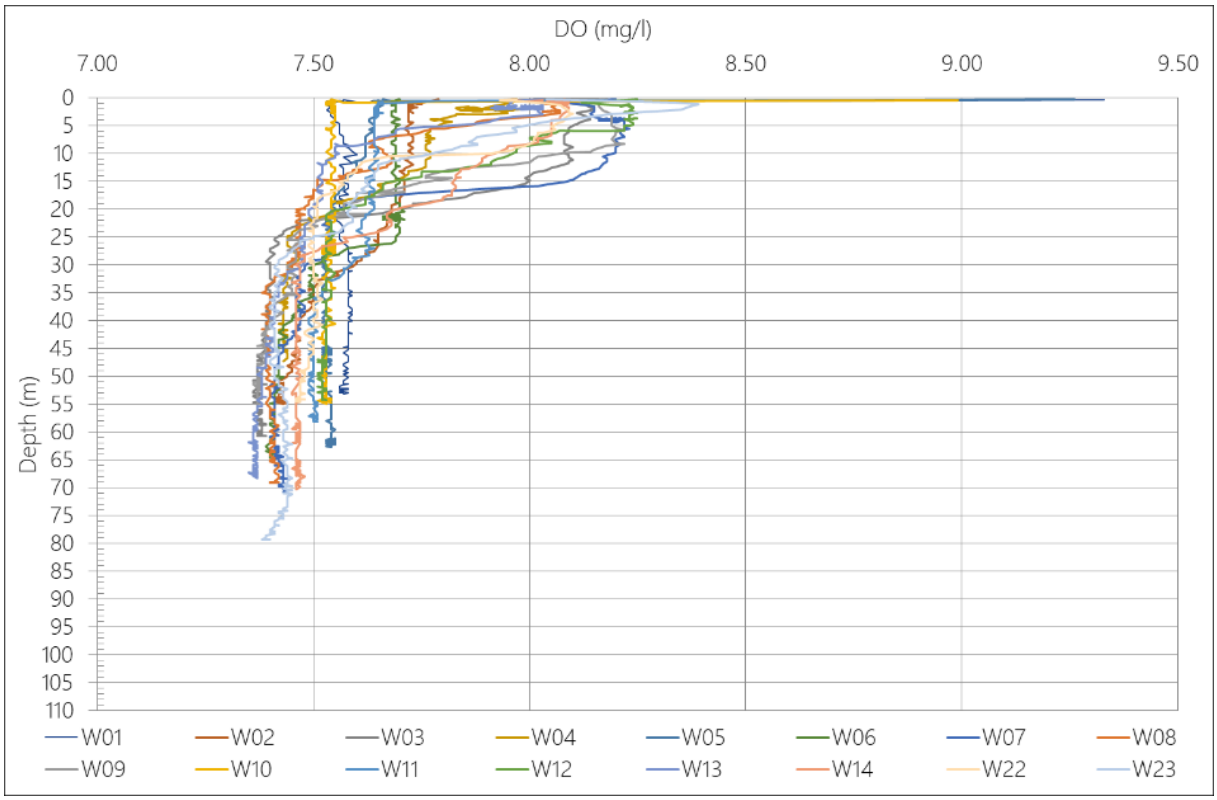
as prominent. Therefore, tidal flows associated with spring and neap conditions and water depth influence the presence of DO stratification.

Table 9-9 DO concentrations throughout the water column within the water and sediment quality offshore study area (corresponding to locations in Figure 9-3)

SAMPLE POINT		WATER DEPTH (MLAT)	MIN DISSOLVED OXYGEN (MG/L)	MAX DISSOLVED OXYGEN (MG/L)	MEAN DISSOLVED OXYGEN (MG/L)	SD DISSOLVED OXYGEN (MG/L)
OAA	W01*	56	7.53	9.33	7.59	0.15
	W02*	56	7.41	7.79	7.59	0.13
	W03	61	7.36	8.15	7.52	0.26
	W04	50	7.42	7.99	7.73	0.22
	W05*	64	7.52	9.26	7.56	0.11
	W06*	64	7.39	7.71	7.63	0.11
	W07	69	7.40	8.23	7.76	0.37
	W08	68	7.38	8.09	7.53	0.20
	W09	57	7.36	8.22	7.79	0.35
	W10*	56	7.51	8.99	7.54	0.06
	W11*	56	7.49	8.18	7.58	0.08
	W12	52	7.51	8.25	7.83	0.32
	W13	67	7.35	8.03	7.58	0.26
	W14	72	7.45	8.09	7.71	0.28
	W22	55	7.46	8.10	7.60	0.21
	W23	81	7.38	8.39	7.53	0.21
Offshore ECC	W15	85	7.20	8.79	7.42	0.26
	W16	84	7.10	8.32	7.36	0.26
	W17	108	7.32	8.17	7.49	0.24
	W18*	88	7.33	8.00	7.43	0.19
	W19*	88	7.28	7.91	7.71	0.25
	W20	83	7.43	7.69	7.47	0.02
	W21	79	7.26	8.56	7.71	0.34
	W24	57	7.53	7.71	7.58	0.04
	NS_W01	36	8.08	8.26	8.17	0.06
	NS_W02	18	8.12	8.25	8.17	0.03
	NS_W03	37	8.12	8.31	8.22	0.05

SAMPLE POINT	WATER DEPTH (MLAT)	MIN DISSOLVED OXYGEN (MG/L)	MAX DISSOLVED OXYGEN (MG/L)	MEAN DISSOLVED OXYGEN (MG/L)	SD DISSOLVED OXYGEN (MG/L)
NS_W04	33	8.16	8.36	8.28	0.06
NS_W05	34	8.08	8.26	8.17	0.06

* Samples W01/W02, W05/W06, W10/W11, W18/W19 are replicates of one another, taken during spring/neap tides.



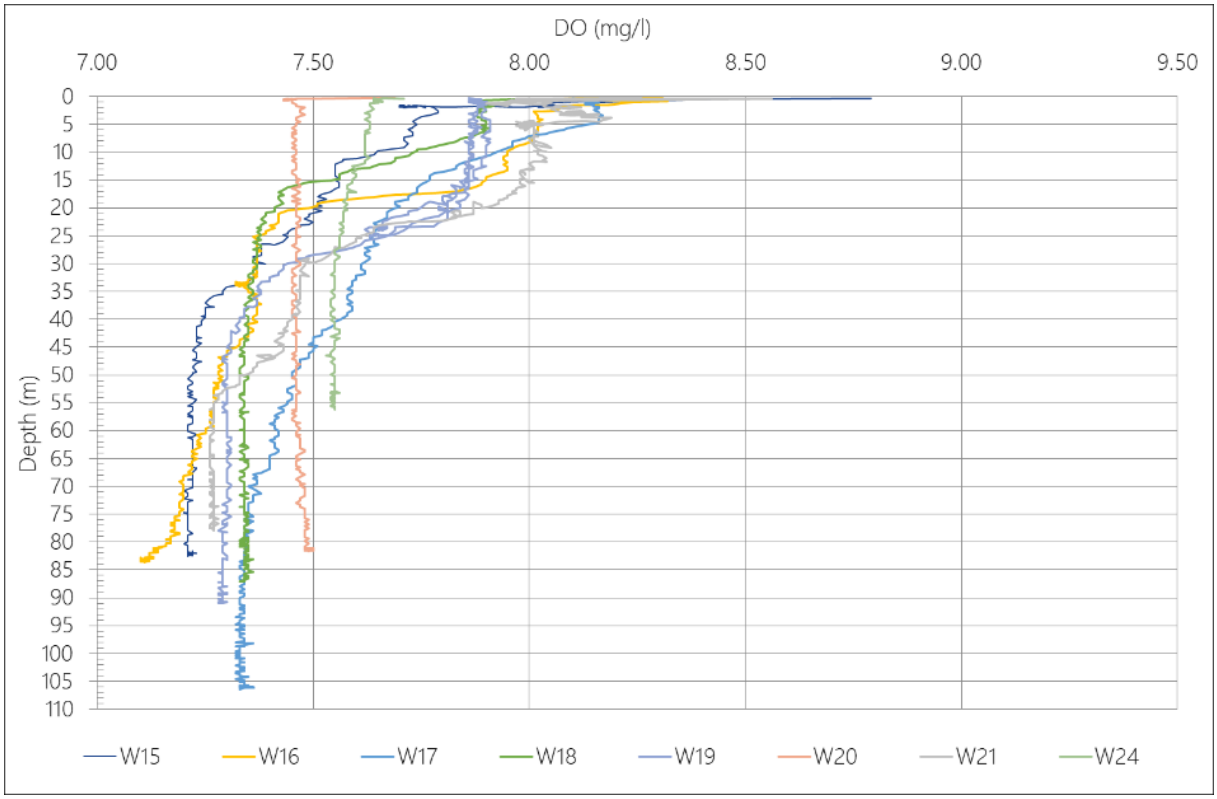


Figure 9-8 Dissolved oxygen profiles through the water column within the OAA (top) and offshore ECC (bottom) (corresponding to locations in Figure 9-3)

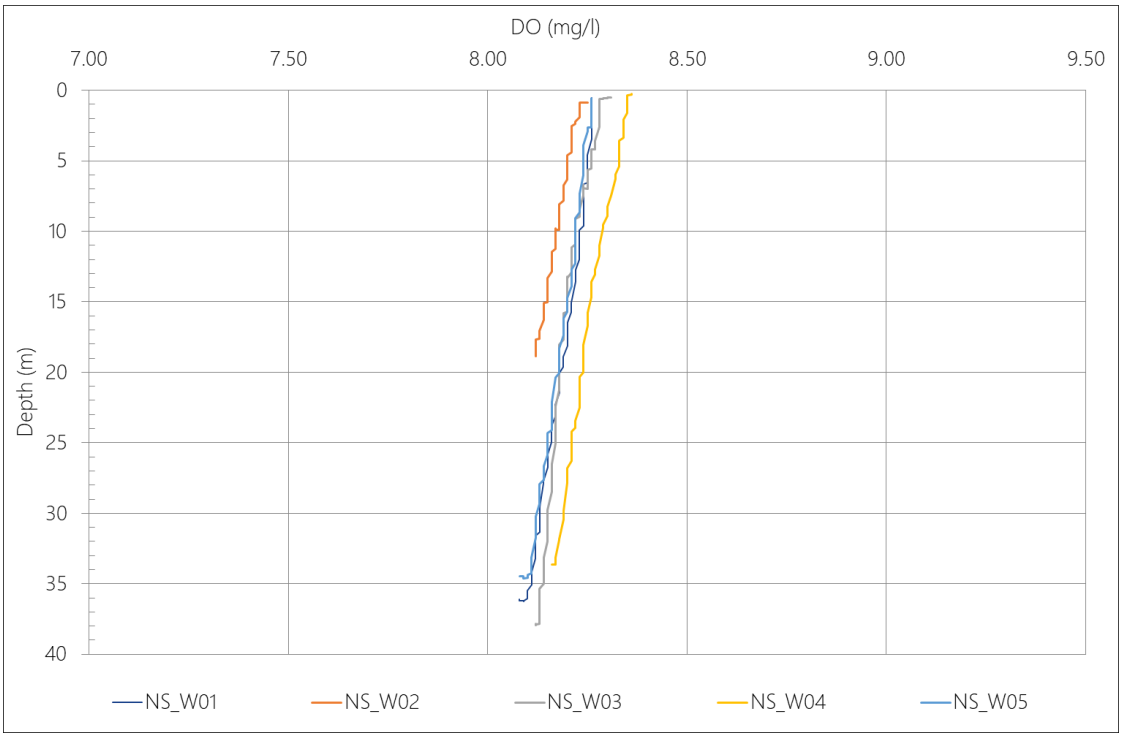


Figure 9-9 Dissolved oxygen profiles through the water column within the nearshore (corresponding to locations in Figure 9-3)

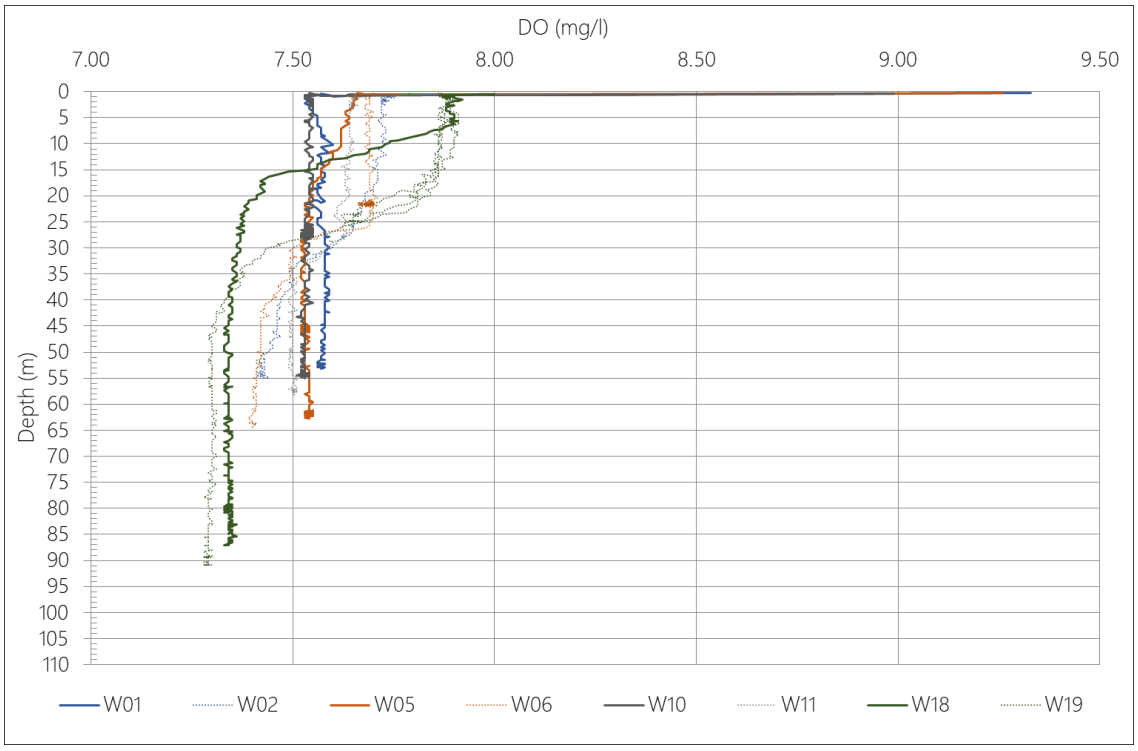


Figure 9-10 Dissolved oxygen profiles through the water column for the replicate pairs. Colours apply to the same locations, with thicker lines for spring observations and dashed lines neap observations

9.4.6.2 Water quality designated waters

SEPA is responsible for producing and implementing River Basin Management Plans (RBMPs) under the Water Environment and Water Services (Scotland) Act, 2003. River basins comprise all surface waters (including transitional (estuaries) and coastal waters) extending to 5.5 km (3 nautical miles (nm)) seaward from the Scottish territorial baseline. Any proposed development within these waters must have regard to the requirements of the WFD to ensure that all surface water bodies achieve 'Good Ecological Status' and that there is no deterioration in status. Five classifications of water quality status are defined: High (near natural), Good, Moderate, Poor and Bad; and each classification is accorded a degree of confidence (high, medium or low) in the overall quality assessment.

Water quality has been determined through an evaluation of the designated waterbodies, designated bathing waters, designated shellfish waters, and nitrate sensitive areas (i.e., urban wastewater treatment sensitive areas and nitrate vulnerable zones) within the water and sediment quality offshore study area. For the purpose of this chapter of the Offshore EIA Report, 'designated waters' is the collective term for all designations and the basis for which the impact assessment is completed (Figure 9-11).

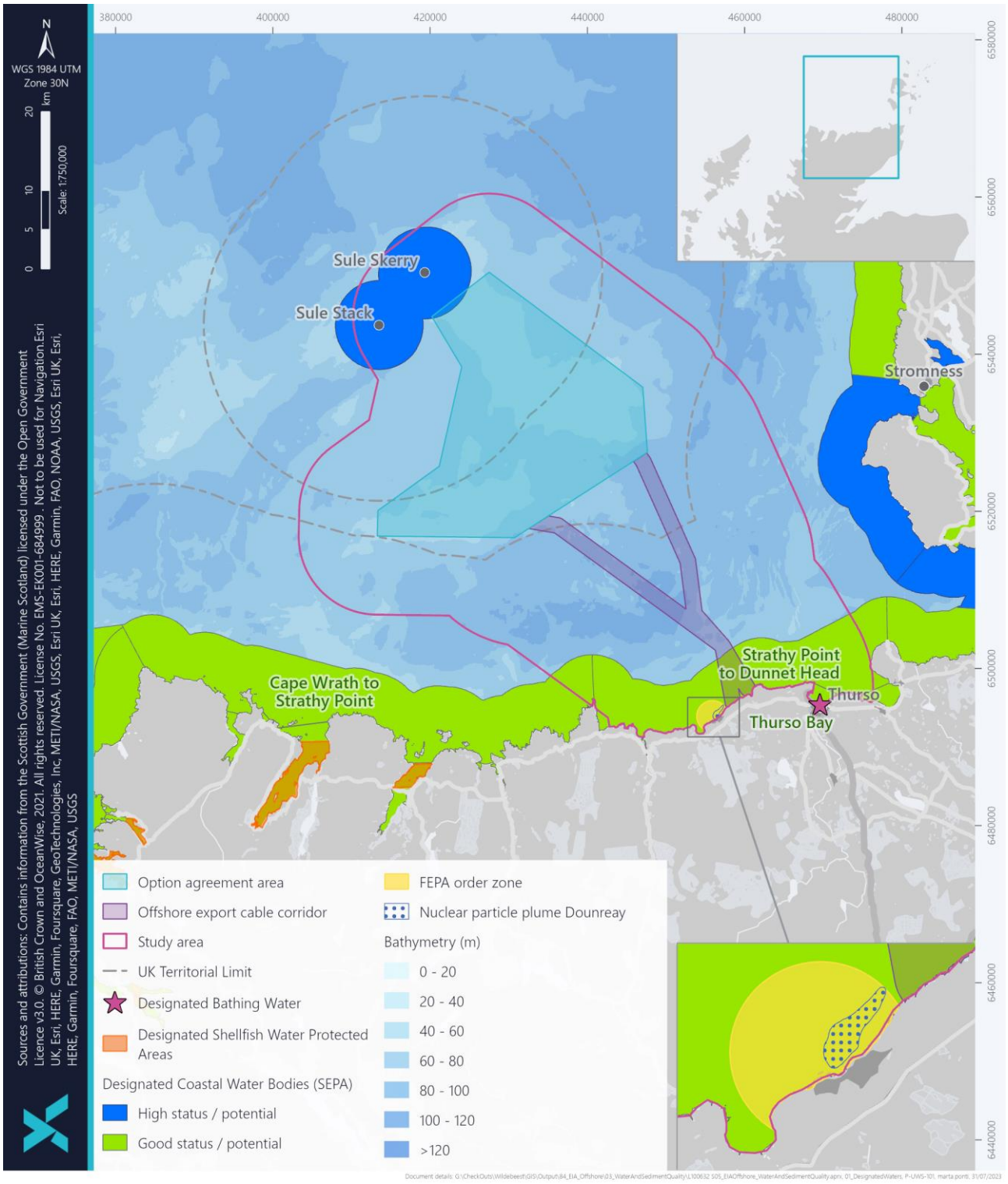


Figure 9-11 Designated waters within the water and sediment quality offshore study area

9.4.6.2.1 Designated coastal waterbodies

The offshore Project area intersects the following designated coastal waterbodies (Figure 9-11):

- Strathy Point to Dunnet Head (ID: 200224) at the cable landfalls; and
- Sule Skerry and Sule Stack (ID: 200239) - a very slight overlap in the extreme north of the OAA.

In addition, the water and sediment quality offshore study area overlaps with the following coastal waterbodies (Figure 9-11):

- Cape Wrath to Strathy Point (ID: 200223) – located approximately 10 km from the offshore ECC; and
- Thurso Bay (ID: 200218) – located approximately 7 km from the offshore ECC.

A summary of the condition of each of these designated coastal waterbodies is included in Table 9-10, whilst a description is provided below.

The Sule Skerry and Sule Stack waterbody has an area of 195.2 km^2 (SEPA, 2023b). The offshore Project slightly overlaps with this waterbody for 3.5 km^2, accounting for 1.8% of the overall waterbody area. The annual classification of water environment condition (2014 – 2020) indicates that Sule Skerry and Sule Stack has an overall status of 'High' with an overall ecology status of 'High' (SEPA, 2023a). The most recent overall chemistry status was listed as 'Pass' with 'Low' confidence in the 2012 water body classification (SEPA, 2012). There were no pressures identified on this waterbody. The condition projections from 2014 and future projections (Table 9-10) list the overall status as 'High' High' physical condition, 'High' freedom from invasive species, and 'High' water quality (SEPA, 2023b).

The Strathy Point to Dunnet Head waterbody has an area of 275.1 km^2 (SEPA, 2023b). The offshore Project overlaps with this waterbody for 20.4 km^2, accounting for 7.45% of the overall waterbody area. The annual classification of water environment condition (2014 – 2020) indicates that Strathy Point to Dunnet Head has an overall status of 'Good' with an overall ecology status of 'Good' (SEPA, 2023a). The most recent overall chemistry status was listed as 'Pass' with 'Low' confidence in the 2012 water body classification (SEPA, 2012). The identified pressures to this waterbody were from point source pollution, specifically from sewage disposal, which could contribute to the waterbody's failure to meet good ecological status and the improved overall status (SEPA, 2012). The condition projections from 2014 and future projections (Table 9-10) list the overall status as 'Good' with 'High' physical condition, 'High' freedom from invasive species, and 'Good' water quality (SEPA, 2023b).

Cape Wrath to Strathy Point has an area of 439.1 km^2 (SEPA, 2023b). The water and sediment quality offshore study area overlaps with waterbody for 20.3 km^2, accounting for 6.7% of the overall waterbody area. The annual classification of water environment condition (2014 – 2020) indicates that Cape Wrath to Strathy Point has an overall status of 'Good' with an overall ecology status of 'Good' (SEPA, 2023a). The most recent overall chemistry status was listed as 'Pass' with 'Low' confidence in the 2012 water body classification (SEPA, 2012). There were no pressures identified on this waterbody. The condition projections from 2014 and future projections (Table 9-10) list the overall status as 'Good' with 'High' physical condition, 'High' freedom from invasive species, and 'Good' water quality (SEPA, 2023b).

Thurso Bay has an area of 5.8 km^2 (SEPA, 2023b). This waterbody is entirely within the water and sediment quality offshore study area. The annual classification of water environment condition (2014 – 2020) indicates that Thurso Bay

has an overall status of 'Good' with an overall ecology status of 'Good' (SEPA, 2023a). The most recent overall chemistry status was listed as 'Pass' with 'Low' confidence in the 2012 water body classification (SEPA, 2012). There were no pressures identified on this waterbody. The condition projections from 2014 and future projections (Table 9-10) list the overall status as 'Good' with 'Good' physical condition, 'High' freedom from invasive species, and 'Good' water quality (SEPA, 2023b).

Table 9-10 Summary of the condition of designated waterbodies in the water and sediment quality offshore study area (SEPA, 2023b)

WATERBODY	CONDITION	2014	2021	2027	LONG-TERM
Sule Skerry and Sule Stack (195.2 km^2)	Overall	High	High	High	High
	Physical condition	High	High	High	High
	Freedom from invasive species	High	High	High	High
	Water quality	High	High	High	High
Strathy Point to Dunnet Head (275.1 km^2)	Overall	Good	Good	Good	Good
	Physical condition	High	High	High	High
	Freedom from invasive species	High	High	High	High
	Water quality	Good	Good	Good	Good
Thurso Bay (5.8 km^2)	Overall	Good	Good	Good	Good
	Physical condition	Good	Good	Good	Good
	Freedom from invasive species	High	High	High	High
	Water quality	Good	Good	Good	Good
Cape Wrath to Strathy Point (439.1 km^2)	Overall	Good	Good	Good	Good
	Physical condition	High	High	High	High
	Freedom from invasive species	High	High	High	High
	Water quality	Good	Good	Good	Good

9.4.6.2.2 Designated bathing water

The water and sediment quality offshore study area overlaps with the Thurso (ID: UKS7616019) designated bathing water at approximately 7 km east of the offshore ECC (Figure 9-11). The Dunnet Bay (ID: UKS7616085) designated bathing water is located 18 km east of the offshore ECC; however, Dunnet Bay is beyond the tidal excursion extent denoted by the water and sediment quality offshore study area and is therefore not considered further (Figure 9-11).

In accordance with the Bathing Water Directive (2006/7/EC), the annual bathing water quality is classified as 'Excellent', 'Good', 'Sufficient', or 'Poor.' The annual bathing water classification is determined using statistics (average value and range of values) calculated from results taken over the previous four years. The water quality indicators SEPA test for are the bacteria *Escherichia coli* (E. coli) and *Intestinal enterococci* (IE). Single sample results above 500 E. Coli and 200 IE are indicative of low water quality when the sample was taken (SEPA, 2022).

The Thurso designated bathing water is listed in 'Good' condition for the 2022 season (SEPA, 2023c) (Table 9-11). Thurso has maintained 'Good' condition for the previous years; however, the condition was lower at 'Sufficient' for the 2017/18 season. In the 2017/18 season, E. Coli was recorded at 10,000 Colony Forming Unit (cfu) / 100 ml, and IE was recorded at 800 cfu / 100 ml and 3,800 cfu / 100 ml (SEPA, 2023c). The principal risks and source of wet weather driven short term pollution at this bathing water arise from surface water urban drainage, agricultural run-off, combined sewer overflows and treated sewage effluent and as such the waterbody is also classified as an urban wastewater treatment directive sensitive area. The identified pressures are mainly terrestrial and in relation to operations occurring within the catchment of the River Thurso, which discharges into Thurso Bay. At present there are no identified pressures from the marine environment. Specifically, there is no risk from overproduction or excessive growth of Cyanobacteria (blue-green algae) or algae (SEPA, 2020c)

Table 9-11 Summary of the condition of designated bathing water in the water and sediment quality offshore study area (SEPA, 2023c)

SITE	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23
Thurso	Sufficient	Good	Good	No data	Good	Good

9.4.6.2.3 Designated shellfish waters protected areas

There are no designated shellfish waters which intersect with the water and sediment quality offshore study area.

The nearest are the Loch Eriboll shellfish water protected area (ID: SWPA35), which is harvested for blue mussel and Pacific oysters, and the Kyle of Tongue shellfish water protected area (ID: SWPA22), which is harvested for Pacific oysters. These shellfish waters are approximately 27 and 29 km west of the offshore ECC respectively (Figure 9-11). Due to the intervening distance between the water and sediment quality offshore study area and these designated shellfish waters, it is unlikely that any localised impacts on water quality from the offshore Project activities would negatively impact upon the water quality of these designated shellfish waters, therefore, no further assessment is required. The status of fisheries of commercial importance are discussed in chapter 14: Commercial fisheries.

9.4.6.2.4 Nitrate sensitive areas

Urban wastewater treatment sensitive areas

The Urban Waste Water Treatment Directive Sensitive Areas 2019 map (SEPA, 2020b) details the areas in Scotland that have been designated as sensitive to the effects of sewage discharges in accordance with the Urban Waste Water Treatment (Scotland) Regulations 2003. These sensitive areas include lochs, rivers, estuaries, designated bathing waters, and designated shellfish water protected areas. The only urban wastewater treatment sensitive area within the water and sediment quality offshore study area is the Thurso designated bathing water (see section 9.4.6.2.2). However, it is noted that the parameters relating to this sensitive area are to do with terrestrial factors.

Nitrate vulnerable zones

The primary source of nitrate is from agricultural diffuse pollution (SEPA, 2023a). Areas where nitrate concentrations in groundwater exceed, or are likely to exceed, the standard level (50 mg/l) set out in Nitrates Directive (91/676/EEC) are designated as NVZs (SEPA, 2023d; Scottish Government, 2023).

There are currently five NVZs in Scotland, with the Scottish Government reviewing designations every four years, and SEPA monitoring the nitrate concentrations in the surface and ground waters. NVZs are mainly terrestrial and associated with agricultural lands; however, the waterways connect to the coastline, and excess nitrate concentrations can lead to algal blooms and eutrophication in estuaries and transitional waters. The closest NVZ is the Moray, Aberdeenshire/Banff and Buchan NVZ (Scottish Government, 2015b) which is over 100 km away. Given the distance between the water and sediment quality offshore study area and these nitrate vulnerable zones, there is no pathway for impacts, and therefore no further assessment is required.

9.4.6.3 Seabed sediment properties

Seabed sediment across the northwest continental shelf is dominated by coarse sediment varying between sand and gravel, with large regions of gravelly sand (and variations of this) and sandy gravel illustrated in Figure 9-12 and Figure 9-13 (British Geological Survey (BGS), 2023). BGS (2023) indicates a dominance of gravelly sand across the OAA and slightly gravelly sand across the offshore ECC, although across the water and sediment quality offshore study area, the following typologies are present:

- Gravelly sand;
- Slightly gravelly sand;
- Sand; and
- Sandy gravel.

BGS seabed sediment along with site-specific sediment classification across the water and sediment quality offshore study area is illustrated in Figure 9-12 and Figure 9-13. The results of the PSA from site-specific surveys confirmed the seabed sediment mainly comprises a coarse sediment fraction, with marginally more fine sediment occurring within the offshore ECC, and sand in the nearshore, although mean grain sizes were highly variable (SS5: Benthic environmental baseline report). The overall mean sediment size within the water and sediment quality offshore study area was 1.50 mm, which is classed as very coarse sand (SS5: Benthic environmental baseline report). Within the OAA specifically, the mean sediment size was 2.21 mm. Most samples were described as being medium or coarse sand or

very fine/fine gravels. Along the ECC, generally sediment sizes were smaller, with an average size of 0.80 mm. In the nearshore, average sediment size was around 0.5 mm, i.e., medium to coarse sand. On the whole, sand of varying sizes is present in all samples from across the water and sediment quality offshore study area at varying proportions, with gravel, silt and finer sediment also occurring at lower proportions and less frequently. As a result, sediments across the whole offshore Project area are generally classed as poorly to moderately sorted (SS5: Benthic environmental baseline report). Additionally, throughout the offshore Project area there was a frequent occurrence and wide distribution of cobbles (i.e., 64-75 millimetre (mm)) and boulders (measuring >75 mm). These cobbles and boulders commonly occur as "fields" across the offshore Project area, but also as isolated targets identified in geophysical surveys. Images of seabed sediment associated with sediment classification are illustrated in Figure 9-12 and Figure 9-13, while the distribution of coarse sediment illustrated by surveyed backscatter from across the offshore Project area is presented in Figure 9-14.

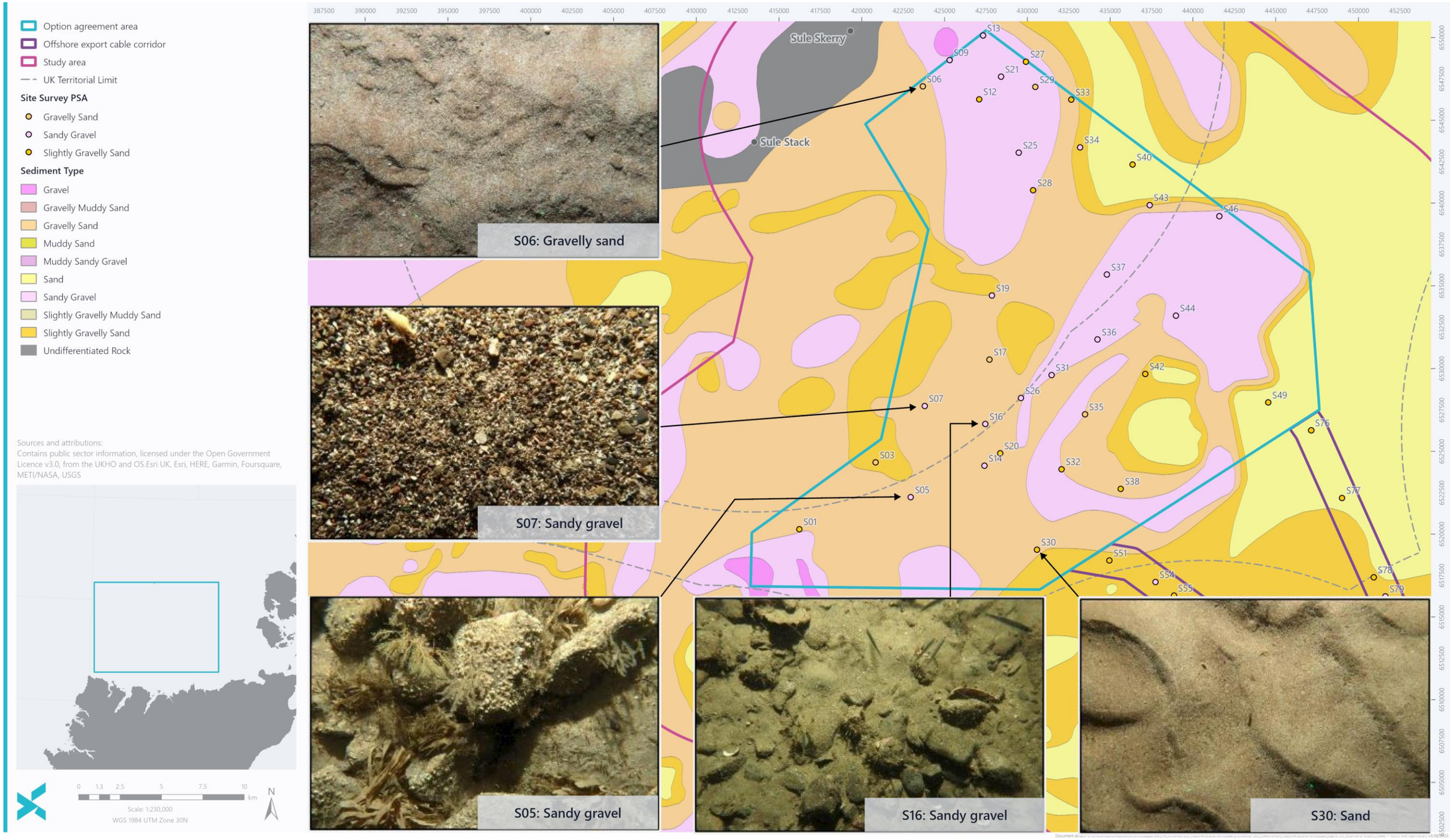


Figure 9-12 Sediments classified from grab samples within the OAA (SS5: Benthic environmental baseline report)

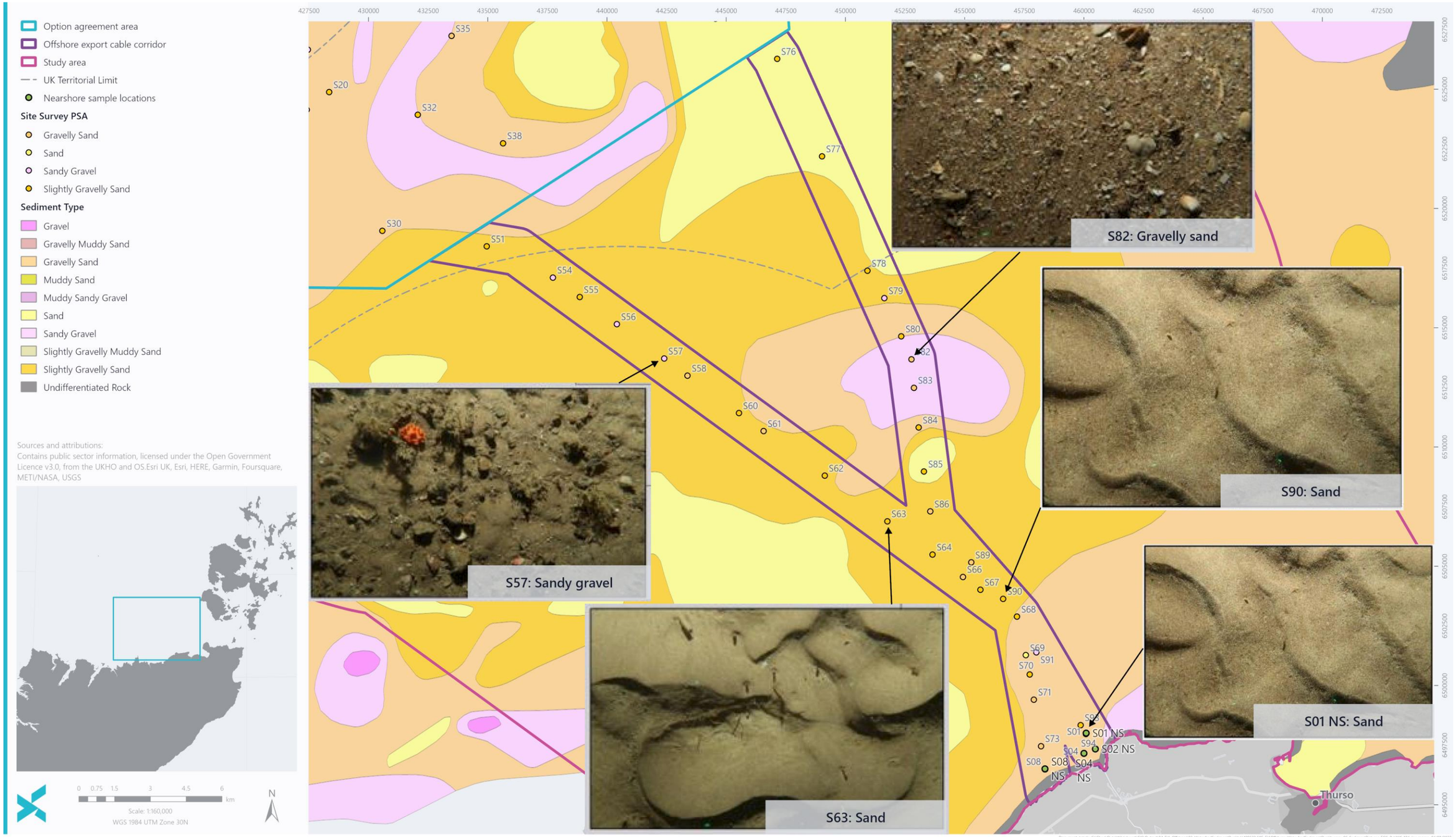


Figure 9-13 Sediments classified from grab samples within the ECC (SS5: Benthic environmental baseline report)

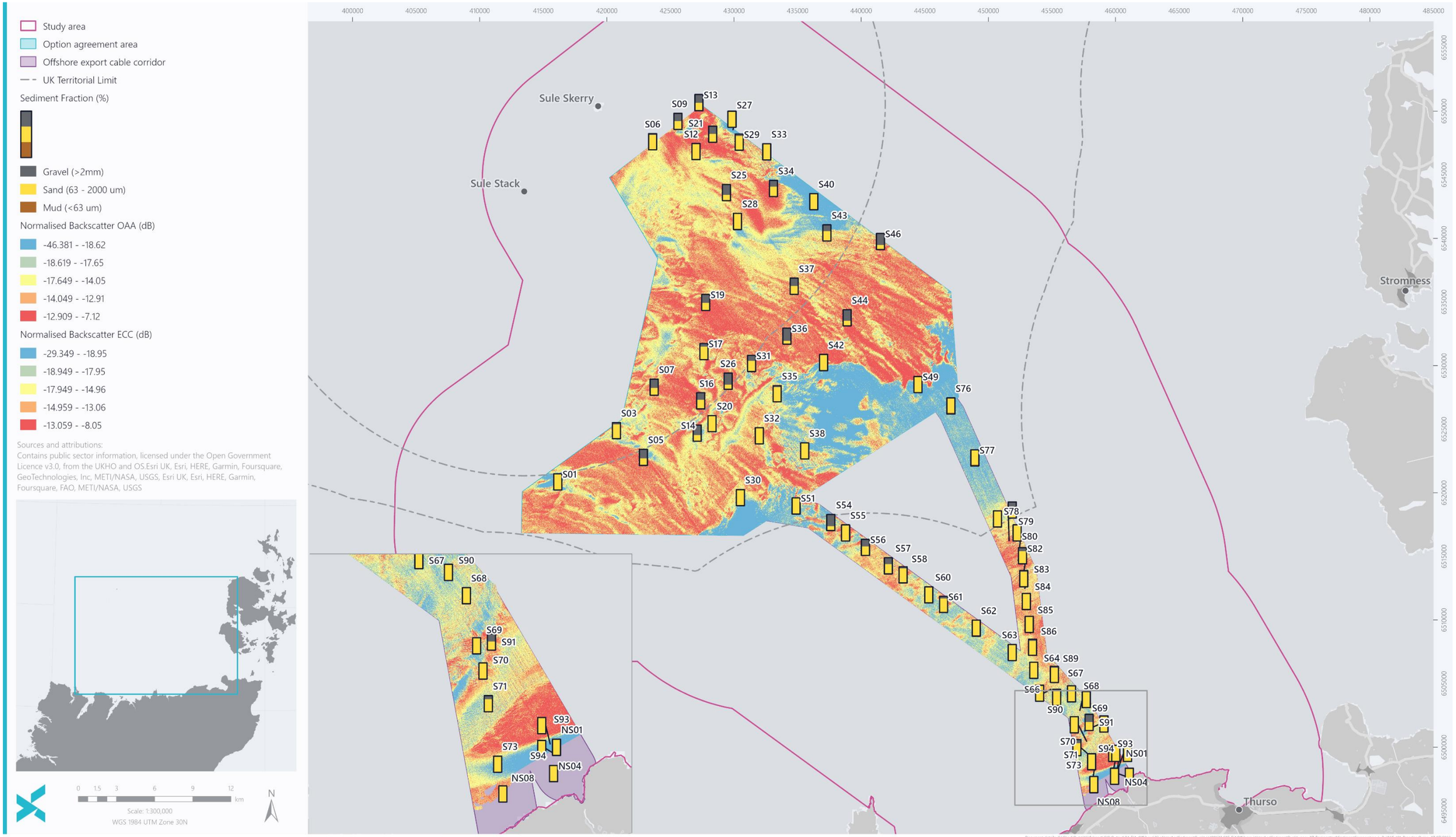


Figure 9-14 Overview of PSA results superimposed with backscatter data (SS5: Benthic environmental baseline report). Due to operational and technical difficulties impairing the dataset the nearshore backscatter data was excluded. Thus, the nearshore data presented is compiled from the primary geophysical data (SSS, MBES, ground truthing)

9.4.6.4 Sediment quality

9.4.6.4.1 Overview

The Marine Scotland 2019 assessment of CSEMP data describes the status and trends of contaminant concentrations in biota and sediment at monitoring stations around the UK between 2013 and 2018. The water and sediment quality offshore study area is within the North Scotland Coast[9] CSEMP monitoring region (Marine Scotland, 2019). There are no fixed CSEMP locations or strata recording sediment chemistry and contaminants for the North Scotland Coast region. The closest monitoring stations to the water and sediment quality offshore study area which provides robust sediment quality datasets are the North Minch Station (located approximately 110 km west) and the Outer Moray Firth Station (located approximately 75 km east). These locations are situated too far from the water and sediment quality offshore study area to supplement any assumptions related to sediment quality in the area. A 2011 review of the status of the marine environment of the northern coastal area of Scotland identified no significant concerns relating to hazardous substances, eutrophication, oil/chemical spills, algal toxins and microbiology of bathing and shellfish waters (Baxter *et al.*, 2011). Review of the Cefas Sediment Management Framework Action Level tool (Cefas, 2023) did not identify any contaminants within or in proximity to the study area, with the closest contaminants occurring within the Cromarty Firth (located within the Moray Firth).

9.4.6.4.2 Site-specific sediment chemistry and contamination analysis results

As introduced in section 9.4.3.2.1, samples for sediment chemistry and contaminants analyses were obtained at a total of 59 locations. For the analyses of pesticides and flame retardants (OCP and PBDE), samples were successfully collected from a total of 29 locations. The results of the analyses are summarised in the sections below, with further information contained within SS5: Benthic environmental baseline report.

Metals

From the 59 acquired samples, 56 were located offshore (25 in the OAA, 31 in the offshore ECC, and three in the nearshore (SS5: Benthic environmental baseline report. In terms of metals samples analysed (see Table 9-12), the only exceedances recorded within the samples obtained were arsenic and nickel. For arsenic, four samples in the OAA marginally exceeded the CCME ISQG/TEL criteria (S07, S34, S44, S46) and three within the offshore ECC also exceeded these criterion (S82, S83, S90) (Figure 9-2). These exceedances were also below the Cefas AL1 and significantly less than the ISQG/PEL criteria. Nickel concentrations marginally exceeded the Cefas AL1 criteria at four sample locations across the OAA (S43; S44; S46; S49) and four sample locations in the offshore ECC (S54, S76, S80, S91) (Figure 9-2). Nevertheless, all nickel exceedances were well below the Cefas AL2 criteria. As none of the exceedances for arsenic or nickel are above the Cefas AL2 criteria, this highlights that all samples would qualify for disposal at sea. Ocean Infinity reported no geographical trends in the arsenic and nickel concentrations; but the levels in the samples taken in the offshore ECC were lower than those from the OAA (SS5: Benthic environmental baseline report).

[9] *The North Scotland Coast CSEMP monitoring region is located within the Scottish Continental Shelf biogeographic region, encompassing from the northern tip of the Isle of Lewis across to the north coast of Scotland and around the Orkney Islands. A map illustrating the CSEMP monitoring regions is available online at: https://data.marine.gov.scot/sites/default/files//CSEMP%20regions_1.pdf.*

*Table 9-12 Metal concentrations (mg/kg dry weight) in samples with threshold values (highlighted cells indicate exceedances) (SS5: Benthic environmental baseline report) *Not included in statistical analyses of min and max*

ANALYTE	AS	CR	CU	NI	PB	ZN	CD	HG
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
Limit of Detection (LoD)	0.5	0.5	0.5	0.5	0.5	2	0.04	0.01
CEFAS AL1	20	40	40	20	50	130	0.4	0.3
CEFAS AL2	100	400	400	200	500	800	5	3
CCME ISQG	7.24	52.3	18.7	-	30.2	124	0.7	0.13
CCME PEL	41.6	160	108	-	112	271	4.2	0.7
Dutch RIVM	85	380	190	210	580	2000	14	10
S01	4.6	5.0	3.5	5.7	4.2	11.7	<0.04*	<0.01*
S03	6.0	7.0	4.1	9.0	4.8	9.8	0.05	<0.01*
S06	2.0	5.2	1.9	5.3	1.4	7.0	0.10	<0.01*
S07	10.2	18.0	6.7	18.1	6.4	33.3	<0.04*	<0.01*
S12	3.2	3.9	2.9	4.6	2.1	7.5	0.06	<0.01*
S13	6.3	6.5	3.6	8.2	7.7	15.6	0.09	<0.01*
S16	4.8	6.0	3.5	5.7	4.1	10.5	0.12	<0.01*
S17	6.6	6.4	2.5	8.0	4.3	10.8	<0.04*	<0.01*
S19	6.1	8.9	5.4	8.0	4.7	15.5	<0.04*	<0.01*
S20	3.6	5.0	2.5	7.3	3.0	7.6	<0.04*	<0.01*
S25	5.1	8.8	5.0	10.1	5.0	14.1	<0.04*	<0.01*
S27	2.4	3.7	2.1	3.9	1.5	7.9	<0.04*	<0.01*
S28	1.8	5.1	2.7	5.9	1.8	11.6	<0.04*	<0.01*
S30	3.0	4.2	2.6	6.2	2.1	8.5	<0.04*	<0.01*
S31	3.3	3.7	2.1	3.9	2.7	6.4	<0.04*	<0.01*

ANALYTE	AS	CR	CU	NI	PB	ZN	CD	HG
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
S33	1.8	2.9	2.1	3.3	1.4	6.0	<0.04*	<0.01*
S34	8.8	10.2	5.1	12.3	5.4	17.9	<0.04*	<0.01*
S35	3.8	4.6	2.4	3.7	1.9	5.7	<0.04*	<0.01*
S38	5.6	5.3	3.3	6.1	2.7	9.4	<0.04*	<0.01*
S40	2.6	6.0	3.0	13.4	1.8	8.6	<0.04*	<0.01*
S42	2.3	5.4	3.7	13.1	2.0	15.6	<0.04*	<0.01*
S43	6.9	11.1	5.3	21.5	4.1	19.0	<0.04*	<0.01*
S44	11.1	20.5	8.6	23.7	15.5	34.7	<0.04*	<0.01*
S46	17.8	18.9	8.5	39.3	15.1	36.0	<0.04*	<0.01*
S49	2.2	7.2	3.6	29.5	1.9	12.3	<0.04*	<0.01*
S51	3.6	6.2	2.9	14.2	2.4	10.0	<0.04*	<0.01*
S54	3.1	6.8	4.0	21.3	1.7	14.1	<0.04*	<0.01*
S55	<0.5	1.0	<0.5	4.9	<0.5	2.7	<0.04*	<0.01*
S56	<0.5	0.7	1.0	6.4	<0.5	2.8	<0.04*	<0.01*
S57	6.6	11.7	3.9	9.8	5.3	18.2	<0.04*	<0.01*
S58	5.2	7.5	2.8	6.0	5.5	12.0	<0.04*	<0.01*
S60	6.0	8.6	3.9	5.3	6.7	13.3	<0.04*	<0.01*
S62	2.7	9.8	3.0	6.2	4.9	15.3	<0.04*	<0.01*
S63	2.8	8.2	2.6	5.3	4.6	13.0	<0.04*	<0.01*
S64	7.2	29.4	3.0	6.7	6.7	13.0	<0.04*	<0.01*
S67	6.9	16.8	3.4	11.2	4.8	16.4	<0.04*	<0.01*
S68	5.8	7.2	2.1	4.9	3.8	11.0	<0.04*	<0.01*
S69	5.8	5.4	2.1	4.4	2.3	8.7	<0.04*	<0.01*
S70	4.1	5.8	2.3	4.6	2.4	11.2	<0.04*	<0.01*
S71	4.7	3.5	2.7	10.7	3.9	30.9	<0.04*	<0.01*

ANALYTE	AS	CR	CU	NI	PB	ZN	CD	HG
UNITS	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG	MG/KG
S73	4.2	4.9	3.5	13.0	3.6	9.4	<0.04*	<0.01*
S76	1.8	8.6	4.1	22.4	4.2	14.0	<0.04*	<0.01*
S77	3.3	5.9	3.1	6.8	4.9	11.8	<0.04*	<0.01*
S78	3.2	8.0	3.3	7.9	4.9	11.8	<0.04*	<0.01*
S79	6.3	12.3	5.2	15.9	5.4	22.1	<0.04*	<0.01*
S80	4.5	11.8	4.1	34.8	5.4	15.2	<0.04*	<0.01*
S82	13.3	8.3	4.1	12.9	8.3	15.8	<0.04*	<0.01*
S83	8.9	10.5	3.5	9.3	6.9	14.3	<0.04*	<0.01*
S84	4.0	6.9	3.8	8.1	4.5	9.4	<0.04*	<0.01*
S85	4.5	8.9	7.0	11.3	5.6	12.9	<0.04*	<0.01*
S86	5.7	13.0	3.4	15.4	4.8	12.6	<0.04*	<0.01*
S89	6.1	7.6	3.5	6.7	4.5	9.2	<0.04*	<0.01*
S90	10.6	11.0	4.1	12.5	5.5	15.4	<0.04*	<0.01*
S91	5.1	5.2	2.9	20.1	6.9	13.0	<0.04*	<0.01*
S93	7.1	7.7	2.8	14.1	2.4	16.4	<0.04*	<0.01*
S94	4.3	5.7	2.3	6.4	1.6	8.8	<0.04*	<0.01*
S001	5.7	6.3	4.9	6.8	2.6	12.1	<0.04*	0.02
S004	5.0	6.8	3.5	5.8	2.5	11.4	<0.04*	0.02
S008	3.8	8.1	3.4	5.1	2.1	10.4	<0.04*	0.01
Min	1.8	0.7	1.0	3.3	1.4	2.7	0.05	0.01
Max	17.8	29.4	8.6	39.3	15.5	36.0	0.12	0.02
Median	4.8	6.9	3.4	8.0	4.2	12.0	0.09	0.02

*Not included in statistical analyses of Min, Max and Median
Highlighted cells indicate instances where samples exceed guidance thresholds for specific analytes, with the guidance threshold also represented by the same colour.

Organics

Throughout the 59 sampled and analysed locations, TOM ranged from 0.8% to 2.4% and TOC ranged from 0.06% to 0.56% (Table 9-13). The minimum value for both TOM and TOC was observed in the OAA (0.8% and 0.06%) (S27), whereas the maximum value for TOM was in the offshore ECC (2.4%) (S76) and the maximum value for TOC was observed in the offshore ECC (0.56%) (S56) (Table 9-13; Figure 9-2). Overall, organic material is considered to be low across the offshore Project area.

Table 9-13 Percentage (%) of Total Organic Matter (TOM) and Total Organic Carbon (TOC) in samples (SS5: Benthic environmental baseline report)

SAMPLE ID	TOTAL ORGANIC MATTER	TOTAL ORGANIC CARBON	SAMPLE ID	TOTAL ORGANIC MATTER	TOTAL ORGANIC CARBON
UNITS	%	%	UNITS	%	%
LoD	0.2	0.02	LoD	0.2	0.02
S01	1.1	0.19	S58	1.9	0.24
S03	1.5	0.25	S60	1.7	0.29
S06	1.7	0.29	S62	1.7	0.29
S07	1.0	0.21	S63	1.9	0.29
S12	1.5	0.25	S64	1.7	0.22
S13	1.8	0.29	S67	1.5	0.20
S16	1.6	0.25	S68	1.2	0.14
S17	1.8	0.21	S69	0.9	0.11
S19	1.2	0.19	S70	1.4	0.16
S20	1.6	0.16	S71	1.8	0.20
S25	1.4	0.21	S73	2.3	0.20
S27	0.8	0.06	S76	2.4	0.32
S28	1.6	0.14	S77	2.1	0.31
S30	1.2	0.12	S78	1.0	0.23
S31	1.7	0.17	S79	1.5	0.22
S33	0.9	0.08	S80	1.2	0.10
S34	1.6	0.15	S82	1.5	0.21
S35	1.7	0.14	S83	1.5	0.23
S38	1.4	0.10	S84	1.2	0.11
S40	1.2	0.09	S85	1.2	0.14
S42	2.0	0.12	S86	1.6	0.20
S43	1.2	0.11	S89	1.6	0.21

SAMPLE ID	TOTAL ORGANIC MATTER	TOTAL ORGANIC CARBON	SAMPLE ID	TOTAL ORGANIC MATTER	TOTAL ORGANIC CARBON
S44	1.0	0.13	S90	1.4	0.19
S46	1.1	0.11	S91	2.2	0.25
S49	1.1	0.12	S93	1.9	0.18
S51	1.4	0.14	S94	1.4	0.16
S54	1.7	0.55	S001	1.5	0.16
S55	1.2	0.35	S004	1.5	0.23
S56	1.7	0.56	S008	0.9	0.13
S57	1.6	0.17			

Organotins (MBT, DBT & TBT)

Concentrations of MBT, DBT, and TBT were analysed across 57 sampled locations, with 26 in the OAA, 31 in the offshore EC, and none in the nearshore area. For all sampled locations, concentrations of organotins were recorded at less than 0.001 mg/kg, below the LoD (0.001 mg/kg) and did not exceed the Cefas AL1 threshold (0.1 mg/kg) or the Cefas AL2 threshold (1 mg/kg). Therefore, the concentrations of organotins are not considered to be a concern across the offshore Project area.

Hydrocarbons

For hydrocarbons (PAH and THC), there were 26 locations sampled in the OAA, 31 locations in the offshore ECC, and three in the nearshore.

Levels of THC were found to be low but variable across the offshore Project area, ranging from <1,000 µg/kg to 27,600 µg/kg in the offshore ECC (S89) (Figure 9-2); however, site S89 had notably higher concentrations compared to the rest of the offshore Project area. Even then, site S89 is several orders of magnitude lower than the Dutch RIVM standard and can be considered a single isolated incidence. No concentrations exceeded the Dutch RIVM thresholds (5,000,000 µg/kg) (Table 9-14), indicating that the concentration of THC is not considered to be a concern across the offshore Project area.

In terms of PAH, concentrations in the OAA were very low and generally below the LoD (1 µg/kg) but variable throughout the offshore ECC. There were three locations in the nearshore area (S001, S004, S008) (Figure 9-2) that marginally exceeded the CCME ISQG thresholds for acenapthylene (5.87 µg/kg) and dibenzo[a,h]anthracene (6.22 µg/kg). Nonetheless, these exceedances were significantly less than the ISQG/PEL and Cefas AL1 thresholds. As such this indicates that all samples obtained would be suitable for disposal at sea. Overall, PAH concentrations were notably

higher nearshore, as most evident in the Sum of the 16 EPA PAHs (∑EPA 16 PAH[10]) which ranged from 320.50 µg/kg to 520.02 µg/kg in the nearshore but ranged from 0.00 to 184.12 in the OAA and offshore ECC (see Table 9-14). The reason for greater occurrences of PAH above LoD in the nearshore is due to the proximity to the coast and the potential for terrestrial input into the marine environment. Nonetheless the analyses results for the compounds indicate that these present no risk from the offshore Project.

[10] The sum of 16 EPA PAHs (∑EPA 16 PAH) represents the 16 polycyclic aromatic hydrocarbons (PAH) identified by the United States Environment Protection Agency (US EPA) as 'priority pollutants' and are now a standard measurement. These include Naphthalene, Acenaphthylene, Acenaphthene, Fluorene, Anthracene, Phenanthrene, Fluoranthene, Pyrene, Benz[a]anthracene, Chrysene, Benzo[b]fluoranthene, Benzo[k]fluoranthene, Benzo[a]pyrene, Dibenz[ah]anthracene, Indeno9123cd]pyrene, and Benzo[ghi]perylene.

Table 9-14 PAH and THC concentrations (microgram per kilogram (µg/kg) dry weight) in samples with threshold values (Highlighted cells indicate where threshold values have been exceeded) (SS5: Benthic environmental baseline report)

ANALYTE	ACENAPHTHENE	ACENAPHTHYLENE	ANTHRACENE	BENZO[A]ANTHRACENE	BENZO[A]PYRENE	BENZO[B]FLUORANTHENE	BENZO[GHI]PERYLENE	BENZO[E]PYRENE*	BENZO[K]FLUORANTHENE	CHRYSENE	DIBENZO[A,H]ANTHRACENE	FLUORANTHENE	FLUORENE	INDENO[123,CD]PYRENE	NAPHTHALENE	PERYLENE *	PHENANTHRENE	PYRENE	∑EPA 16 PAH	THC
UNIT	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
LoD	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1,000
Cefas AL1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	-	-
CCME ISQG	6.71	5.87	46.9	74.8	88.8	-	-	-	-	108	6.22	113	21.2	-	34.6	-	86.7	153	-	-
CCME PEL	88.9	128	245	693	763	-	-	-	-	846	135	1494	144	-	391	-	544	1398	-	-
Dutch RIVM	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5,000,000
S01	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S03	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,360
S06	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	3,040
S07	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	13,600
S09	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S12	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,180
S13	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	5,410
S16	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S17	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	3,270
S19	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S20	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S25	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,090
S27	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,050
S28	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,010
S30	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,240
S31	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S33	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S34	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	7,040
S35	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	2,740
S38	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S40	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S42	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S43	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S44	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,010
S46	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	5,280
S49	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S51	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S54	<1	<1	<1	<1	<1	1.32	<1	1.34	<1	<1	<1	<1	<1	1.69	1.35	<1	1.24	<1	5.60	3,270

ANALYTE	ACENAPHTHENE	ACENAPHTHYLENE	ANTHRACENE	BENZO[A]ANTHRACENE	BENZO[A]PYRENE	BENZO[B]FLUORANTHENE	BENZO[GHI]PERYLENE	BENZO[E]PYRENE*	BENZO[K]FLUORANTHENE	CHRYSENE	DIBENZO[A,H]ANTHRACENE	FLUORANTHENE	FLUORENE	INDENO[123,CD]PYRENE	NAPHTHALENE	PERYLENE *	PHENANTHRENE	PYRENE	∑EPA 16 PAH	THC
UNIT	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
S55	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.04	<1	<1	<1	<1	1.04	<1,000
S56	<1	<1	<1	<1	<1	1.35	<1	1.10	<1	<1	<1	<1	<1	1.42	<1	<1	<1	<1	2.77	<1,000
S57	<1	<1	<1	<1	<1	1.42	1.03	1.53	1.03	<1	<1	<1	<1	1.88	1.33	<1	1.17	<1	7.86	<1,000
S58	<1	<1	<1	<1	<1	2.00	1.21	1.44	1.13	1.06	<1	<1	<1	1.59	<1	<1	1.58	<1	8.57	4,280
S60	<1	<1	<1	<1	<1	2.32	1.47	2.37	1.63	1.11	<1	1.02	<1	3.05	1.06	<1	1.78	<1	13.44	<1,000
S62	<1	<1	<1	<1	<1	1.27	<1	1.41	1.02	<1	<1	<1	<1	1.64	1.29	<1	<1	<1	5.22	<1,000
S63	<1	<1	<1	<1	<1	1.87	1.14	1.62	1.57	<1	<1	<1	<1	2.07	<1	<1	<1	<1	6.65	1,030
S64	<1	<1	<1	<1	<1	1.96	1.23	1.52	1.61	<1	<1	<1	<1	2.08	<1	<1	<1	<1	6.88	1,120
S67	<1	<1	<1	<1	<1	1.95	1.15	1.15	1.34	<1	<1	<1	<1	1.45	<1	<1	<1	<1	5.89	<1,000
S68	<1	<1	<1	4.68	5.95	6.03	4.12	4.54	5.13	5.45	<1	6.51	<1	4.59	<1	1.51	1.26	6.30	50.02	1,490
S69	<1	<1	<1	<1	<1	1.05	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.05	1,500
S70	<1	<1	<1	<1	<1	1.72	<1	1.18	1.16	<1	<1	<1	<1	1.01	<1	<1	<1	<1	3.89	1,750
S71	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S73	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	2,820
S76	<1	<1	<1	<1	<1	2.80	3.44	2.05	2.12	1.22	<1	1.35	<1	3.94	<1	<1	1.83	<1	16.70	1,310
S77	<1	<1	<1	<1	<1	2.32	2.35	1.40	1.38	<1	<1	<1	<1	2.82	1.35	<1	1.33	<1	11.55	1,650
S78	<1	<1	<1	<1	<1	1.40	1.46	<1	1.22	<1	<1	<1	<1	1.76	<1	<1	<1	<1	5.84	<1,000
S79	<1	<1	<1	<1	<1	1.33	<1	1.09	<1	<1	<1	<1	<1	1.31	<1	<1	<1	<1	2.64	<1,000
S80	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S82	<1	<1	<1	<1	<1	1.54	1.19	1.25	<1	1.23	<1	<1	<1	1.35	<1	<1	1.71	<1	7.02	2,420
S83	<1	<1	<1	<1	<1	1.50	1.30	1.13	<1	<1	<1	<1	<1	1.58	<1	<1	1.40	<1	5.78	<1,000
S84	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.13	<1	<1	<1	<1	1.13	<1,000
S85	<1	<1	<1	<1	<1	1.08	<1	<1	<1	<1	<1	<1	<1	1.09	<1	<1	<1	<1	2.17	<1,000
S86	<1	<1	<1	<1	<1	1.78	1.41	1.18	<1	<1	<1	<1	<1	1.90	<1	<1	<1	<1	5.09	<1,000
S89	3.38	<1	9.19	14.0	13.1	11.2	7.35	8.14	10.8	13.8	1.69	30.4	3.07	8.61	5.13	3.11	28.6	23.8	184.12	27,600
S90	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	<1,000
S91	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	0.00	1,750
S93	<1	<1	<1	<1	<1	1.66	<1	1.27	1.44	1.58	<1	<1	<1	<1	<1	<1	<1	<1	4.68	17,900
S94	<1	<1	<1	<1	<1	2.42	<1	1.58	1.60	1.62	<1	1.02	<1	1.03	<1	<1	<1	<1	7.69	11,500
S001	2.49	5.66	6.93	18.5	29.0	33.3	35.2	20.2	33.1	21.9	6.44	32.7	3.25	40.0	7.83	12.5	16.9	27.3	320.50	26,600
S004	1.89	7.54	6.03	19.5	33.2	37.3	37.8	21.2	33.9	23.3	7.17	28.2	3.02	42.8	5.38	12.0	15.2	23.4	325.63	19,900
S008	3.20	8.40	11.6	36.2	46.9	51.7	53.2	30.2	51.6	40.4	10.50	57.6	4.62	59.9	10.8	17.6	25.2	48.2	520.02	3,230

PCBs

PCB concentrations were analysed across 60 locations, with a total of 57 offshore and three nearshore. Samples were taken from 26 locations in the OAA, 31 in the offshore ECC, and three nearshore. As shown in Table 9-15, there were only seven locations where PCB concentrations exceeded the LoD (0.00008 µg/kg) with four in the OAA, two in the offshore ECC, and one nearshore (S06, S28, S33, S34, S68, S69) (Table 9-15; Figure 9-2).

The sum of ICES 7 (∑PCB7) concentrations did not exceed the Cefas AL1 threshold (10 µg/kg) but did very marginally exceed the Dutch RIVM threshold (1 µg/kg) at two locations in the OAA at 1.08 µg/kg (S06) and 1.05 µg/kg (S34). The slight exceedance here would not suggest that there was a serious level of PCB contamination within the OAA. The sum of 25 congeners (∑PCB25) did not exceed the Cefas AL2 threshold (200 µg/kg), CCME ISQG threshold (21.5 µg/kg), or CCME PEL threshold (189 µg/kg), indicating that all samples obtained were suitable for disposal at sea. As with the other sediment chemistry and contaminants results, PCBs are not considered to be a concern across the offshore Project area.

Table 9-15 PCB concentrations (µg/kg) in samples exceeding the LoD (0.00008 µg/kg) for all PCBs as well as the sum of ICES 7 (∑PCB7) (µg/kg) and sum of 25 congeners (∑PCB25) (µg/kg) (SS5: Benthic environmental baseline report)

ANALYTE	PCB 18	PCB 28	PCB 31	PCB 44	PCB 47	PCB 49	PCB 52	PCB 66	PCB 101	PCB 105	PCB 110	PCB 118	PCB 128	PCB 138	PCB 141	PCB 149	PCB 151	PCB 153	PCB 156	PCB 158	PCB 170	PCB 180	PCB 183	PCB 187	PCB 194	∑PCB7	∑PCB25
UNIT	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG	µG/KG
LoD	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	-	-
Cefas AL1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	20
Cefas AL2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	200
CCME ISQG	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	21.5
CCME PEL	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	189
S06	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.12	0.10	0.34	0.20	0.28	0.39	0.23	0.29	0.21	0.16	0.22	0.30	0.25	0.31	0.25	0.27	0.20	0.27	1.08	4.39
S28	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.14	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.14	0.14
S33	<0.08	<0.08	<0.08	0.17	<0.08	0.11	0.27	0.12	0.21	<0.08	0.23	0.09	<0.08	<0.08	<0.08	0.12	<0.08	0.09	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.66	1.41
S34	<0.08	0.09	0.11	0.14	0.13	0.12	0.14	0.16	0.17	0.13	0.17	0.18	0.10	0.13	0.21	0.16	0.15	0.18	0.13	0.16	0.14	0.16	0.16	0.14	0.15	1.05	3.51
S68	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.09	0.14	<0.08	0.13	0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.22	0.44
S69	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	<0.08	0.09	0.09	0.14	0.12	0.15	0.12	0.13	0.09	0.12	0.13	0.15	0.16	0.13	0.13	0.16	0.11	0.15	0.14	0.68	2.31
S04	0.15	0.15	0.25	0.29	0.22	0.19	0.17	0.25	0.15	0.17	0.25	0.17	0.16	<0.08	0.14	0.18	0.12	0.12	<0.08	<0.08	0.09	0.08	<0.08	<0.08	0.17	0.84	3.47

Pesticides (OCP) and flame retardants (PBDE)

Samples for pesticides (OCP) and flame retardants (PBDE) were planned at 32 locations offshore, but due to the coarse sediment, samples from 26 locations offshore were acquired. Nearshore samples were achieved for three of the four planned locations. Samples for the OCP and PBDE analysis were acquired from 29 locations overall, with eight in the OAA, 18 in the offshore ECC, and three in the nearshore.

Throughout the offshore Project area OCP concentrations were below the LoD (0.1 µg/kg) except at three locations: in the OAA (S27), offshore ECC (S71), and nearshore (S004). Dieldrin concentrations were recorded at 0.1 µg/kg (S27), 0.2 µg/kg (S71), and 0.4 µg/kg (S004), concentrations of p,p'-Dichlorodiphenyldichloroethane (PPTDE) were recorded at 0.3 µg/kg (S004), and concentrations of p,p'-Dichlorodiphenyldichloroethylene (PPDDE) were recorded at 0.2 µg/kg (S004) (Table 9-16; Figure 9-2). The Cefas AL1 threshold was not exceeded for dieldrin (5 µg/kg) or p,p'-Dichlorodiphenyltrichloroethane (PPDDT) (1 µg/kg). The CCME ISQG thresholds for PPTDE (1.22 µg/kg), PPDDE (2.07 µg/kg), and PPDDT (1.19 µg/kg), and the CCME PEL thresholds for PPTDE (7.81 µg/kg), PPDDE (374 µg/kg), and PPDDT (4.77 µg/kg) were not exceeded.

PBDE concentrations only exceeded the LoD (0.05 µg/kg with the exception of 0.1 µg/kg for BDE 209) at 19 locations (S28, S30, S38, S49, S51, S55, S56, S62, S64, S67, S70, S71, S73, S76, S82, S89, S001, S004, S008) with four in the OAA, 12 in the offshore ECC, and three nearshore (Table 9-17; Figure 9-2). PBDE concentrations were above LoD for BDE 47 in the offshore ECC (S76), BDE 66 in the offshore ECC and (S51, S76), and BDE 209 for all locations (Table 9-17).

Based on the sampling results, OCPs and PBDEs are again not considered to be a concern across the offshore Project area.

Table 9-16 OCP concentrations (µg/kg dry weight) in grab samples exceeding LoDs, with threshold values (SS5: Benthic environmental baseline report

ANALYTE	ALPHA-HEXACHLOROCYCLOHEXANE	BETA-HEXACHLOROCYCLOHEXANE	GAMMA-HEXACHLOROCYCLOHEXANE	DIELDRIN	HEXACHLOROBENZENE	P,P'-DICHLORODIPHENYL DICHLOROETHANE	P,P'-DICHLORO DIPHENYLDICHLOROETHYLENE	P,P'-DICHLORO DIPHENYLTRICHLOROETHANE
LoD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cefas AL1	-	-	-	5	-	-	-	1
Cefas AL2	-	-	-	-	-	-	-	-
CCME ISQG	-	-	-	-	-	1.22	2.07	1.19
CCME PEL	-	-	-	-	-	7.81	374	4.77
S27	<0.1	<0.1	<0.1	0.1	<0.1	<0.1	<0.1	<0.1
S71	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	<0.1	<0.1
S004	<0.1	<0.1	<0.1	0.4	<0.1	0.3	0.2	<0.1

Table 9-17 PDBE concentrations (µg/kg dry weight) in grab samples (SS5: Benthic environmental baseline report)

ANALYTE	BDE17	BDE28	BDE47	BDE66	BDE85	BDE99	BDE100	BDE138	BDE153	BDE154	BDE183	BDE209	∑PBDE
UNIT	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg	µg/kg
LOD	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.1	-
S01	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S17	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S27	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S28	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.15	0.15
S30	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.32	0.32

ANALYTE	BDE17	BDE28	BDE47	BDE66	BDE85	BDE99	BDE100	BDE138	BDE153	BDE154	BDE183	BDE209	∑PBDE
S38	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.18	0.18
S40	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S49	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.19	0.19
S51	<0.05	<0.05	<0.05	0.06	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	2.30	2.36
S54	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S55	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.19	0.19
S56	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.55	0.55
S62	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.20	1.20
S64	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.42	0.42
S67	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.11
S70	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.33	0.33
S71	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.54	0.54
S73	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	8.75	8.83
S76	<0.05	<0.05	0.05	0.08	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.91	2.04
S77	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S78	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S82	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.40	1.40
S84	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S89	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.18	0.18
S90	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S93	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1	0.00
S001	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.47	0.47
S004	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.53	0.53
S008	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.2	0.00

9.4.6.4.3 Sediment quality information from the Pentland Floating Offshore Wind Farm (PFOWF)

An analysis of sediment chemistry and contaminants was undertaken to support the Pentland Floating Offshore Wind Farm (PFOWF) application. The survey area for the PFOWF is located approximately 2 km west of the offshore Project. No hydrocarbons, PAHs, or PCBs were above Cefas Action Levels or CCME ISQG/TEL standards. The only contaminant above Cefas AL2 criteria was nickel which was identified offshore within the array area with levels of 1,284 mg/kg. This is several times over the Cefas Action Levels. However, as nickel was only identified at such levels at the one site, it was interpreted that the contaminant is most likely an isolated and localised occurrence (HWL, 2022a). Overall, it was found that there was a low to negligible occurrence of contaminants, and it would be unlikely that any significant chemical contamination would be encountered within the Marine Licence application areas (HWL, 2022a). These findings are therefore comparable to those identified through the offshore Project site-specific surveys.

9.4.6.5 Historic radioactive contamination

The Dounreay and Vulcan nuclear sites are located on the north coast of Caithness, to the west of Greeny Geo landfall. As a result of operational reprocessing during the 1960s and 1970s, radioactive particles were released into the sea via a discharge pipeline located centrally in the FEPA Order Zone (Figure 9-15) that extends approximately 600 m offshore, as part of the Liquid Effluent Discharge System (LEDS) that was in place until 1992 (Dounreay Particles Advisory Group, 2006).

The inventory of radioactive particles in the marine environment is not known, however, the Dounreay Particles Advisory Group estimate some several hundred thousand particles may have been discharged from the historic LEDS. A number of these radioactive particles have been discovered on the seabed close to the historic LEDS. Studies undertaken have shown that the most hazardous particles are clustered on the seabed in a radioactive plume running parallel to the coast from southwest to northeast, within the immediate vicinity (~1 km) of the historic LEDS. The size and radioactivity of the particles lessens, further away from the centre of this plume (Dounreay Particles Advisory Group, 2008). It should be noted that the offshore ECC does not overlap with the radioactive plume or the FEPA Order Zone (Figure 9-15).

Due to this area of concern, a FEPA Order Zone was enforced which prohibits the harvesting of seafood within a 2 km radius of the historic LEDS (Figure 9-15). While the FEPA Order Zone overlaps the water and sediment quality offshore study area, the offshore ECC and OAA where pre-construction, construction, operation and maintenance, and decommissioning activities will commence is entirely outside of the FEPA Order Zone, with the ECC located ~0.15 km to the east and the OAA located ~31 km to the north.

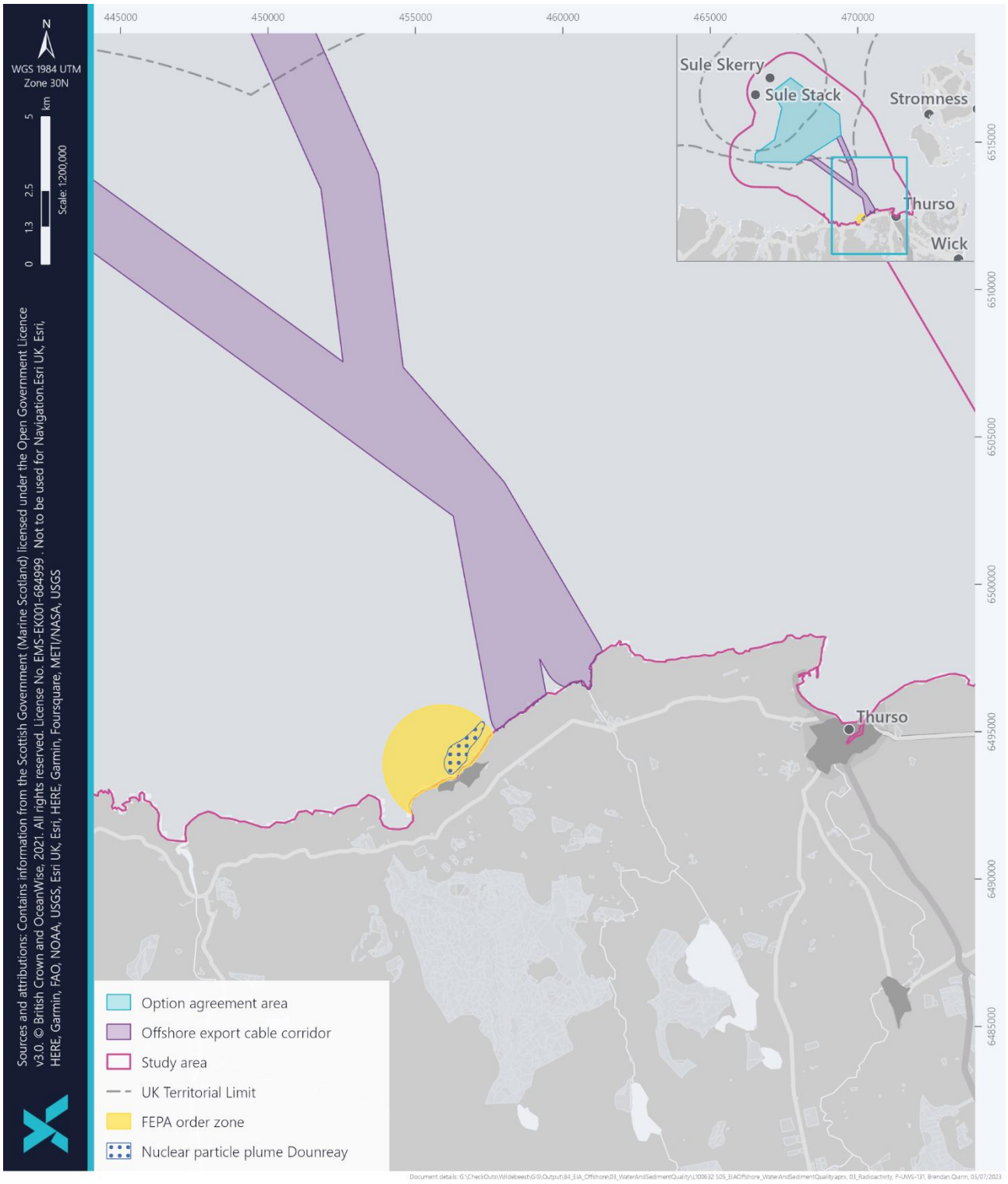


Figure 9-15 Radioactive particles in the seabed clustered in a radioactive plume within the vicinity of the historic LEDS and the FEPA Order Zone

An extensive programme of remediation activity was undertaken by Dounreay Site Restoration Limited (DSRL) to detect and retrieve hazardous particles from a 60-hectare area of seabed near the outfall using Remotely Operated Underwater Vehicles (ROVs), clean-up vehicles and divers. The seabed remedial works commenced in 2008 and continued each summer until 2012 (DSRL, 2021b). In the period up to summer 2012, when the last retrieval activities were conducted, a total of 2,184 particles were removed from the seabed. Of these 411 were deemed significant (particles with activities greater than 1 million Bq and likely to pose a risk to human health) and were removed from the seabed (DSRL, 2014). The presence of the larger radioactive particles near the historic LEDS is believed to be the source of smaller, less hazardous particles detected in the wider area – most notably in the Sandside Bay area.

Presently, under the requirements of the Environmental Authorisations (Scotland) Regulations (EASR) 2018, there is routine monitoring undertaken at the beaches at Sandside Bay and Dounreay Foreshore to monitor the presence of radioactive particles in the environment. There is also bi-annual monitoring at Strathy and Murkle beaches to ensure that these particles have not adversely impacted surrounding beaches. This monitoring is regulated by SEPA and funded by the Nuclear Decommissioning Authority (NDA) (DSRL, 2023). These monitoring activities are confined to beaches that do not overlap with the landfall area for the offshore Project.

Particles found during these monitoring activities are characterised and published on the Dounreay website, the following criteria is used to characterise the risk associated with the particles found based on Ceasium-137 (Cs-137) activity (DSRL, 2023):

- Minor (Cs-137 activity of < 100 kBq);
- Relevant (Cs-137 activity of between 100 kBq and 1 MBq); and
- Significant (Cs-137 activity of > 1 MBq).

Between November 1983 and April 2020, a total of 341 radioactive particles have been found in the Dounreay foreshore area, with the highest Cs-137 activity recorded at 2.0E+08 Bq (26th November 1991) (DSRL, 2023). Additionally, 287 radioactive particles have been found at Sandside Bay between April 1984 and August 2020, with the highest Cs-137 activity recorded at 5.0E+05 Bq (15th February 2007) (DSRL, 2021b). There have been three particles found at Murkle beach in 2007, 2009 and 2016, all of these particles are classified as 'Minor' (DSRL, 2023).

Between 2021 and March 2022, a total of 20 radioactive particles have been identified on the Dounreay foreshore, with 11 of these being considered 'Significant' (which were all identified in 2022) and in relation to Cs-137, whilst the remaining were considered 'Relevant' (DSRL, 2021a). During the same period at Sandside Beach, five radioactive particles were identified, which were all from 2021 and were considered to be 'Minor' (DSRL, 2023). The current interpretation for the higher number of particles found in 2022 compared to previous years is considered to be weather related (Dounreay Stakeholder Group, 2022). Environmental surveys were undertaken for the PFOWF in 2021, approximately 2 km west of the offshore ECC. Environmental samples were obtained from 18 locations immediately adjacent to the northern boundary of the FEPA Order Zone and further offshore. As part of the contaminant analysis undertaken for this development, radioactivity in samples was also analysed to inform Health and Safety requirements. The sediment grab samples were analysed using high resolution gamma spectrometry, including gross Alpha and gross Beta analysis (HWL, 2022a).

Of the 18 samples retrieved during the PFOWF survey campaign only one sample obtained from the northern edge of the FEPA Order Zone, approximately 2 km from the coast, showed a positive result for Americium-241 at 0.0064 Bq/g. This type of radioactive isotope is associated with the radioactive particles originating from the historic nuclear

activities. However, the positive result was 15 times lower than the 'out of scope[11]' threshold for being considered to be radioactive under the EASR 2018 (HWL, 2022b). The gross Alpha (as Plutonium-242 (Pu-242)) and gross Beta (as Cs-137) / Potassium-40 (K-40) analysis showed that reported levels were highest at sampled locations taken closest to the coast, where the levels were reported as 186 ± 76 Bq/kg and 1,300 ± 280 / 1,240 ± 260 Bq/kg respectively, which was concluded to be classified as 'very low' in terms of potential harm (HWL, 2022a).

9.4.6.6 Marine invasive non-native species (INNS)

With respect to benthic ecology, no invasive non-native taxa, but one non-native taxon, was identified during the Project-specific environmental survey (section 9.4.3.2.1). Non-native taxa do not naturally occur in an area but have been introduced unintentionally or deliberately by humans, and these are not considered to harm the ecosystem where introduced, in contrast to invasive non-native taxa. Invasive non-native taxa are a threat to the ecosystem, the economy and/or the health of humans and/or animals (SS5: Benthic environmental baseline report).

The non-native taxon identified was the polychaete *Goniadella gracilis*. It occurred in low abundances (1 to 19 individuals per 0.1 m^2) at 23 different grab sample locations, six within the offshore ECC and 17 within the OAA[12], with a total of 80 individuals recorded. The species was described from eastern North America, and the first British records are from 1970 in Liverpool Bay (Eno *et al.*, 1997; SS5: Benthic environmental baseline report.

9.4.7 Future baseline

The future baseline is expected to be broadly comparable to the existing baseline described in section 9.4.6 above.

Targets have been predicted for the future status of waterbodies, with the recognition of pressures that contribute to a waterbody's failure to meet good ecological status and the implementation of ongoing monitoring and management to minimise impacts on the waterbody status. EQS for the designated coastal waterbodies within the water and sediment quality offshore study area (i.e., Strathy Point to Dunnet Head, Cape Wrath to Strathy Point, and Thurso Bay) are noted as having a 'Good' status in 2021 with the same status predicted for 2027 and beyond. However, the Strathy Point to Dunnet Head coastal waterbody is noted as having pressure from point source pollution, particularly in relation to sewage disposal. The management strategy is to increase treatment which has been agreed upon by Scottish Water and has been implemented since 2008 (SEPA, 2012). It is expected that the monitoring and management will be ongoing, meaning the continuation of the good ecological status into the future. Furthermore, the ongoing implementation of SEPA guidance on pollution prevention and acceptable EQS for surface waters and discharges to sea mean that the good ecological status of the intersected coastal waterbodies is also likely to continue and potentially improve into the future.

The Thurso designated bathing water is in 'Good' condition for the 2022/23 season and has maintained 'Good' condition since the 2018/19 season, so the condition is not expected to deteriorate. Climate change effects resulting

[11] *The 'out of scope' threshold for radioactive particles indicates levels which can be considered 'not radioactive' with regards to the relevant legislation (EASR, 2018), and are not subject to further regulatory requirement.*

[12] *Including a fragment in the OAA at sample location OAA_S09*

in changes to water column pH and salinity are likely to occur resulting in changes to water column properties and quality. With respect to the potential for radioactive particles, although the inventory is unknown, the historic LEDs are no longer in operation and as such no further particles will enter into the marine environment. There will be a continued programme of monitoring at the beaches near the Dounreay Nuclear Facility to ensure any radioactive particles finds are removed.

9.4.8 Summary and key issues

Table 9-18 Summary and key issues for water and sediment quality

SUMMARY AND KEY ISSUES	OFFSHORE PROJECT AREA
	• Water quality: – The offshore Project area overlaps with the Strathy Point to Dunnet Bay designated coastal waterbody which is in 'Good' overall condition, and slightly overlaps the Sule Stack and Sule Skerry coastal waterbody which is in 'High' overall condition; and – There are an additional two designated coastal waterbodies and one designated bathing water located within the wider water and sediment quality offshore study area, which are all in 'Good' overall condition. • Sediment quality: – Metals exceeded thresholds at 13 of the 59 sampled locations, with arsenic exceeding the CCME ISQG threshold at seven locations and nickel exceeding Cefas AL1 threshold at eight locations (with two locations exceeding in both arsenic and nickel); and – THC concentrations did not exceed the Dutch RIVM threshold at any of the 60 locations, but PAH exceeded CCME ISQG thresholds at the three nearshore locations. • Radioactivity contamination: – The offshore Project area is outwith the areas where radioactivity contamination has been previously detected. There has been extensive remediation and monitoring efforts over the years which has reduced the levels of contamination in the area surrounding the offshore Project area. Monitoring will continue into the future; – Reported particle finds have been mainly in relation to those at the Dounreay Foreshore and Sandside Bay with those in 2022 characterised as 'Significant' and 'Relevant' particles; and – A site-specific radioactivity investigation for the nearby PFOWF found that the radioactivity in sediment was attributed to environmental levels and only one positive result for Americium-241 was identified 2 km from the coast but this was below "out of scope" levels as defined by the EASR 2018.

9.4.9 Data limitations and uncertainties

The baseline environment detailed in section 9.4.6 above has been established through an extensive review of the available primary (i.e., project site-specific surveys) and secondary data sources and literature (Table 9-4) and information gained through consultation, which are considered to be sufficient. Although primary data were not gathered on radioactivity, as the offshore Project area is out with the FEPA Order Zone, secondary public data sources have been used to strengthen the understanding of the radioactivity in the environment and key risk areas. Therefore,

there is a robust baseline available to inform the impact assessment and there are no significant data gaps regarding water and sediment quality.

9.5 Impact assessment methodology

9.5.1 Impacts requiring assessment

The impacts identified as requiring consideration for water and sediment quality are listed in Table 9-19. Information on the nature of impact (i.e. direct or indirect) is also described.

Table 9-19 Impacts requiring assessment for water and sediment quality

POTENTIAL IMPACT	NATURE OF IMPACT
Construction (including pre-construction) and decommissioning	
Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediment concentration	Direct
Impacts on water quality status of designated waterbodies	Direct

9.5.2 Impacts scoped out of the assessment

The impacts scoped out of the assessment during EIA scoping, and the justification for this, are listed in Table 9-20.

Table 9-20 Impacts scoped out for water and sediment quality

IMPACT SCOPED OUT	JUSTIFICATION
Construction (including pre-construction) and decommissioning	
Changes in water and sediment quality from accidental discharges from vessels during construction	The construction and decommissioning activities associated with the Wind Turbine Generators (WTG), Offshore Substation Platform (OSP) and cables (including pre-construction activities) (see Table 9-24), may potentially result in reduced water and sediment quality due to accidental discharges. The accidental release of pollutants is limited to oils and fluids contained within the WTGs and vessels. For WTGs, the nacelle, tower and rotor will be designed and constructed in order to contain leaks, thereby reducing the risk of spillage into the marine environment. Therefore, the potential for a full inventory release from any individual WTG is considered extremely remote, requiring a catastrophic unplanned event. The use of construction support and installation vessels during construction will be in accordance with best practice and maritime conventions, as summarised in the embedded mitigation for the offshore Project. Emergency response

IMPACT SCOPED OUT	JUSTIFICATION
	procedures will be in place for the offshore Project, including pollution control and spillage response plans secured through the construction and operation environmental management plans. Any such incidents would be short lived and very localised. It is anticipated that the risk will be entirely managed through the embedded mitigation measures presented in section 9.5.4. Therefore, this impact is scoped out of the assessment.
Operation and maintenance	
Changes in water and sediment quality from accidental discharges from vessels during operation and maintenance	As with the construction stage, although operation and maintenance activities associated with the offshore Project may potentially result in reduced water and sediment quality due to accidental discharges from vessels, any such incidents would be short lived and very localised and it is anticipated that the risk will be entirely managed through the embedded mitigation measures (including agreed environmental management plans) presented in section 9.5.4. Therefore, this impact is scoped out of the assessment.
Impacts on water quality status of designated waterbodies due to increased suspended sediment and potential release of contaminants or radioactive particles	Operation and maintenance activities may potentially result in changes to SSC in the Strathy Point to Dunnet Head, Cape Wrath to Strathy Point, and Thurso Bay designated coastal waterbodies (currently all in 'Good' overall condition) (section 9.4.6.2), or in the Thurso designated bathing water ('Good' condition for the 2022/23 season) (section 9.4.6.2.2). The increases in turbidity from the repair of cables would be localised to the area of the works, transient and temporary. Depending on the nature of the repair required it may entail raising a section of the cable to the sea surface, but any displaced material will quickly be redeposited back to the seabed. Only a small proportion of the sediment fraction would develop into a plume and would be likely less than the extents described for construction activities. Maximum increases in sediment concentration would be similar to construction, but the concentrations would again quickly reduce within 500 m of the operational repair activity and with increasing distance. Should any operational repair of cables be necessary, the short-term and localised changes to turbidity associated with such activity will not ultimately alter the water quality across the water and sediment quality offshore study area. Therefore, this impact is scoped out from further assessment.
Changes in water and sediment quality associated with operational cleaning of Project infrastructure	Routine operation and maintenance activities including cleaning biofouling of offshore Project infrastructure may potentially result in reduced water and sediment quality in the immediate vicinity of the offshore Project infrastructure. Operational cleaning may also release paints used on the offshore Project infrastructure. Any impacts are likely to be short lived and localised. Risks will also be adequately managed through the embedded mitigation measures presented in section 9.5.4, including using anti biofouling paints suitable for the marine environment and fauna.

9.5.3 Assessment methodology

An assessment of potential impacts is provided for the construction stage of the offshore Project. The assessment for water and sediment quality is undertaken following the principles set out in chapter 7: EIA methodology. The sensitivity of the receptor is combined with the magnitude to determine the impact significance. Topic-specific sensitivity and magnitude criteria are assigned based on professional judgement, as described in Table 9-21 and Table 9-22.

Table 9-21 Sensitivity criteria

SENSITIVITY OF RECEPTOR	DEFINITION
High	• Receptor is of very high importance and is protected under national and international legislation (e.g., WFD); • The receptor is recognised to be very sensitive to impacts and has no capacity to avoid or adapt to an effect, tolerate or absorb an effect, or recover to baseline conditions; and • Impacts would result in a change to the status of the receptor.
Medium	• Receptor is of high importance and is protected under national and international legislation (e.g., WFD; • The receptor is recognised to be sensitive to impacts, with a very little capacity to avoid or adapt to an effect, tolerate or absorb an effect, or recover to baseline conditions; and • Impacts could lead to a potential change in the status of the receptor.
Low	• Receptor is of high importance and is protected under national and international legislation (e.g., WFD; • The receptor has high capacity to avoid or adapt to an effect, tolerate or absorb an effect, or recover to baseline conditions; and • Impacts unlikely to result in a change to the status of the receptor.
Negligible	• Receptor of very low importance, with no associated designations; • Receptor has full capacity to avoid or adapt to an effect, tolerate or absorb an effect, or recover to baseline conditions; and • No change is expected to the status of the receptor.

Table 9-22 Magnitude criteria

MAGNITUDE CRITERIA	DEFINITION
High	• The impact occurs over a large spatial extent resulting in widespread, long-term, or permanent changes in baseline conditions; and • The impact is very likely to occur and/or will occur at a high frequency or intensity.
Medium	• The impact occurs over a local to medium extent with a short- to medium-term change to baseline conditions; and • The impact is likely to occur and/or will occur at a moderate frequency or intensity.

MAGNITUDE CRITERIA	DEFINITION
Low	• The impact is localised and temporary or short-term, leading to a detectable change in baseline conditions; and • The impact is unlikely to occur or may occur but at low frequency or intensity.
Negligible	• The impact is highly localised and short-term, with full rapid recovery expected to result in very slight or imperceptible changes to baseline conditions; and • The impact is very unlikely to occur; if it does, it will occur at a very low frequency or intensity.

The consequence and significance of effect is then determined using the matrix provided in chapter 7: EIA methodology.

9.5.4 Embedded mitigation

As described in chapter 7: EIA methodology, certain measures have been adopted as part of the Project development process in order to reduce the potential for impacts to the environment, as presented in Table 9-23. These have been accounted for in the assessment presented below. The requirement for additional mitigation measures (secondary mitigation) will be dependent on the significance of the effects on water and sediment quality receptors.

Table 9-23 Embedded mitigation measures relevant to water and sediment quality

MITIGATION MEASURE	FORM (PRIMARY OR TERTIARY)	DESCRIPTION	HOW MITIGATION WILL BE SECURED
Site selection	Primary	The offshore ECC avoids any direct overlap with the FEPA Order Zone at Dounreay, reducing the potential release of radioactive contaminants associated with the offshore Project.	Already secured through offshore ECC boundary.
WTG and OSP design	Primary	The WTG and OSP topsides are designed and constructed to contain leaks, thereby reducing the risk of spillage into the marine environment. Details on control measures for reducing the risk of accidental leaks and spills will be detailed within the MPCP.	The production and approval of an Environmental Management Plan (EMP), including the MPCP, will be required under Section 36 Consent and/or Marine Licence conditions. An outline EMP is provided as part of the offshore application in Offshore EIA Report, Outline Plan (OP) 1: Outline Environmental Management Plan. The

MITIGATION MEASURE	FORM (PRIMARY OR TERTIARY)	DESCRIPTION	HOW MITIGATION WILL BE SECURED
			outline MPCP is contained within the outline EMP.
Environmental management plan (EMP)	Tertiary	The development of, and adherence to, an EMP covering pollution prevention, biosecurity and waste management. A Marine Pollution Contingency Plan (MPCP) and INNS management plan will be included within the EMP.	The production and approval of an EMP, including the MPCP and INNS management plan, will be required under Section 36 Consent and/or Marine Licence conditions. An outline EMP is provided as part of the offshore application in OP1: Outline Environmental Management Plan. The outline MPCP is contained within the outline EMP.
Adherence to the International Convention for the Prevention of Pollution from Ships (MARPOL)	Tertiary	The risk of marine pollution will be minimised through compliance with The International Convention for the Prevention of Pollution from Ships (MARPOL) convention requirements. Control measures and shipboard oil pollution emergency plans (SOPEP) (for oil tankers of 150 gross tonnage and above and all vessels of 400 gross tonnage and above) will be established and adhered to, as required under MARPOL Annex I.	Secured through the production of a MPCP within the EMP, required under Section 36 Consent and/or Marine Licence conditions. An outline EMP is provided as part of the offshore application in OP1: Outline Environmental Management Plan. The outline MPCP is contained within the outline EMP.
Decommissioning Programme	Tertiary	The development of, and adherence to, a Decommissioning Programme, approved by Scottish Ministers prior to construction and updated throughout the Project lifespan.	The production and approval of a Decommissioning Programme will be required under Section 105 of the Energy Act 2004 (as amended).

9.5.5 Worst case scenario

As detailed in chapter 7: EIA methodology, this assessment considers the worst case scenario for the offshore Project parameters which are predicted to result in the greatest environmental impact, known as the 'worst case scenario'. The worst case scenario represents, for any given receptor and potential impact, the design option (or combination of options) that would result in the greatest potential for change. The worst case scenario is based on the design option (or combination of options) that represents the greatest potential for change, the development of any alternative options within the design parameters will give rise to no worse effects than those assessed in this impact assessment. Table 9-24 presents the worst case scenario for potential impacts on water and sediment quality during pre-construction, construction, operation and maintenance, and decommissioning.

Table 9-24 Worst case scenario specific to water and sediment quality receptor impact assessment

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
Construction		
Impacts on water quality status of designated waterbodies	• Pre-construction activities: – Unexploded Ordnance (UXO) clearance requiring detonation of up to 22 targets, with a maximum duration of clearance of 22 days (one detonation every 24 hours). The method of detonation would be High-Order, involving up to 5 kg bulk high explosive disposal charge and fragments deposited out to a 10 – 15 m radius; – Area of boulder clearance across offshore Project area 30.4 km^2 covering all cables and WTG and OSP foundations; – Bedform[13,14] clearance area along the inter-array cables of 3.4 km^2; – Bedform clearance area along ECC of 19.2 km^2; and – Bedform clearance along interconnector cables 2.9 km^2.	The parameters that represent the greatest increase in SSC based on the maximum area and duration of construction and decommissioning activities with the greatest impact to water quality status of designated waters.
Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediment		The parameters that represent the greatest disturbance to contaminated sediments and radioactive particles based on the largest area used by the offshore Project and the longest duration of the construction and decommissioning activities.

[13] Seabed preparation may also include bedform clearance which can be performed using dredging techniques, jetting tools or CFE. CFE and dredging by Trailing Suction Hopper Dredger (TSHD) have been accounted for as the potential worst case activities in the assessment. Should TSHD be used, excavated material may be disposed of in designated/licensed disposal sites or within the offshore Project area. Dredging by TSHD includes disposal, which could entail a separate Marine Licence application to MD-LOT. The exact need for dredging and disposal will not be confirmed until a further stage of the Project. If dredging is required, OWPL understand that sediment samples must be collect, analysed and provided to MD-LOT in support of the Marine Licence application. Please note, this disposal location has not yet been selected as part of the Project Design Envelope. For the purposes of this assessment and for ease of quantification of impacts, a nominal indicative disposal area has been chosen for some context.
[14] Bedforms include sandwave bedforms, bedform fields comprising of sand and gravel, megaripples and rippled scour depressions which are present in different areas across the offshore Project area (see chapter 8: Marine physical and coastal processes for further information).

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
	• For WTGs, construction of: – 125 WTGs, equating to a total disturbance area and volume of 31,875 m^2 and 1,375,000 m^3 respectively; • For OSPs, construction of: – Five OSP jacket foundations, with eight legs per foundation and two piles per leg, equating to a total disturbance area and volume of 18,500 m^2 and 46,500 m^3; • For cables, construction of: – Six interconnector cables with a total length of 150 km within the OAA; – Inter-array cables with a total length of 500 km within the OAA; – Five offshore export cables with a total length of 320 km within the offshore ECC; – 1,000 m corridor width for export cables (utilising both Stormy Bank and Whiten Head Bank ECCs); – Up to 3 m target burial (5 m maximum) burial depth for export, interconnector, and inter-array cables, associated with a 2 m trench width for export, interconnector, and inter-array cables; – 16 km^2 total area of seabed disturbance for export cable route, 7.5 km^2 total area of seabed disturbance for OWF for interconnector cables, and 25 km^2 for total area of seabed disturbance for OWF for inter-array cables; – 224 km total length of export cables buried; and – 93.5 km length of cables requiring cable protection for export cables, 99 km for interconnectors, and 100 km for inter-array.	

POTENTIAL IMPACT	WORST CASE SCENARIO	JUSTIFICATION
	• Landfall works including: – Horizontal Directional Drilling (HDD) bore exit at 10 – 40 m below LAT (approximately at a minimum of 100 m offshore from 0 mLAT); – Excavation of up to six HDD exit pits (five plus one spare), each measuring 30 m long by 10 m wide and 5 m deep (300 m^2, totalling 1,800 m^2); and – Excavation of up to six receiver pits at the HDD exit, measuring 30 m long by 10 m wide and 5 m deep; and – Excavated by dredging. • A construction period of four years (with an additional year for pre-construction activities, such as UXO clearance and boulder clearance).	
Decommissioning		
In the absence of detailed information regarding decommissioning works, the implications for water and sediment quality are considered analogous to or likely less than those of the construction stage. Therefore, the worst case parameters defined for the construction stage also apply to decommissioning. The decommissioning approach is set out in chapter 5: Project description.		

9.6 Assessment of potential effects

9.6.1 Potential effects during construction (including pre-construction)

9.6.1.1 Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediment concentration

This impact relates to the potential for disturbance and release of chemical contaminants and radioactive particles potentially trapped in sediment into the water column during pre-construction and construction activities e.g., seabed preparation and clearance activities. It also evaluates the potential increases in SSC as a result of the disturbance.

The potential for chemical contaminants and radioactive particles to be present within the offshore Project area was investigated through site-specific surveys, as summarised in section 9.4.3, with results presented in section 9.4.6.4. The understanding of risk of radioactivity is based on secondary information as described in section 9.4.6.4.3. The completed site-specific sediment sampling and contaminant analyses identified limited contamination within samples obtained across the offshore Project area, as discussed in section 9.4.6.4, and the locations of these samples are shown in Figure 9-2. Overall, it was found that only low occurrences of the contaminants analysed were present, with the majority of contaminants being below the Cefas AF1, ISQG/TEL and Dutch RIVM guidelines. Only nickel concentrations slightly exceeded Cefas AF1 at eight locations, four within the OAA and four within the offshore ECC. Nevertheless, these concentrations were significantly below the Cefas AL2 criteria and as such, under this criterion, would qualify for disposal at sea.

As detailed in section 9.4.6.4.3, radiological contamination in the form of radioactive particles are known to be present in the marine environment at the coast of Dounreay. The most hazardous particles are within a 1 km plume surrounding the historic LEDS (Dounreay Particles Advisory Group, 2008). The plume is now designated by a FEPA Order Zone which extends to a 2 km radius around this area (see Figure 9-15). The offshore Project area, specifically the offshore ECC, does not overlap the FEPA Order Zone. Eleven radioactive particles found during the 2022 beach monitoring activities at Sandside Bay were classified as 'Significant' due to their Caesium -137 activity (DSRL, 2023).

As a result of the site-specific sediment chemistry and contaminant analyses and desk based environmental characterisation detailed in section 9.4.6, there is considered to be a low occurrence of contaminants and a low potential for radiological particles across the offshore Project area, with all analysed samples from the site specific surveys reporting concentrations which are well below the Cefas AL2 criteria.

With respect to the SSC properties across the offshore Project area as informed by site-specific benthic and environmental surveys (section 9.4.3.2.2) and described in section 9.4.6.1.2. TSS were analysed within samples obtained during the environmental surveys (section 9.4.3.2.2). It was found that background concentrations in the OAA generally showed a TSS of <5 mg/l across all depths analysed (Table 9-8). In the offshore ECC, more variable TSS concentrations were found owing to the more active metocean conditions at the coast and larger proportion of fine sediment. TSS was generally <5 mg/l for surface samples, but marginally higher concentrations of TSS were found in the middle and bottom water samples (<5 mg/l to 31 mg/l), likely due to an increase of fines content in this region. DO concentrations ranged from 7.1 to 9.3 mg/l throughout the offshore Project area (Table 9-9), with evidence of stratification particularly within the offshore ECC and during neap tides as described in section 9.4.6.1.2 and illustrated in Figure 9-8 and Figure 9-10. A DO concentration of >6 mg/l near the seabed is considered an

indicator of a healthy marine environment (OSPAR, 2017b), as is characteristic of the offshore Project area. The worst case disturbance footprint from pre-construction and construction activities within the OAA and the offshore ECC is associated with the seabed preparation works, such as bedform clearance, as detailed in Table 9-24. The maximum area of disturbance equates to 38.7 km^2 in the OAA and 30.4 km^2 in the offshore ECC. It is considered that bedform clearance by CFE operations result in the worst case scenario in terms of impacts to water and sediment quality. This is due to the slow clearance rate associated with CFE transit during clearance (i.e., at 25 m/hr) and as such, SSC may be elevated above background levels for longer periods.

For any potential occurrence within the disturbance footprint, the majority of contaminant concerned would largely be attached to sediment particles. In the event of disturbance, only very small concentrations of contaminants enter to the dissolved phase, with the vast majority remaining adhered to the sediment particles when temporarily entering suspension in the water column. Should contaminants enter the dissolved phase, partition coefficients would indicate that concentrations would typically reduce by several orders of magnitude than the concentrations associated with suspended sediments. Therefore, should any contaminants, such as arsenic or nickel, be disturbed during seabed preparations, these would largely settle out quickly. Should any proportion be dissolved into the water column, these would be of very low concentrations and would be rapidly dispersed by tidal processes.

As presented in chapter 8: Marine physical and coastal processes and the supporting technical report (SS3: Marine physical and coastal processes supporting study), the modelling results assume approximately 0.25% of the sediment bulk disturbed during construction activities would develop into a plume to extend further afield from the disturbance site. The remaining 99.75% of the sediment bulk would quickly fall to the seabed in proximity to the disturbance activity during the active phase of sediment deposition. Although increases in SSC associated with the active depositional phase would be several orders of magnitude greater than background levels of <5 mg/l (i.e. thousands of mg/l), this would only be within tens of metres of the disturbance. The high SSC would also only be short-lived and temporary and reduce very quickly with increasing distance from the disturbance site, as the sediment quickly settles to the seabed on the order of minutes.

It is only a much smaller proportion of sediment that would develop into a plume over a greater extent. The 0.25% sediment bulk likely to develop into a plume is representative of the offshore Project area as a whole and takes into consideration the difference in sediment composition within the OAA and offshore ECC – with sediments likely to enter into a plume comprising approximately 0.12% and 0.52%, respectively. This difference is due to the higher percentage fines content within the offshore ECC. In terms to the potential changes to SSC associated with the offshore Project, only that in relation to the potential sediment plume (i.e. associated with the smaller proportion of the sediment bulk) is considered, due to the wider extent of the potential plume.

Within the OAA, modelling of SSC from CFE activities showed that the maximum plume extent is approximately 5 km to the east and 4 km to the west, associated with the flood and ebb respectively. The maximum SSC for the CFE activities is 48 mg/l. However, this reduces to less than 4 mg/l by the time the plume reaches 2 km (at 3.72 hours after the initial release). A return to background levels characteristic of the OAA also occurs rapidly with the cessation of activity with concentrations of around 2 mg/l occurring over longer durations (at approximately 18 hours).

Modelling of SSC from CFE activities showed that the maximum plume extent in the offshore ECC is approximately 7 km to the east and 5 km to the west, associated with the flood and ebb respectively. A maximum SSC of 1,200 mg/l was modelled, although this was shown to quickly reduce with increasing distance from the disturbance site. Modelled observation locations in relation to ongoing clearance, identified SSC reducing to less than 10 mg/l within 1 km of the

disturbance, with the SSC returning to background levels of less than 5 mg/l at distances of 2 to 3 km. In terms of the extent and duration of the plume, modelled results (discussed further in the marine physical and coastal processes technical report (SS3: Marine physical and coastal processes supporting study)), demonstrated that locations that remained above 2 mg/l for more than 3.72 hours only extended about 3 km away from the offshore ECC and well within the study area. However, after 18.6 hours, concentrations are generally less than 2 mg/l and at background levels characteristic to the offshore ECC everywhere. Across the OAA the orientation of the plume is aligned with the flow axis. Within the offshore ECC, the orientation of the plume is broadly parallel to the coast, but with the slow transit of the CFE during clearance, the plume has a broader north-south axis, with increased SSC reaching the coast.

Based on the relative short duration of the active deposition phase or for the small proportion of the sediment bulk that would develop into a plume, the period of higher SSC will not ultimately affect the water column DO properties, as the increased SSC is only on the order of minutes (in the case of the active deposition phase) to several hours (in the case of the sediment plume).

9.6.1.1.1 The OAA

The receiving environment (i.e., the sediment and water column) within the OAA is considered to be of **medium sensitivity** due to the overlap of the Sule Skerry and Sule Stack waterbody in this area, approximately 3.5 km^2 (1.81% of the overall waterbody area).

Within the OAA the **magnitude of impact** is considered to be **low**. This is as a result of the low occurrence of contaminants above guidance thresholds within the OAA, the temporary nature of the sediment dispersion impacts associated with the construction activities, maximum plume extents and short-duration of increased SSC associated with the worst case modelling of clearance by CFE. This coupled with the highly dispersive nature of the environment ensures that impacts are low in the OAA. Furthermore, the OAA is not located within the FEPA Order Zone where radioactive particles are likely to be present. It cannot be fully discounted that radiological particles would be present further offshore, however, given the large intervening distance of 31 km between the FEPA Order Zone and the OAA, it is highly unlikely that radioactive particles would be present in the OAA. As such, it is considered very unlikely that activities in the OAA would result in direct disturbance of radioactive particles. While there will be a low likelihood of release of pollution from vessels or equipment during the construction (including pre-construction) activities, with the implementation of the EMP and pollution control measures including MARPOL convention requirements and the marine pollution and contingency plan (as detailed in Table 9-23), any additional impacts from accidental releases would be minimised.

Evaluation of significance

Taking the medium sensitivity of the OAA and the low magnitude of impact, the overall effect within the OAA is considered to be **minor** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
OAA seabed sediment and water column in the wider environment	Medium	Low	Minor
Impact significance - NOT SIGNIFICANT			

9.6.1.1.2 The offshore ECC

Due to the overlap of the Strathy Point to Dunnet Head coastal waterbody within the offshore ECC (an overlap of 20.4 km^2, accounting for 7.45% of the overall waterbody area) at the cable landfall(s), the **sensitivity** of the offshore ECC receiving environment is considered to be **medium.**

The offshore ECC is located close to the eastern edge of the FEPA Order Zone (~150 m). Within the FEPA Order Zone there is the potential for radiological particles to be present on the seabed. Nonetheless, the offshore ECC does not overlap the FEPA Order Zone and as such there is no potential for direct impacts on the area of concern. Although unlikely, there is the potential that there could be radioactive particles within the offshore ECC. Given the work done by DSRL to map the extent of the contamination, the 1 km identified plume around the historic LEDS does not encroach on the offshore ECC. As such there is a low likelihood that there will be radioactive particles present and therefore limited potential for direct disturbance to radiological particles. Indirect effects from suspended sediments during bedform clearance works in the offshore ECC will result in a larger plume of SSC than the OAA, due to the fine sediments present in this region. The duration of the plume within the offshore ECC is also longer at up to 18.6 hours. The SSC plume will reach the FEPA Order Zone, nevertheless this would not result in the resuspension of radioactive particles. Furthermore, there is only a low occurrence of other contaminants within the offshore ECC as identified from the site-specific contaminant analyses. While there will be a low likelihood of release of pollution from vessels or equipment during the construction activities, with the implementation of the EMP and pollution control measures (including MARPOL convention requirements and the marine pollution and contingency plan (as detailed in Table 9-23)), any additional impacts from accidental releases would be minimised. As such, the **magnitude of impact** is considered to be **low**.

Evaluation of significance

Taking the medium sensitivity of the offshore ECC and the low magnitude of impact, the overall effect within the offshore ECC is considered to be minor and not significant in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
Offshore ECC seabed sediment and water column in the wider environment	Medium	Low	Minor
Impact significance - NOT SIGNIFICANT			

9.6.1.2 Impacts on water quality status of designated waterbodies

This impact relates to the potential for impacts to water quality status of designated waters in the vicinity of the offshore Project area as a result of pre-construction and construction activities through the following pathways:

- Increases in SSC;
- Release of chemical contaminants and radioactive particles trapped in sediment into the water column; and
- Risk from marine invasive non-native species (INNS).

Designated waters are protected through various legislative regimes which implement the WFD (2000/60/EC) and the Bathing Waters Directive (2006/7/EC). As such any proposed development within these waters must have regard to the requirements of the directives to ensure that all surface water bodies achieve 'Good' ecological status and that there is no deterioration in status. As detailed in section 9.4.6.1, the designated waters of relevance to this impact include coastal waterbodies and designated bathing waters within the water and sediment quality offshore study area. No designated shellfish protected areas or NVZs are identified within the study area and as such are not relevant to the assessment. The designated waters considered by this assessment include:

- Coastal waterbodies:
  - Sule Skerry and Sule Stack (ID: 200239), which directly overlaps the very north of the OAA;
  - Strathy Point to Dunnet Head (ID: 200224) which directly overlaps the offshore ECC at the landfall; Thurso Bay (ID: 200218) which is located approximately 7 km east of the offshore ECC; and
  - Cape Wrath to Strathy Point (ID: 200223) which is located approximately 10 km west of the offshore ECC.
- Designated bathing waters:
  - Thurso (ID: UKS7616019) which is located approximately 9 km east of the offshore ECC.

The potential for chemical contaminants and radioactive particles to be present within the offshore Project area and disturbed has been assessed in section 9.6.1.1. There is only a low occurrence of contaminants exceeding quality standards across the offshore Project area and a limited potential for radioactive particles to be present within the offshore Project area. Consideration of the potential increases in SSC are also assessed in 9.6.1.1, where increases in SSC associated with Project activities are short-lived and only extend over a limited extent. With respect to the consideration of marine INNS, none were identified across the offshore Project area. As described in section 9.4.6.6, only one non-native species *Goniadella gracilis* was identified in 23 locations, 20 within the OAA and three within the

offshore ECC. This species is non-native, but is not classified as invasive and therefore will not result in detriment to water quality status of the identified water bodies.

9.6.1.2.1 The Sule Skerry and Sule Stack waterbody

The Sule Skerry and Sule Stack waterbody (section 9.4.6.2) overlaps the most northerly point of the OAA, therefore, only pre-construction and construction activities within the OAA that are relevant (and in reality, only the specific activities that occur in the northerly section of the OAA). The waterbody is a **medium sensitivity** receptor due to its classification under the WFD. There are low occurrences of contaminants and likely very low occurrences of radioactive particles in the OAA (section 9.4.6.4.2). Additionally, the mechanisms for release of contaminants such as through the CFE activities in the OAA will result in only temporary and short lived SSCs above background, with the maximum extent of a sediment plume localised to 5 km to the east and 4 km to the west. Further justification as described in section 9.6.1.2.2 is also applicable here. As such it is considered that the **magnitude of impact** on this receiving waterbody is **low**.

Evaluation of significance

Given the medium sensitivity of the receptor and the low magnitude of impact, the overall effect is considered to be **minor** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
Sule Skerry and Sule Stack (ID: 200239)	Medium	Low	Minor

Impact significance – NOT SIGNIFICANT

9.6.1.2.2 Strathy Point to Dunnet Head coastal waterbody

The Strathy Point to Dunnet Head coastal waterbody directly overlaps the offshore ECC at the coast as described in section 9.4.6.2. The waterbody is a **medium sensitivity** receptor due to its classification under the WFD. There is low occurrences of contaminants and likely low occurrences of radioactive particles in the offshore ECC (section 9.4.6.4.2). Additionally, the mechanisms for release of contaminants such as through the CFE activities in the offshore ECC will result in only temporary and short lived SSCs above background, with the maximum extent of a sediment plume localised to 7 km to the east and 5 km to the west. Furthermore, the limited period for sediments to be held in suspension will not result in depleted oxygen conditions. There are no marine INNS identified from the surveys and as such no potential for detriment on water quality status from potential distribution of INNS present in the marine environment from the construction activities. Furthermore, with the implementation of the EMP and pollution control measures including MARPOL convention requirements, as detailed in Table 9-23, the potential for release of pollution or INNS from vessels or equipment during the construction activities is limited. As such it is considered that the **magnitude of impact** on this receiving waterbody is **low**.

Evaluation of significance

Given the medium sensitivity of the receptor and the low magnitude of impact, the overall effect is considered to be **minor** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
Strathy Point to Dunnet Head Coastal Waterbody (ID: 200224)	Medium	Low	Minor

Impact significance - NOT SIGNIFICANT

9.6.1.2.3 The Thurso Bay coastal waterbody

The Thurso Bay coastal waterbody is located 6.7 km from the eastern edge of the offshore ECC along the coast (section 9.4.6.2). The waterbody is a **medium sensitivity** receptor due to its classification under the WFD and is sensitivity to impacts. The justification as presented in section 9.6.1.2.4 is also applicable here, due to the potential plume extents and this waterbody is located beyond the extent, there is no pathway for impacts. Therefore it is considered that the **magnitude of impact** is **negligible**.

Evaluation of significance

Given the medium sensitivity of the receptor and the negligible magnitude of impact, the overall effect is considered to be **negligible** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
Thurso Bay Coastal Waterbody (ID: 200218)	Medium	Negligible	Negligible

Impact significance - NOT SIGNIFICANT

9.6.1.2.4 The Cape Wrath to Strathy Point coastal waterbody

The Cape Wrath to Strathy Point coastal waterbody is located 9.7 km from the western edge of the offshore ECC along the coast (section 9.4.6.2). The waterbody is a **medium sensitivity** receptor due to its classification under the WFD and is sensitivity to impacts. The worst case plume of suspended sediments within the offshore ECC is as described in section 9.6.1.2.2, with the associated description of impacts also applicable here. As the offshore Project area does not overlap this waterbody and impact extents are shown to not extend to the waterbody approximately 10 km away, the **magnitude of impact** on the waterbody is **negligible**.

Evaluation of significance

Given the medium sensitivity of the receptor and the negligible magnitude of impact, the overall effect is considered to be **negligible** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
Cape Wrath to Strathy Point Coastal Waterbody (ID: 200223)	Medium	Negligible	Negligible
Impact significance - NOT SIGNIFICANT			

9.6.1.2.5 Thurso designated bathing water

Thurso designated bathing water is located approximately 9 km from the eastern edge of the offshore ECC, at Thurso beach, the status and properties of this bathing water are detailed in section 9.4.6.2.2. The waterbody is a **medium sensitivity** receptor due to its classification under the Bathing Waters Directive. As the bathing water is beyond the extents of any plume extents and the implemented mitigation, there is no pathway for impact, therefore, the **magnitude of impact** is considered to be **negligible.**

Evaluation of significance

Given the medium sensitivity of the receptor and the negligible magnitude of impact, the overall effect is considered to be **negligible** and **not significant** in EIA terms.

Receptor	Sensitivity	Magnitude of impact	Consequence
Thurso designated bathing water	Medium	Negligible	Negligible
Impact significance - NOT SIGNIFICANT			

9.6.2 Potential effects during operation and maintenance

As detailed in section 9.5.2, all impacts identified for the operation and maintenance stage have been scoped out of the water and sediment quality impact assessment. The justification for this is provided in Table 9-20 and the rationale for this agreed by consultees within the Scoping Opinion (MS-LOT, 2022).

9.6.3 Potential effects during decommissioning

In the absence of detailed information regarding decommissioning works, the impacts during the decommissioning of the offshore Project are considered analogous with, or likely less than, those of the construction stage.

The worst case scenario for decommissioning will be a clear seabed, where substructures and foundations that extend below the seabed will be cut approximately 1 m below the seabed to allow removal of the substructure. The same applies for the worst case scenario of the offshore export cables, inter-array cables and the interconnector cables; a clear seabed where some materials may be left *in situ*. The cable ends will be buried at an acceptable depth below the seabed and exposed sections of the cable will most likely be cut and removed or subjected to rock placement.

A Decommissioning Programme will be developed and approved pre-construction to address the principal decommissioning measures for the offshore Project, this will be written in accordance with applicable guidance and will detail the management, environmental management and schedule for decommissioning. Prior to the commencement of any decommissioning works, the Decommissioning Programme will be reviewed and revised as required in accordance with the industry practice at that time. The decommissioning activities are expected to take a similar duration as the construction programme.

Given the nature of the decommissioning activities, which will largely be a reversal of the installation process, the impacts during decommissioning are expected to be similar to, or less than those assessed for the construction stage. Therefore, the magnitude of impacts assigned to water and sediment quality receptors during the construction stage is also applicable to the decommissioning stage. It is also assumed that the receptor sensitivities will not materially change over the lifetime of the offshore Project. Therefore, the decommissioning effects are not expected to exceed those assessed for construction.

9.6.4 Summary of potential effects

A summary of the outcomes of the assessment of potential effects from the pre-construction, construction, operation and maintenance and decommissioning of the Project is provided in Table 9-25.

No significant effects on water and sediment quality receptors were identified. Therefore, mitigation measures in addition to the embedded mitigation measures listed in section 9.5.4 are not considered necessary.

Table 9-25 Summary of potential effects

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Construction and decommissioning						
Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediment	OAA Seabed sediment and water column in the wider environment	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
	offshore ECC Seabed sediment and water column in the wider environment	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
Impacts on water quality status of designated waterbodies	Sule Skerry and Sule Stack Coastal Waterbody (ID: 200239)	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
	Strathy Point to Dunnet Head Coastal Waterbody (ID: 200224)	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
	Cape Wrath to Strathy Point Coastal Waterbody (ID: 200223)	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	Thurso Bay (ID: 200218) Coastal Waterbody	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)
	Thurso designated bathing water	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)

9.7 Assessment of cumulative effects

9.7.1 Introduction

Potential impacts from the offshore Project have the potential to interact with those from other projects (developments), plans and activities, resulting in cumulative impacts on water and sediment quality receptors. The general approach to the cumulative effects assessment is described in chapter 7: EIA methodology and further detail is provided below.

The list of relevant developments that have been included within the cumulative effects assessment is provided in Table 9-26. This has been informed by a screening exercise, undertaken to identify relevant developments for consideration within the cumulative effects assessments for each EIA topic, based on defined Zones of Influence (ZoI).

ZoIs with respect to impacts offshore have been defined by a 20 km buffer around the OAA. The ZoI around the offshore ECC is 30 km. These ZoIs are double the study area extent in order to capture any potential buffer of impacts from other surrounding developments. This accounts for the relative higher sensitivity of coastal receptors compared against the offshore environment.

Table 9-26 List of developments considered for the water and sediment quality cumulative impact assessment

LOCATION	DEVELOPMENT TYPE	DEVELOPMENT NAME	DISTANCE TO OAA (KM)	DISTANCE TO OFFSHORE ECC (KM)	STATUS	CONFIDENCE[15]
West of Orkney	Offshore Wind Farm	West of Orkney Windfarm – transmission connection to the Flotta Hydrogen Hub	0	0	Pre-application	Low
Pentland Firth	Offshore Wind Farm	PFOWF[16]	20	2	Consented	Medium

[15] *Confidence ratings have been applied to each cumulative development where: 'Low' = pre-application or application, 'Medium' = consented and 'High' = under construction or operational.*

[16] *Pentland Floating Offshore Wind Farm (PFOWF) will incorporate the currently consented Pentland Floating Offshore Wind Demonstrator turbine, and hence PFOWF only has been considered. The PFOWF Section 36 Consent and Marine Licence was granted for 10 years. However, the cumulative effects assessment has been based on the Project Design Envelope, as specified within the EIA, and therefore, an operational life of up to 30 years for the PFOWF has been considered. Since consent was granted in June 2023, PFOWF have submitted a Screening Report to MD-LOT with the intention to request a variation to the Section 36 Consent. This variation will incorporate refinements to the Project Design Envelope and to extend the operational life to 25 years.*

LOCATION	DEVELOPMENT TYPE	DEVELOPMENT NAME	DISTANCE TO OAA (KM)	DISTANCE TO OFFSHORE ECC (KM)	STATUS	CONFIDENCE[15]
Pentland Firth (Caithness to Warebeth)	Power transmission cable	Scottish Hydro Electric Transmission (SHET-L) Caithness to Orkney High Voltage Alternating Current (HVAC) Link	22	0	Consented	Medium
Muckle Bay, Caithness to Rackwick Bay, Orkney	Power distribution cable	Pentland Firth East (3) Cable Replacement	26	11	Under construction	High

The following impacts have been taken forward for cumulative assessment:

- Construction and decommissioning;
  - Disturbance and release of contaminated sediments or radioactive particles; and
  - Impacts on water quality status of designated waterbodies due to increased suspended sediment and potential release of contaminants or radioactive particles.

9.7.2 Cumulative construction effects

9.7.2.1 Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediment concentration

As described for the water and sediment quality impact assessment above in section 9.6.1.1, the sensitivity of the water and sediment environment is medium for the OAA and the offshore ECC.

The types of developments considered within the cumulative effects assessment are those within 20 km of the OAA and within 30 km of the offshore ECC. These include the West of Orkney Windfarm transmission connection to the Flotta Hydrogen Hub, the SHET-L Caithness to Orkney HVAC Link, PFOWF and the Pentland Firth East (3) Cable Replacement. There will be temporary seabed disturbance during the construction of these four developments. The replacement works for the Pentland Firth East (3) Cable replacement are anticipated to be complete by August 2023, and therefore, these will not overlap with the offshore Project construction stage. The construction timelines for the

West of Orkney Windfarm transmission connection to the Flotta Hydrogen Hub are unknown; however, an overlap with the construction of the offshore Project cannot be ruled out. There is also no confirmed date for the SHET-L Caithness to Orkney HVAC Link construction, however, the Marine Licence is valid until the end of 2027, so it is it is also possible this development may be constructed at the same time as the offshore Project.

The details of the West of Orkney Windfarm transmission connection to the Flotta Hydrogen Hub are still being finalised. However, it is anticipated that up to five offshore export cables may be installed, with a length of up to 340 km to Hoy. For the SHET-L Caithness to Orkney HVAC Link, it is anticipated that up to 1 km^2 of temporary disturbance may result from the seabed preparation and cable installation activities (Scottish and Southern Electricity (SSE), 2019). There is limited information available on contaminants in the cable lay areas at present. Nonetheless, it is expected that for both of these cable installation developments, any temporary disturbance will be highly localised with any SSC from the cable laying operations quickly settling and returning to background conditions and as such there would be a limited extent of any release of contaminants. For the SHET-L Caithness to Orkney HVAC Link, the cable route also runs through the FEPA Order Zone where radioactive particles may be present. Nonetheless, Condition 17 of the Marine Licence requires that the CEMP includes protocols and mitigation measures to be taken in the case of radioactive particles being suspended or disturbed (Marine Scotland, 2020). Given this condition, it is likely that any disturbance would be managed to ensure impacts are reduced. Furthermore, it is likely that the temporal overlap in the construction activities of these developments and the offshore Project will be limited.

The PFOWF will be in its operation and maintenance stage during the offshore Project construction. Therefore, it is anticipated that any seabed disturbance will be limited to maintenance of subsea infrastructure, if required. The application includes embedded mitigation for protocols to manage radioactivity associated with the FEPA Order Zone and radioactive particles (HWL, 2022c). As such the impacts from cumulative disturbance and release of contaminated sediments or radioactive particles and increases in SSC will be limited during this stage of the development.

Overall, the temporary disturbance of contaminated sediments or radioactive particles and increases in SSC of the cumulative developments will not substantially increase that which is associated with the offshore Project, particularly given the required measures to be undertaken for the SHET-L Caithness to Orkney HVAC Link and the proposed embedded mitigations for the PFOWF which will be in place to minimise disturbance within the FEPA Order Zone. Furthermore, with the implementation of the EMP and pollution control measures including MARPOL convention requirements, as detailed in Table 9-23, from the potential for release of pollution from vessels or equipment during the offshore Project construction activities is limited. Therefore, the impact remains as being of a low magnitude for both the OAA and offshore ECC. As such, the overall cumulative effects are assessed to be minor within the OAA and the offshore ECC. All cumulative effects are not significant in EIA terms.

9.7.2.2 Impacts on water quality status of designated waterbodies

As described for the water and sediment quality impact assessment in section 9.6.1.2, the pathways for impacts to designated waterbodies area considered to be through:

- Increases in SSC;
- Release of chemical contaminants and radioactive particles trapped in sediment into the water column; and
- Risk from marine INNS.

In section 9.6.1.2, for all the designated waterbodies considered, the sensitivity is assessed as medium due to their classification under the WFD and the Bathing Waters Directive.

As introduced in section 9.7.2.1, there is the potential for cumulative development with four developments, as listed above.

For the West of Orkney Windfarm transmission connection to the Flotta Hydrogen Hub and the SHET-L Caithness to Orkney HVAC Link, there is limited information available on contaminants in the cable lay areas. For both developments, temporary disturbance will be highly localised with any SSC quickly settling and returning to background conditions. As such, there would be a limited extent of any release of contaminants. This is particularly relevant in the case of the Cape Wrath to Strathy Point coastal waterbody, and the Thurso designated bathing waters where the extent of sediment release from the offshore Project will not in itself reach these designated waters. The Thurso Bay coastal waterbody marginally overlaps the eastern extent of the maximum plume, nonetheless by this point SSC will be minimal. As such it is extremely unlikely that any cumulative suspended contaminants would extend the extent of the sediment release given the short-lived, temporary, and localised nature of the impact with resettling of sediments occurring quickly after release.

As is the case for the offshore Project, the SHET-L Caithness to Orkney HVAC Link and the PFOWF export cables will be brought ashore within the Strathy Point to Dunnet Head coastal waterbody. The SHET-L Caithness to Orkney HVAC Link and the PFOWF overlap the FEPA Order Zone where radioactive particles may be present. Nonetheless, Condition 17 of the SHET-L Caithness to Orkney HVAC Link Marine Licence requires that the CEMP includes protocols and mitigation measures to be taken in the case of radioactive particles being suspended or disturbed (Marine Scotland, 2020). Additionally, the PFOWF will be in its operation and maintenance stage during the offshore Project construction. Therefore, it is anticipated that any seabed disturbance will be limited to maintenance of subsea infrastructure if required. The application includes embedded mitigation for protocols to manage radioactivity associated with the FEPA Order Zone and radioactive particles (HWL, 2022c). As such the impacts from cumulative disturbance and release of contaminated sediments or radioactive particles associated with these developments will be managed to ensure impacts are reduced for activities associated with these developments.

Furthermore, for the offshore Project, the low occurrence of contaminants and likely low occurrence of radioactive particles within the offshore ECC (given the avoidance of the FEPA Order Zone by the offshore Project) will ensure that any cumulative contamination and suspended sediment impacts with these two developments remain of a low magnitude. It is also considered that as these impacts would be short-lived and close to shore in an area of active metocean conditions, that there would be no depletion in oxygen content within the marine environment that may impact the ecological status of the Strathy Point to Dunnet Head coastal waterbody. As such, there is not anticipated to be any significant cumulative effects which result in the deterioration of the overall status of the Strathy Point to Dunnet Head coastal waterbody. Furthermore, it is likely that if temporal overlap did occur with the construction activities of the two developments that this will be limited.

Due to the offshore location of Sule Skerry and Sule Stack waterbody, there is not considered to be the potential for cumulative effects. Overall, the temporary disturbance of contaminated sediments or radioactive particles of the cumulative developments will not substantially increase that which is associated with the offshore Project, particularly given the required measures to be undertaken for the SHET-L Caithness to Orkney HVAC Link and the proposed embedded mitigations for the PFOWF which will be in place to minimise disturbance within the FEPA Order Zone. There are also no INNS within the OAA or offshore ECC and as such no detriment on water quality status from

distribution of INNS will occur. Furthermore, with the implementation of the EMP and pollution control measures including MARPOL convention requirements, as detailed in Table 9-23, the potential for release of pollution or INNS from vessels or equipment during the offshore Project construction activities is limited. The impact on the Strathy Point to Dunnet Head coastal waterbody remains as being of a **low magnitude**. As there is not considered to be the potential for cumulative effects with the Sule Skerry and Sule Stack waterbody, a **negligible magnitude** is applicable. As such, the overall cumulative effects for the Strathy Point to Dunnet Head coastal waterbody is assessed to be **minor** and is **not significant** in EIA terms, and the Sule Skerry and Sule Stack waterbody is assessed to be **negligible** and is **not significant** in EIA Terms.

In the case of the Cape Wrath to Strathy Point coastal waterbody, the Thurso Bay coastal waterbody and the Thurso designated bathing waters, there is very limited potential for cumulative effects as the extent of sediment release from the offshore Project will not in itself reach these designated waters. As such, the impact on these three designated waterbodies is still considered to be of **negligible magnitude** and therefore, the overall cumulative effects on these designated waterbodies are assessed and **negligible** and **not significant** in EIA Terms.

9.7.3 Cumulative operation and maintenance effects

As detailed in section 9.5.2, all impacts identified for the operation and maintenance stage have been scoped out of the water and sediment quality impact assessment. The justification for this is provided in Table 9-20 and the rationale for this agreed by consultees within the Scoping Opinion (MS-LOT, 2022).

9.7.4 Cumulative decommissioning effects

There is limited information on the decommissioning of the offshore Project and that of other developments. However, the cumulative effects are expected to be less than or equal to the construction stage. Furthermore, decommissioning of multiple other developments would not be expected to occur at the same time as the decommissioning stage of the offshore Project.

A Decommissioning Programme will be developed pre-construction to address the principal decommissioning measures for the offshore Project and will be written in accordance with applicable guidance. The Decommissioning Programme will detail the environmental management, and schedule for decommissioning and will be reviewed and updated throughout the lifetime of the offshore Project to account for changing best practices.

9.7.5 Summary of cumulative effects

A summary of the outcomes of the assessment of cumulative effects for the pre-construction, construction, operation and maintenance and decommissioning stages of the offshore Project is provided in Table 9-27.

Table 9-27 Summary of assessment of cumulative effects

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
Construction and decommissioning						
Disturbance and release of contaminated sediments or radioactive particles and increases in suspended sediments	OAA Seabed sediment and water column in the wider environment	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
	offshore ECC Seabed sediment and water column in the wider environment	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
Impacts on water quality status of designated waterbodies	Strathy Point to Dunnet Head Coastal Waterbody (ID: 200224)	Medium	Low	Minor (not significant)	None required above embedded mitigation measures.	Minor (not significant)
	Sule Skerry and Sule Stack Coastal Waterbody (ID: 200239)	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)
	Cape Wrath to Strathy Point Coastal Waterbody (ID: 200223)	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)

POTENTIAL EFFECT	RECEPTOR	SENSITIVITY OF RECEPTOR	MAGNITUDE OF IMPACT	CONSEQUENCE (SIGNIFICANCE OF EFFECT)	SECONDARY MITIGATION REQUIREMENTS	RESIDUAL CONSEQUENCE (SIGNIFICANT OF EFFECT)
	Thurso Bay Coastal Waterbody (ID: 200218)	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)
	Thurso designated bathing water	Medium	Negligible	Negligible (not significant)	None required above embedded mitigation measures.	Negligible (not significant)

9.8 Inter-related effects

Inter-related effects are the potential effects of multiple impacts, affecting one receptor or a group of receptors. Inter-related effects include interactions between the impacts of the different stages of the offshore Project (i.e., interaction of impacts across pre-construction, construction, operation and maintenance and decommissioning), as well as the interaction between impacts on a receptor within an offshore Project stage. The potential inter-related effects for water and sediment quality receptors are described below.

9.8.1 Inter-related effects between offshore Project stages

As detailed in section 9.5.2, all impacts identified for the operation and maintenance stage have been scoped out of the water and sediment quality impact assessment. This was due to the identified impacts having no ability to result in significant effects. The justification for this is provided in Table 9-20 and the rationale for this agreed by consultees within the Scoping Opinion (MS-LOT, 2022).

As such, there is considered to be a limited potential for any interaction between impacts within the construction and operation and maintenance stage of the offshore Project and no potential for significant effects to arise between these stages.

Given the operational life of the offshore Project anticipated for 30 years there is no potential for inter-related effects between the construction and decommissioning stages due to the short lived nature of any realised effects during construction as detailed in section 9.6.

9.8.2 Inter-related effects within an offshore Project stage

Given the nature of the impacts assessed in section 9.6, there is a direct relationship between potential for release of contaminated sediment or radioactive particles and the potential impacts to water quality status of designated waters. The conclusions of the assessment on potential for release of contaminated sediment or radioactive particles (see section 9.6.1.1) identified no significant effects. Given the clear relationship between these impacts, the conclusion of the assessment on impacts from potential for release of contaminated sediment or radioactive particles has been incorporated into the assessment on water quality status of designated waters, and the assessment identified no significant effects (see section 9.6.1.2). As such, it is considered that the inter-related effects between these two impacts considered in the construction stage have already been adequately assessed in section 9.6 and no significant effects are identified.

9.9 Whole Project assessment

The onshore Project is summarised in chapter 5: Project description and a summary of the effects of the onshore Project is provided in chapter 21: Onshore EIA summary. These onshore aspects of the Project have been considered in relation to the impacts assessed in section 9.6. The findings are presented below.

The onshore Project has the potential to overlap with the Forss Water and River Thurso catchments which drain to the Strathy Point to Dunnet Head and Thurso Bay designated coastal waterbodies (section 9.4.6.2) (see Onshore EIA Report: chapter 8: Geology and hydrology and chapter 9: Freshwater ecology). The Forss Water River and River

Thurso are currently listed in 'Good' overall status (SEPA, 2023b), and as described in section 9.4.6.2 the Strathy Point to Dunnet Head and Thurso Bay coastal waterbodies are also in 'Good' overall status. Impacts from the onshore Project to these surface waters could result in changes to the water quality status of the designated coastal waterbodies into which they drain; however, this will be mitigated using standard embedded mitigation measures (e.g., standard best practice mitigation to avoid sedimentation and pollution) and in line with any conditions issued under the Planning Permission in Principle and/or licences issued under the Controlled Activities (Scotland) Regulations 2005 (CAR). The onshore Project will undertake HDD operations above Mean High Water Springs (MHWS), with an HDD exit point offshore within the offshore ECC. Therefore, there will be avoidance of works in the major watercourses (e.g., River Thurso) through the use of HDD. Furthermore, the use of temporary bridges or n-shaped culverts rather than pipework will be used in watercourses where appropriate for the haul roads as provided in the Onshore EIA Report chapter 9: Freshwater ecology. The impacts within the offshore ECC on water and sediment quality receptors has been assessed in full in section 9.6 and there are considered to be no significant effects. It is not anticipated that there will be any additional impacts from the onshore Project on water and sediment quality receptors. Therefore, the potential for effects between the onshore and offshore Projects activities on water and sediment quality receptors is expected to be minimal and no significant effects are anticipated.

9.10 Transboundary effects

Transboundary effects arise when impacts from a development within one European Economic Area (EEA) state's territory affects the environment of another EEA state(s).

There is no potential for transboundary impacts upon water and sediment quality receptors due to pre-construction, construction, operation and maintenance and decommissioning of the offshore Project. The potential impacts are localised within the extent of the water and sediment quality offshore study area as informed by modelling (the 'West of Orkney model') results. As detailed within the impact assessment, from suspended sediment modelling undertaken for the construction stage, the maximum spatial extent where disturbed sediment be deposited is 7 km from the area of disturbance. Therefore, transboundary effects to water and sediment quality receptors are localised and are not expected to affect other EEA states. This was also agreed with consultees within the Scoping Opinion (MS-LOT, 2022), as detailed in section 9.3.

9.11 Summary of mitigation and monitoring

No secondary mitigation, over and above the embedded mitigation measures proposed in section 9.5.4, is either required or proposed in relation to the potential effects of the offshore Project on water and sediment quality as no adverse significant impacts are predicted. No monitoring[17] is proposed for water and sediment quality.

[17] *Seabed preparations ahead of construction may require dredging and excavated material disposed in designated/licensed disposal sites or within the offshore Project area. Disposal of such material could require a separate Marine Licence application to MD-LOT. Sediment samples would be collected and analysed as required in support of the application.*

9.12 References

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9.13 Abbreviations

ABBREVIATION	DEFINITION
AL	Action Levels
AL1	Action Level 1
AL2	Action Level 2
BDE	Brominated Diphenyl Ethers
BGS	British Geological Survey
Bq	Becquerel
Bq/Kg	Becquerel per kilogram
°C	Celsius / Degrees Celsius
CAR	Controlled Activities Regulations
CCME	Canadian Council of Ministers of the Environment
CEDA	Central Dredging Association
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CFE	Controlled Flow Excavator
cfu	Colony Forming Unit
cm	Centimetre
CREW	Centre of Expertise for Waters
Cs-137	Caesium 137
CSEMP	Clean Seas Environmental Monitoring Programme

ABBREVIATION	DEFINITION
CTD	Conductivity, Temperature and Depth
DBT	Dibutyltin
DDT	Dichlorodiphenyltrichloroethane
DDV	Drop Down Video
DO	Dissolved Oxygen
DSRL	Dounreay Site Restoration Limited
DVV	Dual Van Veen
EASR	Environmental Authorisation (Scotland) Regulations 2018
EC	European Commission
ECC	Export Cable Corridor
E. Coli	Escherichia coli
EEA	European Economic Area
EEC	European Economic Community
EIA	Environmental Impact Assessment
EPA	Environment Protection Agency
EMP	Environmental Management Plan
EQS	Environmental Quality Standards
FEPA	Food and Environment Protection Act
GPP	Guidance for Pollution Prevention

ABBREVIATION	DEFINITION
HDD	Horizontal Directional Drilling
HG	Hamon Grab
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HWL	Highland Wind Limited
IADC	International Association of Dredging Companies
ICES	International Council for the Exploration of the Sea
IE	Intestinal enterococci
INNS	Invasive Non-Native Species
ISQG	Interim Sediment Quality Guidelines
JNCC	Joint Nature Conservation Committee
K-40	Potassium-40
kBq	Kilobecquerel
kHz	Kilihertz
km	Kilometre
km^2	Square kilometre
LEDS	Liquid Effluent Discharge System
LoD	Limit of Detection
m	Metre

ABBREVIATION	DEFINITION
m^2	Square metre
m^3	Cubic metre
MARPOL	The International Convention for the Prevention of Pollution from Ships
MBES	Multibeam Echosounder
MBT	Monobutyltin
MBq	Megabecquerel
MD-LOT	Marine Directorate - Licensing Operations Team
PFOWF	Pentland Floating Offshore Wind Farm
µg/kg	Microgram per kilogram
mg/kg	Milligram per kilogram
mg/l	Milligram per litre
MHWS	Mean High Water Springs
mLAT	Metres below Lowest Astronomical Tide
mm	Millimetre
MSFD	Marine Strategy Framework Directive
MS-LOT	Marine Scotland - Licensing Operations Team
MSP	Marine Spatial Plan
NDA	Nuclear Decommissioning Authority
nm	nautical mile

ABBREVIATION	DEFINITION
NMPI	National Marine Plan Interactive
NVZ	Nitrate Vulnerable Zone
OAA	Option Agreement Area
OCP	Organochlorine Pesticides
OEMP	Operational Environment Management Plan
OIC	Orkney Islands Council
OP	Outline Plan
OSP	Offshore Substation Platform
OSPAR	Oslo and Paris 1992 Convention for the Protection of the Marine Environment of the North-east Atlantic
OWF	Offshore Wind Farm
OWPL	Offshore Wind Power Limited
%	Percent
PAH	Polycyclic Aromatic Hydrocarbon
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated Biphenyls
PEL	Probable Effect Level
PFOW	Pentland Firth Orkney Waters
PPDDE	p,p'-Dichlorodiphenyldichloroethylene
PPDDT	p,p'-Dichlorodiphenyltrichloroethane

ABBREVIATION	DEFINITION
PPG	Pollution Prevention Guidance
PPTDE	p,p'-Dichlorodiphenyldichloroethane
PSA	Particle Size Analysis
psu	Practical Salinity Units
Pu-242	Plutonium-242
RBMP	River Basin Management Plan
RIVM	Dutch National Institute for Public Health and the Environment's (Rijksinstituut voor Volksgezondheid en Milieu)
ROV	Remotely Operated Underwater Vehicle
∑EPA 16 PAH	Sum of the 16 EPA PAHs
∑PCB25	Sum of 25 congeners
∑PCB7	Sum of ICES 7
SBP	Sub-Bottom Profiler
SD	Standard Deviation
SEPA	Scottish Environment Protection Agency
SHET-L	Scottish Hydro Electric Transmission Limited
SPM	Suspended Particle Matter
SS	Supporting Study
SSC	Suspended Sediment Concentrations
SSE	Scottish and Southern Electricity

ABBREVIATION	DEFINITION
SSS	Side Scan Sonar
TBT	Tributyltin
TEL	Threshold Effect Level
THC	The Highland Council
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
TOM	Total Organic Matter
TSHD	Trailing Suction Hopper Dredger
TSS	Total Suspended Solids
UHRS	Ultra High Resolution Seismic
UK	United Kingdom
US	United States
USB	Universal Serial Bus
UXO	Unexploded Ordnance
WFD	Water Framework Directive
WTG	Wind Turbine Generator
ZoI	Zones of Influence

9.14 Glossary

TERM	DEFINITION
Analyte	A substance whose chemical constituents are being identified and measured.
Becquerel	A unit of radioactivity, corresponding to one disintegration per second.
Contaminant	A substance within the sediment in which excess levels of the substance could result in adverse impacts on species or habitats (e.g., toxicity or pollution).
Contamination	Contamination in sediment means sediment that is contaminated as determined by the concentrations of the contaminants, actual circumstances of exposure, biological diversity studies, toxicity testing, or other evidence of harmful effects, as applicable.
Designated waters	A general term used to encompass the designated coastal waterbodies, designated bathing water, designated shellfish water protected areas and nitrate sensitive areas as managed under the River Basin Management Plans and afforded protection through the Water Framework Directive.
Ebb tide	The period between high tide and low tide, during which water flows away from the shore.
Flood tide	The incoming or rising tide, occurring between the time when the tide is lowest and the time when the following tide is highest.
Gamma spectrometry	Gamma spectrometry is a method of measuring the energy and intensity of gamma rays emitted by radioactive elements in samples.
Gross alpha	Gross alpha particle activity means the total radioactivity due to alpha particle emission as inferred from measurements
Gross beta	Gross alpha particle activity means the total radioactivity due to beta particle emission as inferred from measurements
Hydrocarbon	A compound of hydrogen and carbon, such as any of those which are the chief components of petroleum and natural gas.
Limit of detection	The lowest possible concentration of the analyte that can be quantified by the method in a reliable way.
Metocean	Metocean conditions refer to the combined wind, wave and climate (etc.) conditions as found on a certain location.

TERM	DEFINITION
Neap tide	A tide just after the first or third quarters of the moon when there is least difference between high and low water:
Organics	An organic chemical is a chemical compound that contains carbon atoms.
Organotins	Concerned with or being an organic compound with one or more tin atoms in its molecules.
Particle	A very small portion of matter.
Pesticides	a substance used for destroying insects or other organisms harmful to cultivated plants or to animals.
Plume	A material spreading from a particular source and traveling through environmental media, such as air or ground water.
Polybrominated diphenyl ethers (PBDE)	A class of organobromine compounds (organic compounds that contain carbon bonded to bromine) that are used as flame retardants i.e., a substance that prevents or inhibits the outbreak of fire.
Polychlorinated biphenyls (PCB)	Any of a class of toxic aromatic compounds, often formed as waste in industrial processes, whose molecules contain two benzene rings in which hydrogen atoms have been replaced by chlorine atoms.
Remediation	The action of remedying something, in particular of reversing or stopping environmental damage.
Radioactivity	The emission of ionizing radiation or particles caused by the spontaneous disintegration of atomic nuclei. Radiological particles referenced in this chapter refer to those released into the marine environment from the historic practices of the coastal nuclear locations and could cause contamination in the marine environment.
Salinity	The quality or degree of being saline i.e., the quantity of salt within a sample.
Spring tide	A tide just after a new or full moon, when there is the greatest difference between high and low water.
Stratification	The separation of water in layers.
Substrate	A geologic substrate is a surface (or volume) of sediment or rock where physical, chemical, and biological processes occur.

TERM	DEFINITION
Suspended sediment	Sediment transported by a fluid that it is fine enough for turbulent eddies to outweigh settling of the particles.
Tidal excursion	The extent to which suspended sediment, resulting from seabed disturbance from the offshore Project activities, may be carried through physical processes (e.g., spring tides).
Turbidity	Water turbidity is a physical measure within water and is in respect of how clear or cloudy water is.