The Great Grid Upgrade

Eastern Green Link 3 (EGL 3) and
Eastern Green Link 4 (EGL 4)

Preliminary environmental information report (PEIR)

Volume 1, Part 3, Chapter 18 Coastal and Marine Physical Processes

May 2025

nationalgrid

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18. Coastal and Marine Physical Processes

18.1 Introduction

18.1.1 This chapter presents the preliminary findings of the Environmental Impact Assessment (EIA) undertaken to date for the English Offshore Scheme, with respect to the marine physical processes, including hydrodynamics, geomorphology, sediment transport and water/sediment quality. The preliminary assessment is based on information obtained to date, March 2025. It should be read in conjunction with the description of the Projects provided in **Volume 1, Part 1, Chapter 4: Description of the Projects**.

18.1.2 This chapter describes the methodology used, the datasets that have informed the preliminary assessment, baseline conditions, environmental measures, and the effects that could result from the English Offshore Scheme during the construction, operation (and maintenance) and decommissioning phases. Specifically, it relates to the English offshore elements of Eastern Green Link 3 (EGL 3) and Eastern Green Link 4 (EGL 4) (the English Offshore Scheme) seaward of Mean High Water Springs (MHWS) to Scottish waters.

18.1.3 Outputs from the marine physical processes assessments presented in this Preliminary Environmental Information Report (PEIR) chapter inform the assessment of significance of effect from impacts on biological receptors such as a temporary increase in suspended sediments and subsequent deposition, and social receptors such as commercial fisheries and marine archaeology.

18.1.4 This chapter should therefore be read in conjunction with:

- **Volume 1, Part 3, Chapter 19: Intertidal and Subtidal Benthic Ecology**;
- **Volume 1, Part 3, Chapter 20: Fish and Shellfish**;
- **Volume 1, Part 3, Chapter 21: Intertidal and Offshore Ornithology**;
- **Volume 1, Part 3, Chapter 22: Marine Mammals and Marine Reptiles**;
- **Volume 1, Part 3, Chapter 24: Commercial Fisheries**; and
- **Volume 1, Part 3, Chapter 26: Marine Archaeology**

18.1.5 This chapter is supported by the following figures:

- **Volume 3, Part 3, Figure 18-1: Study Area Overview**
- **Volume 3, Part 3, Figure 18-2: Bathymetry**
- **Volume 3, Part 3, Figure 18-3: Peak Flow for a Mean Spring Tide**
- **Volume 3, Part 3, Figure 18-4: Seabed sediments and percentage of fines from PSA**
- **Volume 3, Part 3, Figure 18-5: Seabed sediments and percentage of gravels from PSA**
- **Volume 3, Part 3, Figure 18-6: Seabed sediments and percentage of sands from PSA**

- **Volume 3, Part 3, Figure 18-7: Annual mean suspended particulate matter**
- **Volume 3, Part 3, Figure 18-8: January mean suspended particulate matter (representative of winter month).**
- **Volume 3, Part 3, Figure 18-9: June mean suspended particulate matter (representative of summer month).**
- **Volume 3, Part 3, Figure 18-10: Arsenic and nickel concentrations compared with cAL**
- **Volume 3, Part 3, Figure 18-11: Arsenic and Nickel concentrations compared with the NOAA Effect Range**
- **Volume 3, Part 3, Figure 18-12: Lead and Magnesium concentrations compared with the NOAA Effect Range**
- **Volume 3, Part 3, Figure 18-13: Designated sites and bathing waters in the study area**

18.1.6 This chapter is supported by the following appendices:

- **Volume 2, Part 1, Appendix 1.2.A Regulatory and Planning Context**
- **Volume 2, Part 1, Appendix 1.2.B: Marine Plan Assessment**
- **Volume 2, Part 1, Appendix 1.4.B: EGL 3 Heat Calculations**
- **Volume 2, Part 3, Appendix 1.4.C: EGL 4 Heat Calculations**
- **Volume 2, Part 1, Appendix 1.5.A Outline Register of Design Measures**
- **Volume 2, Part 1, Appendix 1.5.B Outline Code of Construction Practice**
- **Volume 2, Part 1, Appendix 1.5.C Outline Construction Environmental Management Plan**
- **Volume 2, Part 3, Appendix 3.18.A: Fine sediment modelling spreadsheet; and**
- **Volume 2, Part 3, Appendix 3.18.B: Wave modelling.**
- **Volume 2, Part 2, Appendix 2.9.B: Water Framework Directive Technical Note Stage 1 and Stage 2**

18.1.7 As set out in Volume 1, Part 1, Chapter 1 Introduction, cable installation and some associated activities beyond 12 nautical miles (NM) are exempt under the Marine and Coastal Access Act (MCAA) as well as repair of the installed cable. This chapter presents a preliminary assessment of the cable route from MHWS at the Anderby Creek Landfall to the border with Scottish adjacent waters. This is to provide a holistic view of the English Offshore Scheme and any associated impacts; however, consent is not being sought for the exempt cable (either installation or repair) and only cable protection and dredging for sandwave levelling will be included in the deemed Marine Licence (dML) beyond 12 NM.

Limitations

18.1.8 The information provided in this PEIR is preliminary and presents the initial assessment of effects on marine physical processes with the purpose of obtaining feedback from stakeholders to inform the final assessment. The final assessment of significant effects will be reported in the Environmental Statement (ES). The PEIR has been produced to fulfil NGET's consultation duties in accordance with Section 42 of the PA2008 and enable consultees to develop an informed view of the preliminary significant effects of the English Offshore Scheme.

18.1.9 This PEIR has been collated based on a range of publicly available data, supported by available survey data collected for the English Offshore Scheme. At the time of writing some survey data was still being processed and therefore not available to support the preliminary assessment. Data that will be included for the ES include the contaminant information from the EGL 3 Project. Results from the EGL 4 survey are therefore used to support this preliminary assessment.

18.1.10 The project description, including details pertaining to construction methods will continue to be developed, therefore, to address uncertainty in methods and design parameters, a precautionary approach has been adopted.

18.1.11 The full Cable Burial Risk Assessments (CBRA) have not yet been completed. Indicative areas requiring cable protection and pre-sweeping (including volumes) have been calculated based on the existing marine characterisation surveys and these are used to support the PEIR assessments. These will continue to be refined for the ES, taking account of the CBRAs.

18.1.12 The spreadsheet-based model applied for fine sediment dispersion makes a number of assumptions which are not fully representative of real-world conditions. In particular, the spreadsheet-based model assumes a steady state flow in space (but accounts for variations in time which occur due to changes in tidal forcing), whereas in reality, flows will vary both over space and time, altering the plume dispersion. This assumption will most likely result in a more conservative assessment, with the route passing directly through the area of fastest flows and with variations in flow directions expected to divert the plume so that the overall spread is reduced. In addition, the spreadsheet-based model does not account for the effects of flocculation (the process, where fine particles suspended in the water form larger aggregates or flocs), whereas in reality, individual fine particles are expected to floc together, altering their settling velocity. The omission of flocculation will typically result in fine sediments remaining in suspension for longer than they would if flocculation was included, resulting in a conservative assessment of sediment concentrations in suspension.

Preliminary Significance Conclusions

18.1.13 The preliminary marine physical processes assessment presented in **Section 18.10 to 18.15**. has concluded that all the potential effects assessed are **Negligible** and have been assessed as **Not Significant.**

18.1.14 Further details of the methodology behind the assessment, and a detailed narrative of the assessment itself are provided within the sections below.

18.2 Relevant Technical Guidance

18.2.1 The legislation and planning policy which has informed the assessment of effects with respect to Fish and Shellfish is provided within **Volume 2, Part 1, Appendix 1.2.A: Regulatory and Planning Context**. Further information on policies relevant to the English Offshore Scheme is provided in **Volume 1, Part 1, Chapter 2: Regulatory and Policy Overview.** A preliminary marine plan assessment is provided as **Volume 2, Part 1, Appendix 1.2.B: Marine Plan Assessment.** Relevant technical guidance, specific to Fish and Shellfish, that has informed this PEIR and will inform the assessment within the ES is summarised below.

Technical Guidance

18.2.2 Relevant technical guidance, specific to marine physical processes, that has informed this PEIR and will inform the assessment within the ES is summarised below:

- Natural England Offshore wind cabling: ten years' experience and recommendations (Natural England, 2018);
- Nature conservation considerations and environmental best practise for subsea cables for English Inshore and UK offshore waters (Natural England and Joint Nature Conservation Committee, 2022);
- Review of Cabling Techniques and Environmental Effects applicable to the Offshore Wind farm Industry (BERR, 2008);
- General advice on assessing potential impacts of and mitigation for human activities on Marine Conservation Zone (MCZ) features, using existing regulation and legislation (Joint Nature Conservation Committee and Natural England, 2011);
- Guidelines for data acquisition to support marine environmental assessments of offshore renewable energy projects (Centre for Environment, Fisheries and Aquaculture Science (Cefas), 2012);
- Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) Assessment of the Environmental Impacts of Cables (OSPAR, 2009);
- OSPAR Guidelines on Best Environmental Practice (BEP) in cable laying and operation (OSPAR, 2012);
- Offshore wind farms: guidance note for Environmental Impact Assessment in respect of Food and Environmental Protection Act (FEPA) and Coast Protection Act (CPA) requirements: Version 2. (Cefas, 2004);
- Guidance Note. Marine Physical Processes Guidance to inform Environmental Impact Assessment (EIA). GN041. NRW, 2020;
- Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment: Best Practice Guidance. COWRIE (2009);
- Development of cumulative impact assessment guidelines for offshore wind farms and evaluation of use in project making (Durning and Broderick, 2018);
- Nationally Significant Infrastructure projects: Advice on the Water Framework Directive (Planning Inspectorate, 2017).
- Flood Risk Assessments: Climate change allowances, Environment Agency, 2015. Flood risk assessments: climate change allowances - GOV.UK; and

- UK Climate Projections (UKCP) 2018, UKCP18 Science Overview Report, November 2018. UK met. Office.

18.3 Consultation and Engagement

Overview

18.3.1 The assessment has been informed by consultation responses and ongoing stakeholder engagement. An overview of the approach to consultation is provided in **Section 5.9** of **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology**.

Scoping Opinion

18.3.2 A Scoping Opinion was adopted by the Secretary of State, administered by the Planning Inspectorate, on 05 September 2024. A summary of the relevant responses received in the Scoping Opinion in relation to coastal and marine physical processes and confirmation of how these have been addressed within the assessment to date is presented in **Table 18-1.**

18.3.3 **Volume 2, Part 1, Appendix 1.1.A Scoping Opinion Responses** outlines the comments made in the Scoping Opinion in relation to coastal and marine physical processes and how these have been addressed within this PEIR.

18.3.4 The information provided in the PEIR is preliminary and not all of the Scoping Opinion comments have been addressed at this stage, however, all comments will be addressed within the ES.

Table 18-1 - Summary of EIA Scoping Opinion responses for coastal and marine physical processes

Consultee	Consideration	How addressed in this PEIR
Planning Inspectorate	ID 5.1.1 - Disturbance of subtidal seabed morphology during operation can be scoped out so long as the ES clearly demonstrates that significant effects are not likely in relation to pre-sweeping	A spreadsheet-based model has been used to assess the potential for fine sediment dispersion from pre-sweeping during construction, with results presented in **Section 18.12**. Any increases in suspended sediments during operation from pre-sweeping of sandwaves for cable repair would be of similar magnitude but smaller extent than those from construction. Therefore, given that the impact for construction was assessed to be **Not Significant,** the impact for operation is also expected to be **Not Significant.**

Consultee	Consideration	How addressed in this PEIR
Planning Inspectorate	ID 5.1.3 - Temporary increase and deposition of suspended sediments during operation can be scoped out, however the ES should demonstrate that the reduced area and magnitude do not result in a significant effect	A spreadsheet-based model has been used to assess the potential for fine sediment dispersion during construction with results presented in **Section 18.12.** Any increases in suspended sediments during operation from cable repair would be of similar magnitude but smaller extent than those from construction. Therefore, given that the impact for construction was assessed to be **Not Significant,** the impact for operation is also expected to be **Not Significant.**
Planning Inspectorate	ID 5.1.4 - Temporary increase and deposition of suspended sediments during decommissioning cannot be scoped out without additional information on decommissioning techniques	Additional information on decommissioning techniques which could increase sediments in suspension is provided in Section 0**.** Effects during decommissioning would be expected to result in a similar or smaller magnitude impact. Therefore, given that the impact for construction was assessed to be **Not Significant,** the impact for decommissioning is also expected to be **Not Significant.**
Planning Inspectorate	ID 5.1.5 - Modifications to tidal and wave regimes and associated impacts to morphological features during decommissioning cannot be scoped out without a clearer understanding of why the decommissioning effect are expected to be less than those from construction.	Additional information on decommissioning is provided in **Volume 1, Part 1, Chapter 4: Description of the Projects**. An assessment of the potential effect on tidal and wave regimes during decommissioning is provided in **Section 0.**
Planning Inspectorate	ID 5.1.6 - Accidental spills can be scoped out noting the legal requirements upon vessels to manage any accidental releases or spills of materials or chemicals. The ES should include details of the mitigation and explain how its delivery is assured with reference to relevant documents.	Environmental measures are detailed in **Section 18.6**.

Consultee	Consideration	How addressed in this PEIR
Planning Inspectorate and Environment Agency	ID 5.1.7 - Temperature increases during operation cannot be scoped out.	Assessment of potential for temperature increases during operation is provided in **Section 18.15**. This assessment will be refined in the ES following completion of the full CBRAs.
Planning Inspectorate and Marine Management Organisation	ID 5.1.8 - The Marine Management Organisation have highlighted that the potential receptors listed do not encompass the northeast of Farnes Deep HPMA.	A complete list of designated sites, including the northeast of Farnes Deep HPMA is provided in **Section 18.5**. The potential impacts are also assessed in **Volume 2, Part 3, Appendix 3.17.A MCZ Assessment Screening** and **Volume 2, Part 3, Appendix 3.17.B MCZ Stage 1 Assessment**
Marine Management Organisation	ID 5.1.9 - The Marine Management Organisation have requested that tidal surge should be assessed in addition to wave and tidal activity on transport.	Tidal surge is discussed in **Section 18.5** and implications on temporary increases in SSC are addressed in **Section 18.12**.
Joint Nature Conservation Committee	ID 5.1.10 - Potential receptors – all potential receptors should be considered noting spatial impact into a site and receptor and ecosystem pathways.	The list of receptors in **Section 18.7** has been expanded to specifically include the northeast of Farnes Deep HPMA.
Environment Agency	ID 5.1.11 - The ES should clearly set out the climate change scenarios modelled. The SMP policy for epoch 3 is pending approval, while it could still be hold the line there is a need to consider the risk of a foreshore lowering and beach recession – contingency plans should be made to account for this possibility	Trenchless techniques are being adopted for cable installation across the intertidal and tidal rivers. The cable ducts would be into the underlying bedrock below the surficial sediment layer and is therefore not at risk of exposure from beach recession. Potential implications of climate change and extreme climate will be assessed in the Flood Risk Assessment (FRA) as part of the ES.

Consultee	Consideration	How addressed in this PEIR
Environment Agency	The intertidal area at the Anderby Creek Landfall location is directly within the Moggs Eye designated bathing water and under 100 metres from the Anderby designated bathing water. We would expect the assessment to ensure that works within both the onshore and offshore elements do not risk impacting these designated areas. Sutton-on-Sea designated bathing waters is not included in the report.	An updated list of bathing waters is provided in **Section 18.5**. An assessment of impacts on water quality at the designated bathing water sites is provided in **Section 18.12** and **Section 18.14**.

Technical Engagement

18.3.5 Other than Scoping, no other technical engagement has been undertaken that is relevant to coastal and marine physical processes.

18.3.6 In addition to responses to this PEIR, technical engagement with Cefas (and potentially the Environment Agency) will be undertaken to present and discuss the preliminary results from the spreadsheet-based model. Engagement will continue post statutory consultation to inform the final assessments for the ES.

18.4 Data Gathering Methodology

18.4.1 Baseline conditions have been established using a desk-based study of open source data (as reported in the Scoping Report and refined through consultation) and further characterised using Project specific marine survey data.

Study Area

18.4.2 The English Offshore Scheme would route from Anderby Creek across the Southern and Central North Sea to the boundary between the English and Scottish Exclusive Economic Zones (EEZ). The draft Order Limits for the English Offshore Scheme is illustrated in **Volume 3, Part 3, Figure 18-1 Study Area Overview.**

18.4.3 The draft Order Limits are nominally 500 m wide, widening in areas where there are seabed features such as sandwaves, challenging seabed conditions or sensitive habitats to allow micro-routeing. The draft Order Limits match that area characterised by the marine geophysical survey. The English landfall is situated at Anderby Creek on the Lincolnshire coastline.

18.4.4 The study area for coastal and marine physical processes includes the draft Order Limits up to MHWS, plus an additional 15 km buffer either side. This buffer is informed by the tidal excursion, which varies along the English Offshore Scheme. Regional scale modelling tools indicate that the largest tidal excursions occur close to the landfall where they are 10 km on a mean tide (equivalent to around 14 km on a spring tide). Locally, some larger excursions can occur. In other areas of the English Offshore Scheme tidal excursions are much shorter, being around 5 km on a mean tide. The adoption of a 15 km buffer throughout provides a precautionary approach. Kilometre Points (KP s) are used throughout this Chapter to provide context as to where within the English Offshore Scheme a feature lies. The KP s are referenced as KP 0 to KP 436 for the EGL 3 Project and KP 0 to KP 422 for the EGL 4 Project, with KP 0 defined at the Anderby Creek Landfall.

Desk Study

A summary of open source data that has been used in the desk study is outlined, along with information on the nature of the data, in **Table 18-2.**

Table 18-2 - Data Sources Used to Inform the Coastal and Marine Physical Processes Assessment

Organisation	Data source	Data provided
The European Marine Observation and Data Network	EMODnet, (2020, REF 18.1)	Digital Terrain Model (DTM)
UK Hydrographic Office	UKHO, (2014, REF 18.2)	Admiralty bathymetric survey data used to generate navigational charts and a major data source in the EMODnet DTM.
Admiralty Total Tide (ATT) software package	Admiralty (REF 18.3)	Tidal planes and tidal diamonds informing water levels and tidal flows
Environment Agency Coastal Design Sea Levels for the UK	Environmental Agency, (2018, REF 18.4)	Coastal flood boundary conditions around the coast
UK climate change projections	UKCP (2018, REF 18.5)	Sea level rise predictions along the coast
UK Renewable Atlas	ABPmer (2017, REF 18.6)	Maps of tidal range (spring and neap), peak tidal flows (spring and neap) and mean tidal ellipses, annual wave heights and wind speeds.
SEASTATES	ABPmer (2018, REF 18.7)	Modelled hindcast wind and wave data.
WaveNet	Cefas (2025, REF 18.8)	Wave data from offshore wave buoys.

Organisation	Data source	Data provided
Climate System Forecast Reanalysis (CFSR)	Saha *et al.,* (2010, REF 18.9)	Hourly hindcast wind data at 0.2 degree resolution, spanning 44 years (1979 to 2023), used to drive SEASTATES.
British Geological Survey (BGS)	BGS, (2021, REF 18.10)	Maps of seabed sediments, quaternary deposit thickness and structural geology offshore.
Shoreline Management Plan – SMP3	Scott Wilson, (2010 REF 18.11)	Local annual surveys of coastline.
Shoreline Management Plans	Department for Environment, Food & Rural Affairs, (2025 REF 18.12)	Details on current and future shoreline management approach.
Joint Nature Conservation Committee Coasts and seas of the UK	Barne *et al.,* (1996 REF 18.13)	Region 3 North-east Scotland: Cape Wrath to St. Cyrus – description of coastal landform, sediment transport and geology.
Joint Nature Conservation Committee Coasts and seas of the UK	Barne *et al.,* (1995 REF 18.14)	Region 6 Eastern England: Flamborough Head to Great Yarmouth – description of coastal landform, sediment transport and geology.
Kenyon and Cooper	Kenyon and Cooper (2005, REF 18.15)	Sediment transport pathways in the North Sea
Cefas	Cefas (2016, REF 18.16)	Suspended Particulate Matter (SPM) – monthly, seasonal and annual maps. We understand that an updated climatology is expected in the coming months but this is not yet available.
Database on the Marine Environment	DOME, (2023, REF 18.17)	Sediment quality data
Environment Agency Bathing Waters map and monitoring data	Magic, (2023, REF 18.18)	Water quality
Joint Nature Conservation Committee	Joint Nature Conservation Committee, (2023, REF 18.19)	Marine Designated Sites shape file layer.
Crown Estate Marine Data Exchange	RWE Npower, (2012, REF 18.20), Offshore Wind Power, (2003, REF 18.21)	Environmental Impact Assessment Report (EIAR) for English OWF projects including Triton Knoll, Lincs, Lynn and Inner Dowsing, Hornsea 1 and 2.

Survey Work

18.4.5 To inform the baseline within the study area, a range of environmental and technical surveys have been conducted. A method statement for the marine characterisation survey was agreed with Marine Management Organisation, Cefas, Joint Nature Conservation Committee and NE prior to the survey commencing.

18.4.6 Marine characterisation surveys consisting of geophysical, geotechnical and environmental survey techniques were undertaken on a nominal 500 m wide corridor on the EGL 3 Project and the EGL 4 Project between September 2023 and November 2024. The dates for the survey campaigns are provided in **Table 18-3**.

Table 18-3 - Marine Characterisation Survey Campaign Dates

Survey	EGL 3	EGL 4
Anderby Creek Intertidal	26 Oct 2023 – 02 Nov 2023	26 Oct 2023 – 02 Nov 2023
Geophysical – Nearshore	21 Aug 2023 – 22 Aug 2023 (onboard SHORE Presence)	18 Sep 2023 – 29 Nov 2023
	22 Aug 2023 – 09 Sep 2023 (onboard SHORE Opportunity)	
	18 Sep 2023 – 30 Sep 2023 (onboard Deep Seapal)	
	01 Oct 2023 – 05 Oct 2023 (onboard SHORE Possibility)	
	08 Nov 2023 – 25 Jan 2024 (onboard Miranda)	
Geophysical – Offshore	14 Aug 2023 – 10 Nov 2023 (onboard Ievoli Cobalt)	03 Nov 2023 – 28 Mar 2024
Geotechnical – Nearshore	07 Jul 2024 – 15 Sep 2024 (onboard Viking Energy)	07 Jul 2024 – 03 Sep 2025 (onboard Viking Energy)
	01 Nov 2024 – 06 Nov 2025 (onboard NG Driller)	05 Nov 2024 – 06 Nov 2024 (onboard NG Driller)
Geotechnical - Offshore	15 Dec 2023 – 25 Jun 2024 (onboard Ievoli Grey)	21 Jul 2024 – 04 Sep 2024 (onboard Geo Ocean III)
Environmental – Nearshore	16 Sep 2024 – 25 Sep 2024 (onboard Viking Energy)	-16 Sep 2024 – 25 Sep 2024 (onboard Viking Energy)
	21 Sep 2024 – 08 Oct 2024 (onboard Ievoli Grey)	21 Sep 2024 – 08 Oct 2024 (onboard Ievoli Grey)
Environmental - Offshore	20 Jun 2024 – 05 Aug 2024 (onboard Ievoli Grey)	12 Jun 2024 – 20 Jul 2024 (onboard Geo Ocean IX)

18.4.7 The objectives of the geophysical survey were to:

- Map the intertidal area, seabed and sub-surface to optimise cable routeing within the proposed cable corridor and to enable assessment of cable burial depth.
- Plan the scope and position of the geotechnical and environmental sampling programme.
- Identify marine habitat areas from which the benthic survey can be undertaken.
- Identify sensitive marine habitats which will need to be avoided during geotechnical and environmental sampling and cable installation.
- Provide the geophysical data from which a marine archaeological assessment can be undertaken as part of the future consenting process.

18.4.8 To meet these objectives, the geophysical survey undertook the following:

- Measured intertidal topography and seabed bathymetry, surface morphology and identify the nature of the seabed sediments - in particular the height, length and slopes of bedforms using multibeam echosounder (MBES) and sidescan sonar (SSS).
- Identified the distribution and thickness of superficial sediments and rock head using sub-bottom profiling (SBP).
- Identified the distribution of subsea geological features such as areas of exposed bedrock using MBES and SSS.
- Identified the location, extent and nature of any impediments to laying or burial of the cables such as wrecks, debris on seafloor, rock outcrop, other cables, pipelines etc. Survey techniques deployed to meet this objective included magnetometer, MBES, and SSS.
- Used a remotely operated vehicle at third-party crossings (e.g., existing in-service cables) to survey 200 m either side of the proposed crossing location to confirm the location of the asset and its depth of burial. The survey provided accurate information that will be used when designing infrastructure crossings.

18.4.9 The interpretation of the geophysical survey was used to focus the geotechnical and environmental survey strategies.

18.4.10 The purpose of the geotechnical survey was to evaluate the nature and mechanical properties of the superficial intertidal and seabed sediments. Vibrocores and cone penetrometer tests (CPTs) were acquired at regular intervals along the EGL 3 Project and the EGL 4 Project. This allowed for both ground truthing of the geophysical interpretation but also testing to determine mechanical properties.

18.4.11 The benthic survey is described in detail in **Volume 1, Part 3, Chapter 19: Intertidal and Subtidal Benthic Ecology.** However, of note to the characterisation of marine physical processes, the survey included the acquisition of sediment samples, which were used to determine sediment composition (including particle size) and tested for sediment contamination (heavy and trace metals, total organic carbon and presence of hydrocarbons). Water profiling was undertaken at 120 stations across the English Offshore Scheme recording conductivity, temperature and depth to assist in identification of the physio-chemical parameters of the water column.

18.4.12 Not all survey reports were available for the preparation of the PEIR and this chapter and assessments will be updated for the ES to include all results. Despite this, many of the results from the survey have been made available for use in the PEIR.

18.4.13 The following survey reports were available for the PEIR:

- Environmental baseline assessment and habitat assessment survey for the EGL 4 Project (GEOxyz, 2024 REF 18.22)
- Environmental baseline assessment and habitat assessment survey for the EGL 3 Project (REF 18.1, and REF 18.23).
- Integrated Geophysical and Geotechnical Survey Report for the EGL 3 Project (Ref 18.24)

18.5 Overall Baseline

Current Baseline

18.5.1 This section provides an overview of the coastal and marine physical processes baseline in the study area.

18.5.2 Following the organisation presented in the scoping report, this section has been divided into the following topics:

- Bathymetry and seabed features
- Water Levels
- Currents
- Winds and Waves
- Temperature and Salinity
- Geology and Seabed Sediments
- Geomorphology and Sediment Transport
- Coastal Geomorphology
- Sediment and Water Quality
- Designated Sites

Bathymetry and Seabed Features

18.5.3 The EMODnet Digital Terrain Model (DTM) has been used to inform baseline understanding of bathymetry across the wider study area, with the detailed bathymetric survey data used to enhance understanding of water depths along the English Offshore Scheme.

[1] NextGeo document code: P2101-010-REP-005-OFS-NSH-EGL3, Benthic Solutions document code: BSL2335_OFS_HAS_00

18.5.4 Water depths across the study area generally increase with distance along the English Offshore Scheme for both the EGL 3 Project and the EGL 4 Project, being -25 m lowest astronomical tide (LAT) offshore of Spurn Head at KP 60, -55 m LAT offshore of Flamborough Head at KP 150 and >-75 m LAT at the northern end of the study area beyond KP 300 (**Volume 3, Part 3, Figure 18-2 Bathymetry)**.

18.5.5 Other than the gradual deepening along the English Offshore Scheme, significant bathymetric features are constrained to within approximately 50 km off the Lincolnshire coast. The most prominent of these being Silver Pit (a naturally deep, glacially carved channel with steep-sided topography), reaching depths of -96 m LAT. Both the EGL 3 Project and EGL 4 Project transit through the northern end of Silver Pit (between KP 65 and KP 68.5 for the EGL 3 Project and between KP 65 and KP 68 for the EGL 4 Project) where the channel is approximately 3 km wide with depths of approximately -50 m LAT.

18.5.6 Although the southern North Sea contains several regions of sandbanks, the draft Order Limits do not intersect these areas. There are several smaller shoals and banks adjacent to the draft Order Limits including:

- Inner Dowsing sandbank (approximately 8 km east southeast (ESE) from the EGL 3 Project, KP 7) - approximately 3 km wide with water depth ranging from -1 to -30 m LAT.
- North Ridge and Race Bank (approximately 25 km ESE from the EGL 3 Project, KP 35) – banks situated within The Wash Approaches with generally shallow water depths of less than -30 m LAT up to -4 m LAT.
- Outer Dowsing Shoal (approximately 11 km south southeast (SSE) of the EGL 3 Project, KP 72) - shallow-water sand bank aligned northwest (NW) – southeast (SE), approximately 19.5 km long and rarely more than 1 km wide. Running roughly parallel to the immediate southwest of the bank is the Outer Dowsing Channel with depths of approximately -45 m LAT.

Water Levels

18.5.7 Data from the UK renewables atlas (ABPmer, 2017 REF 18.25) and the ATT software package have been used to inform the baseline understanding on tidal levels across the study area, while data from the Environment Agency's coastal flood boundary conditions (EA, 2018 REF 18.26) and from the UK climate change projections (UKCP, 2018 REF 18.27) have been used to inform the baseline understanding of non-tidal influences on water levels.

18.5.8 Water levels in the study area are predominantly driven by tidal processes. Tides in the study area are semi-diurnal, with two high and two low tides per day. Tidal planes have been extracted from the ATT software package at Skegness (at the southern extent of the study area on the coast) and at T022B (approximately 28 km west of KP 395) and are given in **Table 18-4**. The tides vary across the study area, with largest spring tidal ranges of approximately 6 m close to the Anderby Creek Landfall, reducing offshore and northwards to 2.5 m at the northern extent of the study area. Neap tidal ranges are approximately half the spring tidal range. The tide arrives from the north so that high water at the northern extent of the study area occurs approximately three hours before high water at the Anderby Creek Landfall.

Table 18-4 - Tidal Levels Extracted from ATT at Locations in the Study Area

	Tide Level (m relative to LAT)	
	Skegness	T022B – approx. 28 km west of KP 395
Highest Astronomical Tide (HAT)	7.4	4.0
MHWS	6.7	-
Mean High Water Neap (MHWN)	5.1	-
Mean Low Water Neap (MLWN)	2.3	-
Mean Low Water Spring (MLWS)	0.7	-

18.5.9 Non-tidal or meteorological effects can also influence the water level. The heights of extreme surge levels are provided for a range of return periods, along with the probability of occurrence during the 40 year design life in **Table 18-5.** Values are quoted relative to Mean Sea Level (MSL), which is 3.8 m above LAT at Skegness.

Table 18-5 - 95th Percentile Extreme Water Levels for 2020 at Anderby Creek Landfall Site (EA, 2018 REF 18.4)

Return Period (years)	Level (m relative to MSL)	Probability of occurrence in 40 years (%)
1	3.81	100
10	4.17	99
50	4.49	55
100	4.62	33
200	4.78	18
500	5.01	8

Currents

18.5.10 Data from the UK renewables atlas (ABPmer, 2017 REF 18.2525) and the ATT software package have been used to inform the baseline understanding on tidal flows across the study area. Peak spring tidal flows across the study area are shown in **Volume 3, Part 3, Figure 18-3 Peak Flow for a Mean Spring Tide**.

18.5.11 Tidal currents in the study area are generally orientated southwards on the flood tide and northwards on the ebb tide. The currents close to the landfall in the study area are bi-directional in nature, aligned with the coast, while currents become slightly more orbital in nature offshore. The fastest currents occur offshore of Spurn Head where peak spring tide current speeds are up to approximately 1.4 m/s. Current speeds reduce inshore and in a northward direction with spring tide current speeds of 1 m/s close to the landfall and of 0.45 m/s at the northern end of the study area. Peak neap current speeds are approximately half the quoted peak spring tide current speeds.

18.5.12 There is a slight dominance in the southward flowing flood currents, particularly in the southern part of the study area. Superimposed on the regional scale flow pattern, local flow variations can be expected to occur in response to bathymetric features (for example to realign with channel features, or around banks).

18.5.13 The southern North Sea is particularly prone to surge-driven flows during winter months, when intense low-pressure systems, particularly from the North Atlantic, dominate the region. These systems can generate strong easterly and / or northerly winds and heightened sea levels, driving elevated surge flows into the southern North Sea which is relatively shallow compared to the deeper North Sea basins. These flows are accentuated by strong surface winds, occurring at high tide (particularly during a spring tide), topography that funnels flows into narrow channels, and shallow regions of sea bed including coastlines. Elevated surge flows can temporarily lead to an increase in sediment resuspension and transport, particularly in shallow regions and along coastlines (Spencer *et al.,* 2013 REF 18.28*).*

Winds and Waves

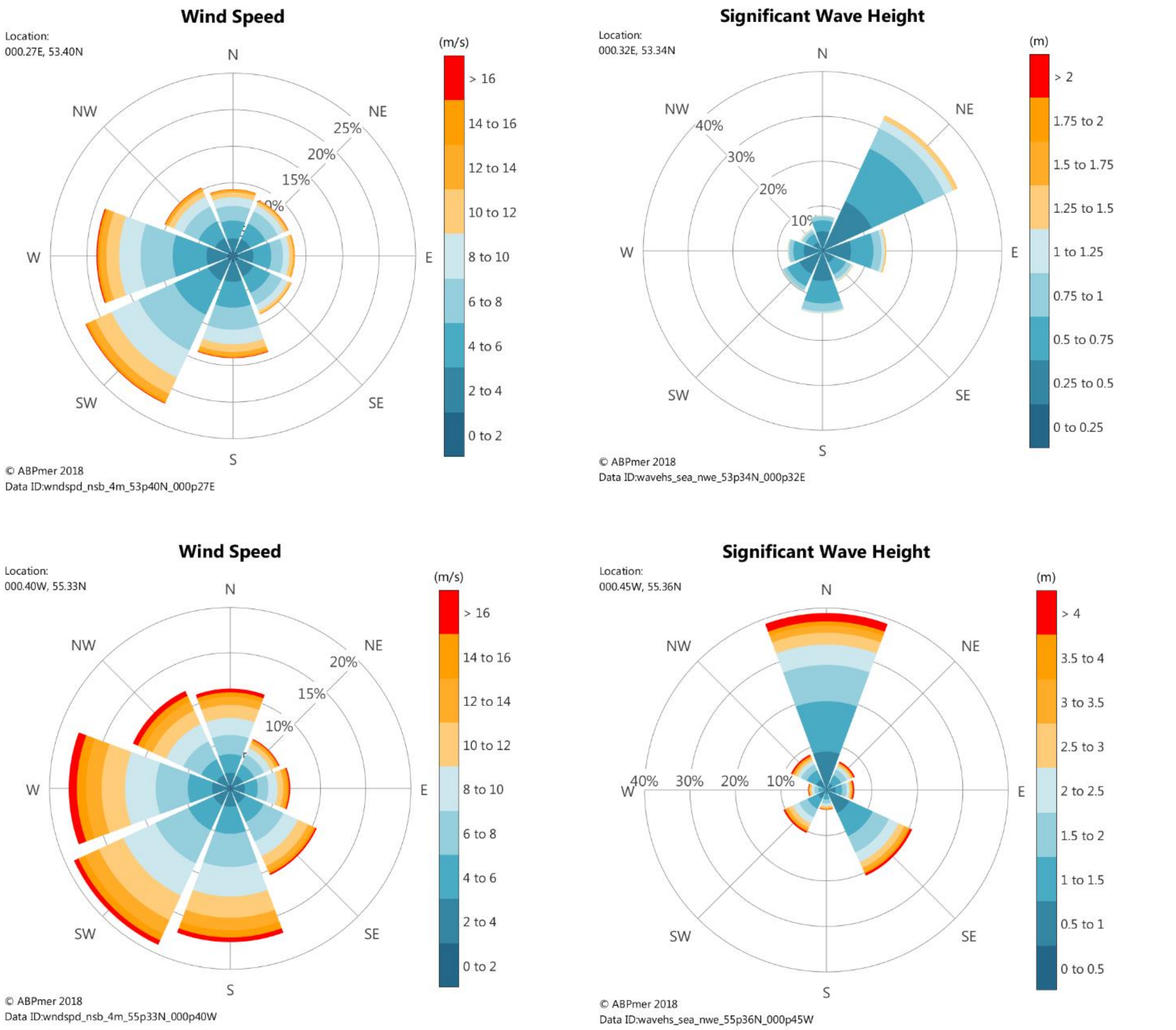
18.5.14 Climatological wind and wave data from SEASTATES (ABPmer, 2018 REF 18.29) have been used to inform the baseline understanding of the wind and wave climate across the study area. SEASTATES is driven by the CFSR wind dataset (Saha *et al*., 2010 REF 18.9).

18.5.15 Prevailing winds across the study area are from the south to west sectors. The strength of the winds increases with distance offshore (due to the effect of coastal sheltering to the dominant wind directions inshore), with mean wind speeds of 6.4 m/s at KP 14 (close to the landfall), increasing to 8.1 m/s at KP 306 (close to the northern extent of the study area). Wind roses at KP 14 and KP 306 are shown in **Plate 18-1**.

18.5.16 The wave climate across the study area is controlled by a combination of locally generated wind waves and swell waves generated elsewhere in the North Sea. The primary wave direction along the English Offshore Scheme changes, with waves most frequently from the northeast close to the landfall and from the north further offshore. This change reflects the varying fetch lengths for different wind directions with distance along the English Offshore Scheme.

18.5.17 In addition to the change in direction, wave heights reduce in an inshore direction as a result of friction effects in the shallower nearshore waters. Mean significant wave heights close to the northern extent of the study area (at KP 306) are 1.7 m, reducing to 0.6 m close to the landfall (at KP 14). There is a seasonal trend in the wave climate with smallest mean significant wave heights in the summer months and largest mean significant wave heights in the winter months (up to 2.1 m at KP 306). Wave roses at KP 14 and KP 306 are shown in **Plate 18-1**.

Plate 18-1: Wind and Wave Roses at KP 14 (Upper Panels) and KP 306 (Lower Panels) (ABPmer, 2018 REF 18.29)



Temperature and Salinity

18.5.18 In the southern North Sea, winter sea temperatures typically range from 4 °C to 8 °C, while summer sea surface temperatures vary between 16 °C and 19 °C, with minimal changes both vertically and from nearshore to offshore (UKMMAS, 2010 REF 18.30). Salinity levels decrease both southward and towards the coast, influenced by freshwater inputs from surrounding landmasses. South of the Dogger Bank, salinities average around 34.8, decreasing to below 34.6 near the UK coast.

18.5.19 The EGL 4 marine surveys showed that:

- The nearshore region water column was well mixed with homogenous temperature values of 12 - 14 °C, and for offshore sites, the top 10 m of the water column was generally well mixed with temperature values ranging between 11 - 14 °C.

- The presence of a thermocline varied with the majority of stations showing a thermocline between 15 - 25 m below LAT, shallower offshore stations showed no evidence of a thermocline, and deeper stations revealed a thermocline between -20 to -35 m LAT.
- The majority of offshore sites showed homogeneous mixed salinity values through the full water column, with some offshore sites revealing a halocline between -20 and -35 m LAT.
- Most nearshore sites had a mixed surface layer which became more homogenous with increasing water depth. A few nearshore sites showed a halocline between 0 to -5 m LAT indicating variable salinity across the surface of the water column.

18.5.20 While no similar data was collected during the EGL 3 marine survey, due to the close proximity of the EGL 3 Project and the EGL 4 Project, data collected as part of the EGL 4 marine survey is considered to provide a good representation of temperature and salinity across the study area.

Geology and Seabed Sediments

18.5.21 The bedrock geology across the study area is characterised by sand and clay based surficial sediments, overlaying glacial tills, comprised of gravels and stiff clays[31]. A number of similar formations consisting of middle to Late Pleistocene deposits of firm clays with interbedded sands, fine to medium sands and gravels, and poorly sorted sands predominate much of the route (Anderby Creek to northeast of Newcastle). Bedrock is pre-quaternary in origin, and consists of sedimentary bedrock in the south, and crystalline bedrock to the north (Geoxyz, 2025 REF 18.31) (Next Geosolutions, 2025 REF 18.32).

18.5.22 The thickness of surficial sediments across the study area is typically around 5 m. The nearshore sections are characterised by thinner than average deposits, while the deepest patches of surficial sediments are found between KP 80 and 100, where thicknesses of 10 m to 12 m are typical. Between the Humber and Tyne Estuaries (EGL 3 KP 97 to KP 288 and EGL 4 KP 83 to KP 278), the thickness of surficial sediments is consistently around 5 m. North of the Tyne estuary, surficial sediments become thinner, ranging between 2.6 m and 0.1 m (REF [31]). Cable burial may not be possible in all areas of thicker surficial sediments, for example in areas of high strength clays.

18.5.23 The percentages of fines, sands and gravels from the marine characterisation survey results are shown in **Volume 3, Part 3, Figure 18-4 Seabed sediments and percentage of fines from PSA to Figure 18-6 Seabed sediments and percentage of gravels from PSA**. Surficial sediments in the study area are predominantly sands. Shallower portions of the route, from the Humber Estuary (KP 50) to the eastern edge of the Holderness Offshore MCZ (EGL 3 KP 90 and EGL 4 KP 83) are characterised by a comparatively higher fraction of gravels. These areas are generally classed as “Sandy gravel” under the Folk classification system. The majority of stations north of this section are classified as “Sand”, “Muddy Sand” & “Gravelly Sand”. The difference in sand proportion is attributed to differences in water depth across the English Offshore Scheme, with the deeper areas being less exposed to current flows, encouraging the deposition and accumulation of finer gran sizes.

18.5.24 The study area intersects some active marine aggregate extraction zones including Humber (Area 514) 1, 2, 3 and 4 to the north of the draft Order Limits close to KP 53 and Off Saltfleet (Area 197), Humber Estuary (Area 400 and Area 106) and Humber Overfalls (Area 493) to the south of the draft Order Limits close to KP 20 to KP 30, all of which are licenced until at least the end of 2029.

Geomorphology and Sediment Transport

18.5.25 Net sediment transport in the study area is southwards close to shore, driven by the tidal asymmetry (with residual tidal flows to the south) (Kenyon and Cooper, 2005 REF 18.33). Further offshore there is a bed-load parting zone (an area where sediment transport pathways diverge, causing sediment to be transported in different directions), beyond which the net sediment transport is northwards. The English Offshore Scheme crosses the bed-load parting zone at around KP 30, which is therefore an area of low net sediment transport. Further north the sediment transport is driven by wave action and little sediment transport is expected (with wave driven transport restricted to shoals and/or storm events).

18.5.26 Megaripples and sandwaves dominate the southern portion of the seabed geomorphology (south of KP 200). Smaller, less contiguous sections of megaripples occur in the northern portion of the route. Low density boulder fields were identified along the EGL 3 submarine cable corridor in the geophysical survey, with the density of boulder fields increasing in the southern portion of the EGL 3 submarine cable corridor. The highest density of boulders is where the EGL 3 and EGL 4 submarine cable corridors pass around the MCZ, between KP 95 and KP 110 (UKMMAS , 2010 REF 18.3030).

18.5.27 Surge driven flows in the study area are not expected to contribute significantly to sediment transport (Kenyon and Cooper, 2005 REF 18.15).

Coastal Geomorphology

18.5.28 The coastline within the study area extends along the Lincolnshire coast from Sand Hail Flats in the north to just north of Gibraltar Point in the south. The coastline is generally made up of soft geology (predominantly gravelly sand and gravelly muddy sand) with many wide sandy beaches up to Donna Nook, decreasing in width towards Mablethorpe. The beaches and sand flats in this region are accreting, fed by sediment from the eroding Holderness cliffs, with a greater build up occurring at the top of the beaches than at the bottom resulting in a steepening of the beaches (Scott Wilson, 2010 REF 18.11).

18.5.29 At Donna Nook and Gibraltar Point there is extensive and well-developed salt marsh. In some locations (including Donna Nook, Saltfleetby and Gibraltar Point) sand dunes have formed.

18.5.30 The beaches further south between Saltfleetby and Gibraltar Point (including the landfall) are formed of a thin layer of sand, overlying clay. Historically during storms, the thin layer of sand has been eroded exposing the underlying clay. To counter this erosion the Environment Agency undertakes annual beach nourishment along the entire coast between Mablethorpe and Skegness. The beach nourishment has been undertaken over the past 30 years and the current management strategy is for continued beach nourishment. Each year between Easter and mid-July, a dredger is used to transport approximately 400,000 m^3 of sand from licenced offshore sites and pump it onto the beach (Environment Agency, 2025 REF 18.34). Much of this coastline also has a variety of ‘hard’ defences and dunes behind the beaches which, along with the ongoing beach nourishment, provide protection against flooding. Beaches where nourishment occurs include the landfall site at Huttoft and Moggs Eye. Huttoft Beach is backed by a seawall and grassy dunes.

18.5.31 The ongoing beach nourishment offsets the natural tendency for erosion along the coastline, but it does not prevent the net southward longshore drift.

18.5.32 The Lincolnshire shoreline management plan along the coastline within the study area is to hold the line for the epoch 2025 to 2055. The strategy for 2055 to 2105 is pending agreement.

Sediment and Water Quality

18.5.33 Data from the Cefas Suspended Sediment Climatology model (Cefas, 2016 REF 18.35) provides long term average (1998 to 2015) annual and monthly readings of non-algal suspended particulate matter (SPM) (note that Cefas use the term non-algal SPM rather than Suspended Sediment Concentration (SSC), but these terms are analogous and further discussion adopts the term SSC). An updated climatology considering data collected over a longer duration is believed to be under development but as of March 2025 has not yet been made publicly available. The availability of an updated climatology will be checked for the ES.

18.5.34 SSC is highly variable, both spatially and temporally, depending on proximity to terrestrial sources, water depth, current regimes and weather conditions (UKMMAS 2010 REF 18.3030). The climatology shows that over the period between 1998 – 2015, annual mean SSC values are approximately 35 mg/l close to the landfall (up to KP 7) reducing to 15 mg/l at KP 30 and 5 mg/l at KP 50. SSC is less than 1 mg/l from KP 172 to the northern extent of the study area, as shown in **Volume 3, Part 3, Figure 18-7 Annual mean suspended particulate matter**.

18.5.35 SSC is also seasonally variable as depicted in **Volume 3, Part 3, Figure 18-8 January mean suspended particulate matter (representative of winter month) and Figure 18-9 June mean suspended particulate matter (representative of summer month)**, which show representative months for winter (January) and summer (June), respectively. In January, SSC is significantly higher than in June, especially along the coastal areas and extending offshore within the southern section of the study area and over Dogger Bank. This is likely due to increased winter storm activity, stronger wave action, and turbulent mixing, which resuspend sediments from the seabed (Stanev *et al*., 2008 REF 18.36). In contrast, summer months show a decrease in SSC, particularly along the coastline and offshore areas. This reduction is likely attributed to calmer sea conditions and potentially increased biological productivity causing sediment particles to settle.

18.5.36 It should be noted that these measurements of SSC are representative of near-surface conditions under non-storm / cloud free conditions and as such are likely to provide an underestimate of average conditions, particularly in close proximity to the seabed. Other studies have shown that there are likely to be frequent short-term increases in background SSC in the near-bottom waters as a result of natural events, with much higher values during storm events (UKMMAS 2010 REF 18.3030).

18.5.37 The draft Order Limits pass through the Water Framework Directive (WFD) Lincolnshire water body, which is classed as a moderately exposed macrotidal water body (Water body ID GB640402492000). There are designated bathing waters at Mablethorpe Town, Sutton-on-Sea, Moggs Eye (renamed Huttoft and Marsh Yard in 2024) and Anderby. All four have achieved ‘Excellent’ status for 2024, having maintained this classification for more than the last six bathing seasons (based on samples taken from 2018 through to 2024, with no data available for 2020). Unofficially, it is considered by the Environment Agency that the full coastline from Mablethorpe to Anderby is a bathing water. The bathing water of Huttoft and Marsh Yard is traversed by the draft Order Limits, while Anderby is approximately 200 m to the south of the draft Order Limits.

18.5.38 The concentrations of metals in sediments within the North Sea are generally higher in the coastal zone and around estuaries, decreasing offshore indicating that river input and run-off from land are significant sources. The sediments within the study area are typically coarse sediments (sands and gravels with only low mud content), which pose a low risk for anthropogenic contaminants.

18.5.39 Sediment samples from the marine characterisation survey collected from 54 locations along the EGL 4 Project were analysed for trace and heavy metals, specifically aluminium (Al), arsenic (As), barium (Ba), cadmium (Cd), chromium (Cr), copper (Cu), lead (Pb), lithium (Li), mercury (Hg), nickel (Ni), Tin (Sn) and Zinc (Zn). In addition, samples were analysed for total organic carbon and presence of hydrocarbon. No results were available for EGL 3 at the time of writing, but these will be analysed and presented in the ES.

18.5.40 Analysis of the samples corroborated the expected spatial pattern for lower concentrations at offshore relative to nearshore sites. Concentrations of total organic carbon and total hydrocarbon content were relatively low in the offshore sampling stations, and higher in the nearshore. Nearshore in this instance is defined as being from the landfall, to KP 95. In the case of total organic carbon, this is attributed to the higher proportion of fines in the sediment, and influence of runoff from the Humber estuary catchment. Both total organic carbon and presence of hydrocarbons showed a negative correlation with increased distance from the Humber Estuary. It is suggested the source of hydrocarbons are both diffuse (from the Humber Estuary), and petrogenic material from industrial activities (e.g., shipping)[31]. The presence of heavy metals was low in offshore sample stations, negatively correlating with distance from the Humber Estuary, but positively correlating with locations for which total hydrocarbon content is high[31].

18.5.41 A variety of reference values are used to assist in the interpretation of the sediment quality data as no approach is relevant for all the sediment quality analyses undertaken. Contaminant concentrations were compared with Cefas action levels (cAL) 1 and 2 (Marine Management Organisation, 2015 REF 18.37). Cefas action levels are non-statutory and are intended to inform decision making on the disposal of dredged sediment to sea rather than as indicator of contamination. Levels below cAL1 are of no concern, while levels above cAL2 are generally considered to be unsuitable for disposal at sea. NOAA developed the Effect Range Low (ERL) and Effect Range Median (ERM) levels for hydrocarbons and metals, whereby at that level adverse effects were reported in 10% (ERL) and 50% (ERM) of the data (Buchman, 2008 REF 18.38).

18.5.42 Statistics of all offshore and nearshore sampling stations from the Environmental Baseline report[31] are summarised in Table 18-6, with reference given to the number of samples exceeding the cAL1 and ERL reference value thresholds. In addition, map plots showing contaminant levels are shown for parameters which exceed the cAL 1 threshold (**Volume 3, Part 3, Figure 18-10 Arsenic and nickel concentrations compared with cAL** – only As and Ni) and for parameters which exceed ERL (**Volume 3, Part 3, Figure 18-11 Arsenic and Nickel concentrations compared with the NOAA Effect Range** for As and Ni and **Volume 3, Part 3, Figure 18-12 Lead and Magnesium concentrations compared with the NOAA Effect Range** for Pb and Hg).

18.5.43 As is the metal to most exceed both cAL1 and ERL. Seven offshore samples and one nearshore sample exceeded cAL1, while 15 and 17 samples in the offshore and nearshore, respectively exceeded the lower ERL threshold. Pb, Hg and Ni are seen to exceed ERL at one sample location offshore, while in the nearshore, three sites exceed the ERL threshold for Ni.

18.5.44 No samples of any contaminant exceeded the higher levels of threshold (cAL2 and ERM).

18.5.45 The results from the survey are consistent with results presented in the Scoping Report based on sediment quality samples from the International Council for the Exploration of the Sea (ICES) DOME Portal (DOME, 2023 REF 18.39). Sediment sampling from OWF studies also concluded that seabed sediment does not contain significant levels of pollution (although these studies were constrained to the southern part of the study area only).

Table 18-6 - Heavy & Trace Metal Concentrations (Mg/Kg) for Samples Collected Across Locations in the Study Area

Sample Location	Statistic	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Zinc (Zn)
Offshore Stations (Total of 35)	Mean	12.7	0.07	11.8	3.3	13.3	0.03	7.4	24.2
	Standard Deviation	14.2	0.04	2.67	1.4	9.8	0.04	3.6	11.4
	Variance (%)	111.5	54.3	22.8	41.2	73.2	116.5	48.3	47
	Minimum	2.9	0.04	5.1	1	5.2	0.01	3.7	9.7
	Maximum	63	0.16	16.9	6.8	47	0.23	21.5	65.4
	Number of Samples Above NOAA ERL	15	0	0	0	1	1	1	0
	Number of Samples above cAL1	7	0	0	0	0	0	0	0
Nearshore Stations (Total of 19)	Mean	14.3	0.1	12.9	6.1	9.68	0.03	14.9	37.6
	Standard Deviation	4.69	0.02	4.37	2.4	2.94	0.01	4.7	12.9
	Variance (%)	32.8	23.2	34	39.3	30.4	31.6	31.7	34.2

Sample Location	Statistic	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Nickel (Ni)	Zinc (Zn)
	Minimum	7.6	0.06	6.1	2.9	5.3	0.02	7.3	21.9
	Maximum	27.9	0.16	21.7	12.1	17	0.04	23.7	68
	Number of Samples Above NOAA ERL	17	0	0	0	0	0	3	0
	Number of Samples above cAL1	1	0	0	0	0	0	0	0
Reference Values	NOAA ERL (Buchman, 2008)	8.2	1.2	81	34	46.7	0.15	20.9	150
	NOAA ERM (Buchman, 2008)	70	9.6	370	270	218	0.71	51.6	410
	Cefas cAL1 (Marine Management Organisation 2015)	20	0.4	40	40	50	0.3	20	130
	Cefas cAL2 (Marine Management Organisation 2015)	100	5	400	400	500	3	200	800

18.5.46 Concentrations are mg/kg. Substances without reference values (Aluminium, Barium, Lithium and Tin) have been omitted from this table, but are reported on in the Environmental Baseline report[31].

18.5.47 There are numerous closed disposal sites within the study area, many of which are associated with OWF developments. These closed disposal sites include Spurn Head (HU100), Hornsea disposal area (HU209), Triton Knoll (HU204), West of Inner Dowsing Bank (HU200) and Sheringham Shoal drillings (HU123). One active dredge disposal site exists within the study area - the Hornsea OWF disposal area (HU205).

18.5.48 The draft Order Limits pass through an area of gas fields, some of which remain in production. For the most part the draft Order Limits avoid passing through active gas fields, the only exception to this is the Wollaston gas field at EGL 3 KP 139. Gas fields could be a potential source of sediment contamination, however as noted above, analysis of sediment samples from the benthic survey and from the ICES DOME Portal indicated no elevated contaminants above Cefas AL 1 (including at a sampling site within 3 km of the Wollaston gas field).

Designated Sites

18.5.49 Designated sites in the study area, which are designated for the protection and conservation of marine habitats of relevance to coastal and marine physical processes are shown in **Volume 3, Part 3, Figure 18-13 Designated sites and bathing waters in the study area** (Joint Nature Conservation Committee, 2023 REF 18.40).

18.5.50 The draft Order Limits pass through the following designated sites:

- Greater Wash Special Protection Area (SPA): a large region covering the nearshore sections of both EGL 3 and EGL 4 (KP 0 – 40 and KP 0 – 30, respectively). The EGL 3 Project crosses the SPA for approximately 36.3 km whereas, the EGL 4 Project crosses the SPA for and 30.1 km. The area supports breeding and foraging grounds for a large number of bird species. Specific marine habitats protected here include intertidal mudflats and sandflats, subtidal sandbanks and biogenic reef;
- Holderness Offshore Marine Conservation Zone (MCZ): an area of mixed coarse sediment and sand, supporting habitats for a wide variety of species, such as, ocean quahog, crustaceans (crabs and shrimp), starfish and sponges. The site is also a spawning and nursing ground for a range of fish species; and also includes the northern tip of the Silver Pit North Sea glacial tunnel valley. The EGL 4 Project crosses the site for 8.7 km at the southeast corner (approximately KP 62) and again clips the northeast corner at around KP 90, while the EGL 3 Project passes around the eastern edge of the MCZ, outside the boundary; and
- Southern North Sea Special Area of Conservation (SAC): an area of importance for Harbour Porpoise. The mixed seabed of coarse and sandy sediments found here are an important physical characteristic, as these are preferred by harbour porpoise, due to availability of prey. Both the EGL 3 Project and the EGL 4 Project pass through the SAC from KP 90 – 136 and KP 85 – 127, respectively. The EGL 3 Project intersects with the winter grounds of the SAC for 2.2 km and the summer grounds for 47.1 km. Whereas, the EGL 4 Project intersects with the winter grounds for 6.3 km and the summer grounds for 41.6 km.

18.5.51 In addition, the following designated sites lie within the 15 km study area:

- Farnes East MCZ is characterised by subtidal mixed sediments and a diversity of species which includes sponges, anemones, segmented worms and bivalve molluscs. A glacial trench in the deepest part of the MCZ contains subtidal mud which is home to sea pens and Norway lobster. The zone lies approximately 7 km south of the northern section of the EGL 4 Project (KP 380 – 410) and approximately 19 km west of KP 330 – 360; and
- The northeast of Farnes Deep MCZ: characterised by predominantly sandy sediment, with patches of gravelly sand. The site is important for its ‘mosaic of habitats’ supporting a diverse range of marine flora and fauna. The MCZ retains broadscale habitat features and species features. The EGL 4 Project passes adjacent to the western boundary of the MCZ between KP 336 – 361 and comes within 0.5 km of the boundary at points. The EGL 3 Project passes to the east of the MCZ approximately 5.1 km away between KP 341 – 370.

- The northeast of Farnes Deep Highly Protected Marine Area (HPMA) is designated for the protection of the entire marine ecosystem of the area. The boundary overlaps with that of the northeast of Farnes Deep MCZ. The EGL 4 Project passes adjacent to the western boundary of the HPMA between KP 336 – 361 and comes within 0.5 km of the boundary at points. The EGL 3 Project passes to the east of the HPMA approximately 5.1 km away between KP 341 – 370.
- The Humber Estuary Site of Special Scientific Interest (SSSI), also designated as a SAC and SPA with marine components: The estuary features mudflats, sandbanks, salt marshes, sand dunes, and reedbeds which support a vast range of migratory and wintering birds, making it crucial for bird conservation. The estuary is also a nursery ground for North Sea fish such as herring and is home to protected fish species, including river lamprey and sea lamprey.
- The Saltfleetby to Theddlethorpe Dunes SSSI: designated for important tidal sand and mudflats, marshes and sand dunes.
- Chapel Point to Wolla Bank SSSI: designated to protect the sand dunes, salt marshes, and intertidal areas which contribute to coastal protection, and support a variety of flora and fauna including both resident and migratory bird species.
- Inner Dowsing, Race Bank and North Ridge SAC: a site characterised by sandbanks and biogenic reefs, protected benthic communities and ecology;
- Annex I Subtidal sandbanks: in addition to the Inner Dowsing, Race Bank and North Ridge sandbanks (also designated as a SAC), there are a number of Annex I subtidal sand bank features which partially lie within the study area. These are located close to the landfall (inshore of KP 8) and include the Humber Estuary bank and two unnamed banks whose northern edges just extend into the study area.

18.5.52 Please also refer to **Volume 1, Part 3, Chapter 17 Designated Sites** for further information on designated sites and features.

Future Baseline

18.5.53 Due to climate change and natural cycles, some aspects of the baseline environment are expected to undergo change over time. For the purposes of this assessment, the future baseline is defined for 2068 (assuming a design life of 40 years and a start year of 2028).

18.5.54 UKCP18 provides the most up to date assessment of climate change projections. The future change in climate over the UK will depend strongly on future emissions of greenhouse gases. UKCP18 uses scenarios for future greenhouse gases called the representative concentration pathways (RCPs) which were designed to cover a range of assumptions around future population, economic development and to explicitly include the possibility of mitigation of greenhouse gas emissions towards international targets. The RCP pathways lead to a broad range of climate outcomes but are neither forecasts nor policy recommendations (UKCP, 2018 REF 18.5).

18.5.55 RCP2.6 represents a future in which the world aims for and is able to implement sizeable reductions in emissions of greenhouse gases, giving a sizeable chance of limiting global average warming to 2°C.

18.5.56 RCP8.5 represents a world in which global greenhouse gas emissions continue to rise.

18.5.57 RCP4.5 and RCP6.0 consider some emission reductions based on pledges to reduce emissions as per the Paris climate agreement, which extends to the year 2030. If, after 2030, no further emission reductions are achieved but emissions do not rise then a number of studies suggest the temperature outcome of RCP4.5 may be the most likely. However, RCP6.0 allows for some further increase in emissions.

18.5.58 The four RCPs considered in UKCP18 attempt to capture a range of potential alternative futures, spanning a range of outcomes. The adoption of the climate response to a RCP8.5 future provides a precautionary view. For RCP8.5 the sea level rise between 2028 and 2068 is 0.44 m at the 95th percentile at Anderby.

18.5.59 Future changes in storm surges have been predicted to be indistinguishable from background variation (Lowe et al., 2009 REF 18.41), although extreme surge level event frequency is likely to increase (IPCC, 2021 REF 18.42).

18.5.60 In addition to SLR, extreme water levels in response to surge are also expected to be increased in 2068, compared to the present day. The extreme levels for the future baseline are provided for a range of return periods in **Table 18-7**.

Table 18-7 - 95th Percentile Extreme Water Levels for 2070

Return Period (years)	Level (m relative to OD)
1	4.36
10	4.73
50	5.06
100	5.20
200	5.37
500	5.61

18.5.61 UKCP18 conclude that there are no compelling trends in storminess (as determined by maximum gust speeds) from the UK wind network over the last four decades. Further, global projections do not show a trend in winds in the first half of the 21st Century. However, changes in future wind and wave conditions provided in Environment Agency guidance (Environment Agency, 2015 REF 18.43) states that flood risk assessments should allow for an increase in wind speeds and wave heights by 10% for the planned lifetime of the development (2056 to 2115 epoch).

18.5.62 A rise in sea level and increased storminess may allow larger waves, and therefore more wave energy, to reach the coast resulting in increases in local erosion rates. Increases to water temperature is expected to continue throughout the next century, with thermal expansion contributing to sea level rise (Met Office, 2018 REF 18.44). The Southern North Sea has experienced the greatest rate of sea surface temperature warming, and this is expected to continue over the coming century, with a rise of 3.11°C expected by the end of the century (Cornes *et al.,* 2023 REF 18.45).

18.5.63 There is evidence of an increasing trend in the annual average SSC concentrations in some regions, which may result from increased wind and wave energy or changes to land use and river management (Silva *et al*., 2016 REF 18.46).

18.5.64 In addition to changes resulting from climate change, there are a number of developments which have the potential to alter the future baseline. These include the Offshore Wind Farm (OWF) developments of Hornsea 3 and Hornsea 4, Dogger Bank A, B and C and Sofia.

18.6 Environmental measures

18.6.1 As set out in **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology**, the environmental measures are characterised as design measures or control and management measures. A range of environmental measures would be implemented as part of the English Offshore Scheme and will be secured in the DCO as relevant. **Table 18-8** outlines how these design and control measures will influence the coastal and marine physical processes assessment.

18.6.2 Several management plans will be provided as Outline Management Plans with the DCO application to support the deemed Marine Licences (dML). These will include an Outline Construction Environmental Management Plan (CEMP) and an Outline Marine Pollution Contingency Plan. These documents will outline measures to be implemented to comply with legislation (e.g., in relation to the prevention of oil and chemical spills) during all phases of the English Offshore Scheme. An Outline CEMP can be found in **Volume 2, Part 1, Appendix 1.5.C Outline Construction Environmental Management Plan**. In addition, design measures identified through the EIA process have been applied to avoid or reduce potential significant effects. Design measures included that are relevant to coastal and marine physical processes receptors are included in Table 18-8 below and are also included in **Volume 2, Part 1, Appendix 1.5.A: Outline Register of Design Measures**.

Table 18-8 - Summary of the Environmental Measures

Receptor	Potential changes and effects	Embedded measures
Coastline	Construction in the intertidal area has the potential to affect sensitive habitats and to alter the baseline sediment transport.	Intertidal zone would be crossed by horizontal directional drill to avoid disturbance to surface sediments and habitats.
		The Applicant would liaise with the Environment Agency to communicate and agree timings of works at landfall.
Subtidal morphology	Changes to water depths, seabed features and sediment types along the English Offshore Scheme.	The intention is to bury the cables in the seabed, except in areas where trenching is not possible e.g. where ground conditions do not allow burial or at infrastructure crossings.
		Micro-routeing within the draft Order Limits to avoid environmental features and sensitive seabed features where possible.
		Sediment displaced for exit pits and cable installation (sandwave clearance and trenching) will be side cast/locally placed.

Receptor	Potential changes and effects	Embedded measures
		The profile of rock berms used for cable protection would be designed to minimise the potential for scour to occur as much as possible (including alignment with flow and profiling).
		Cable protection features would only be installed where considered necessary for the safe operation of the English Offshore Scheme. This includes the repair of cables due to accidental damage, where depth of lowering is not achieved and at infrastructure crossings.
		Where possible, cable protection materials would be selected to match the environment (e.g., when cables are installed in areas of cobbles or other natural rock features, rock of similar diameter and material as the receiving environment should be used as an alternative to the current normal approach of using terrestrially sourced granite.
Water Quality, particularly at designated bathing waters	Pollution risk from vessels	All project vessels must comply with the International Regulations for Preventing Collisions at Sea (1972) (IMO, 2019a) (REF 18.47), regulations relating to International Convention for the Prevention of Pollution from Ships (the MARPOL Convention 73/78) (IMO, 2019e) (REF 18.48) with the aim of preventing and minimising pollution from ships and the International Convention for the Safety of Life at Sea (SOLAS, 1974) (REF 18.49).
		An offshore Outline Construction Environmental Management Plan (CEMP) including an Emergency Spill Response Plan and Waste Management Plan, Marine Pollution Contingency Plan (MPCP), Shipboard Oil Pollution Emergency Plan (SOPEP) and a dropped objects procedure would be produced prior to installation.
Water Quality	Pollution risk	All oil, fuel and chemical spills will be reported to the Marine Management Organisation Marine Pollution response team.
Water Quality, particularly at designated bathing waters	Pollution risk	Drilling fluids required for trenchless operations would be carefully managed to minimise the risk of breakouts into the marine environment. Specific avoidance measures would include: — the use of biodegradable drilling fluids (pose little or no risk (PLONOR) substances) where practicable, — drilling fluids will be tested for contamination to determine possible reuse or disposal; and

Receptor	Potential changes and effects	Embedded measures
		— If disposal is required drilling fluids would be transported by a licensed courier to a licensed waste disposal site. Chemicals will be chosen from the list of chemicals approved under the Offshore Chemical Notification Scheme. https://www.cefas.co.uk/data-and-publications/ocns/ and a chemical risk assessment will be provided as part of the offshore Outline CEMP.
Subtidal morphology Benthic Ecology Water Quality	Changes to seabed features and temporary increases in SSC	Designated (and as minimal as possible) anchoring areas and protocols shall be employed during marine operations to minimise physical disturbance of the seabed.

18.7 Scope of the Assessment

Spatial Scope and Study Area

18.7.1 The spatial scope of the assessment of coastal and marine physical processes covers the area of the English Offshore Scheme contained within the draft Order Limits, together with the Zones of Influence (ZoIs)/study area(s). The study area for coastal and marine physical processes is informed by the tidal excursion. The tidal excursion varies both along the English Offshore Scheme and over time in response to lunar variations in tidal forcing. The ABPmer renewables atlas provides an indication of tidal excursions on mean range tides, varying from around 14 km in the areas of fastest flows to less than 5 km in the areas of weaker tidal forcing. Spring tidal excursions would be longer than those on mean tides - for a mean tide excursion of 14 km, mean spring tidal excursions would be in excess of 18 km. However, an assessment of SSC resulting from construction activities indicates that values of more than 10 mg/l are constrained to less than 10 km from the draft Order Limits.

18.7.2 The study area for coastal and marine physical processes is shown on **Volume 3, Part 3, Figure 18-1 Study Area Overview.** The English Offshore Scheme and study area have been refined since the Scoping Report was submitted. In particular, only the Anderby Creek Landfall is now considered and the optionality around cable routes through and around the Holderness Offshore MCZ has been removed.

Temporal Scope

18.7.3 The temporal scope of the assessment of coastal and marine physical processes is consistent with the period over which the English Offshore Scheme would be carried out. It assumes construction of the English Offshore Scheme would commence at the earliest 2028 and cover a period of approximately 6 years of total construction time. Operation would commence in 2033 with periodical maintenance required during the operational phase of the English Offshore Scheme. It is assumed that maintenance and repair activities could take place at any time during the life span of the English Offshore Scheme.

18.7.4 The English Offshore Scheme is expected to have a life span of more than 40 years. If decommissioning requires cessation of operation and removal of infrastructure at this point in time, then activities and effects associated with the decommissioning phase are expected to be of a similar level to those during the construction phase works. The duration of activities and effects during decommissioning would have a shorter duration than construction phase works of two years. The English Offshore Scheme could also remain operational for a period after the 40 years or be taken out of service and left within the draft Order Limits after 40 years. Acknowledging the complexities of completing a detailed assessment for decommissioning works up to 60 years in the future, based on the information available, the projects have concluded that impacts from decommissioning would be no greater than those during the construction phase. Furthermore, should decommissioning take place, it is expected that an assessment in accordance with the legislation and guidance at the time of decommissioning would be undertaken.

Identification of Receptors

18.7.5 The principal coastal and marine physical processes receptors that have been identified as being potentially subject to significant effects are summarised in **Table 18-9** and are shown in **Volume 3, Part 3, Figure 18-13: Designated Sites.**

Table 18-9 - Coastal and marine physical processes receptors subject to potential effects

Receptor	Reason for consideration
Adjacent coastline, particularly at the landfall and in adjacent SSSIs (including Saltfleetby to Theddlethorpe Dunes and Chapel Point to Wolla Bank).	Sensitivity of receptors in the coastal zone which lie within the study area.
Designated sites within the draft Order Limits and study area including the Greater Wash SPA, Inner Dowsing, Race Bank and North Ridge, Annex 1 Sandbanks, Holderness Offshore MCZ and Southern North Sea SAC	Designated nature of the sites, placing them at high value (although not necessarily high sensitivity).
Northeast of Farnes Deep HPMA	The EGL 4 Project passes within 0.5 km to the west of the HPMA which is designated for protection and recovery of marine ecosystems.
Water quality, particularly at designated bathing waters (most notably Huttoft and Marsh Yard and Anderby)	The draft Order Limits pass directly through the Huttoft and Marsh Yard bathing water. Anderby bathing water lies within the study area, 200 m south of the draft Order Limits.

18.7.6 Marine physical processes are best described as pathways, rather than as receptors. While outputs from the coastal and marine physical processes assessments are reported in Section 18.10 to Section 18.15, for the most part it is not practical for the outputs to be accompanied by statements of effect of significance. Instead, the information on changes to the coastal and marine physical processes pathways has been used to inform other preliminary assessments for other receptors including:

- **Volume 1, Part 3, Chapter 19: Intertidal and Subtidal Benthic Ecology**;
- **Volume 1, Part 3, Chapter 20: Fish and Shellfish**;
- **Volume 1, Part 3, Chapter 21: Intertidal and Offshore Ornithology**;
- **Volume 1, Part 3, Chapter 22: Marine Mammals**;
- **Volume 1, Part 3, Chapter 24: Commercial Fisheries**; and
- **Volume 1, Part 3, Chapter 26: Marine Archaeology**

18.7.7 The assessment of direct and indirect impacts from the identified coastal and marine physical processes pathways are assessed within the relevant topic chapters.

Potential Effects Considered within This Assessment

18.7.8 The effects on coastal and marine physical processes receptors which have the potential to be significant and have been taken forward for detailed assessment within this chapter are summarised in **Table 18-10.**

18.7.9 Information on changes to the coastal and marine physical processes receptors which are covered by their own chapter, are provided within that specific chapter and no further assessment is provided here.

Table 18-10 - Coastal and marine physical processes receptors scoped in for further assessment

Receptor	Likely significant effects
Seabed geomorphology	Disturbance of sub-tidal seabed morphology
Intertidal and coastal geomorphology	Disturbance of intertidal morphology
Water quality (particularly at designated bathing waters (most notably Moggs Eye and Anderby) and the northeast of Farnes Deep HPMA), seabed substrates	Temporary increases in SSC and subsequent deposition
Currents, water levels, waves bathymetry and seabed features	Modifications to tidal and wave regimes and associated impacts to morphological features
Water quality	Release of contaminated sediment
Sediment quality	Temperature increases

18.7.10 The receptors/effects detailed in **Table 18-11** have been scoped out from being subject to further assessment because the potential effects are not considered likely to be significant.

Table 18-11 - Summary of effects scoped out of the coastal and marine physical processes assessment

Receptors/potential effects	Justification
Accidental spills	The Planning Inspectorate agreed that accidental spills can be scoped out noting the legal requirements upon vessels to manage any accidental releases or spills of materials or chemicals.

18.8 Key Parameters for Assessment

Realistic Worst-Case Design Scenario

18.8.1 The assessment has followed the Rochdale Envelope approach as outlined in **Volume 1, Part 1, Chapter 4: Description of the Projects** and **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology of the PEIR.** The assessment of effects has been based on the description of the Projects and parameters outlined in **Volume 1, Part 1, Chapter 4: Description of the Projects**. However, where there is uncertainty regarding a particular design parameter, the realistic worst-case design parameters are provided below with regards to coastal and marine physical processes, along with the reasons why these parameters are considered worst-case. The preliminary assessment for coastal and marine physical processes has been undertaken on this basis. Effects of greater adverse significance are not likely to arise should any other development scenario, based on details within the Rochdale Envelope (e.g., different infrastructure layout within the draft Order Limits), to that assessed here be taken forward in the final design.

18.8.2 In relation to coastal and marine physical processes the following assumptions are made regarding the English Offshore Scheme design parameters in order to ensure a realistic worst-case assessment has been undertaken:

- With respect to sandwave clearance, it is assumed that 138,830 m^3 and 108,280 m^3 require levelling along a 11.34 km length and 8.28 km length for the EGL 3 Project and the EGL 4 Project, respectively;
- With respect to HDD exit pit excavation, it is assumed that 4 pits would require excavation, each with an *in-situ* volume of 1,500 m^3; and
- With regards to cable protection at infrastructure crossings, it is assumed that that crossing berms have a height of 1.5 m, a base width of 10 m and a crest width of 1 m. This is the upper limit of the berm dimensions as these provide the greatest potential for an impact to the wave climate.

Consideration of Construction Scenarios

18.8.3 As detailed in **Volume 1, Part 1, Chapter 4: Description of the Projects**, the timing of construction activities set out within this PEIR is indicative. To allow for any unexpected circumstances and a realistic worst-case assessment, the impact assessment for the English Offshore Scheme considers the following construction scenarios to ensure the worst-case scenario for each aspect can be identified and assessed:

- with regards to sandwave clearance it is assumed that a large trailing suction hopper dredger (TSHD) with a hopper size of 30,000 m^3 and a high production rate of 7,000 m^3 per hour would be used. It is assumed that dredged sediment would be sidecast as dredging occurs. These assumptions provide the greatest rates of sediment disturbance and potential for fine sediment plume dispersion during sandwave clearance;
- with regards to HDD exit pit excavation, it is assumed a controlled flow excavator (CFE) would be used as this would result in the greatest release of fine sediment; and
- with regards to cable trenching it is assumed that a CFE would be used, achieving a cross sectional trench area of 10 m^2 (representing a triangular trench of 5 m wide and 4 m deep) and an installation speed of 150 m per hour. These assumptions provide the maximum realistic rate of sediment disturbance and greatest potential for fine sediment plume dispersion during cable trenching.

18.9 Assessment Methodology

Overview

18.9.1 The generic project-wide approach to the assessment methodology is set out in **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology**, and specifically in **Sections 5.4** to **5.6**. However, whilst this has informed the approach that has been used in the coastal and marine physical processes assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of this coastal and marine physical processes assessment. The details are provided below.

18.9.2 The scope of the coastal and marine physical processes assessment is to characterise the baseline physical processes within the study area and to consider the magnitude and duration of potential impacts of the English Offshore Scheme.

18.9.3 The project specific survey data (detailed in **Section 18.4**) is being used to inform the CBRAs, which will consider:

- micro-routeing;
- minimum burial depths along the English Offshore Scheme;
- identification of potential burial tools and methods; and
- methods and locations of cable protection where full cable burial cannot be achieved (either due to sediment properties or infrastructure crossings), or risk of subsequent cable exposure is high.

18.9.4 As noted in **Section Limitations**, the CBRAs have not yet been completed but preliminary calculations of areas requiring cable protection and pre-sweeping (including volumes) have been made based on the existing marine characterisation surveys. Once available, the ES will be refined to account for the more detailed assessment presented within the CBRAs.

18.9.5 The assessment of potential effects has been established using the standard Source-Pathway-Receptor Approach. The assessment of coastal and marine physical processes follows the guidance documents listed in **Section 18.2**, where they are specific to this topic.

18.9.6 The assessment approach includes a range of desktop analyses and spreadsheet-based models, supplemented by evidence from analogous assessments and monitoring data.

18.9.7 Spreadsheet based models are applied to assess the potential SSC and sedimentation associated with construction activities for a range of hydrodynamic conditions, sediment types and release rates to capture the impact (in terms of plume extent and concentration and extent and thickness of deposits on the seabed). The assessment is focussed on the realistic worst-case installation scenario. The available baseline information and geophysical, geomorphological and benthic surveys provide the data inputs for this assessment. The effects are assessed in terms of the difference caused relative to the normal range of natural occurrence and variability. An assessment of duration of increases in SSC is informed by results from the evidence base which includes multiple similar assessments using numerical modelling tools to assess impacts from cable installation for a range of methods.

18.9.8 A spectral wave model has been developed and applied to assess the potential impacts of rock berms at cable crossings on the wave climate. From this assessment the likelihood for adverse effects to sediment transport both locally and at the coast, has been determined.

18.9.9 A WFD Scoping assessment has been undertaken to assess the potential impacts of the English Onshore Scheme and English Offshore Scheme on hydromorphology (provided in **Volume 2, Part 2, Appendix 2.9.B WFD Technical Note Stage 1 and Stage 2**). The impacts on water and sediment quality are assessed in the coastal and marine physical processes chapter of the ES. The assessment of water quality impacts in the PEIR will focus on the impact on turbidity using the results from spreadsheet-based model, with release of contaminated sediments having been shown to have a **Negligible** impact.

18.9.10 The criteria for defining sensitivity and value for coastal and marine physical process receptors and the magnitude of impacts to receptors are provided in **Table 18-12 and Table 18-13**.

18.9.11 The significance of an effect, either adverse or beneficial, will be determined using a combination of the magnitude of the impact and the sensitivity of the receptor. A matrix approach is used throughout all topic areas to ensure a consistent approach within the assessment. This is described further in **Volume 1, Part 1, Chapter 5: PEIR Approach and Methodology,** and is replicated for ease in **Table 18-14.**

Table 18-12 - Criteria for Characterising the Sensitivity and Value of Receptors

Receptor sensitivity/value	Definition
High	Receptor has low/no capacity to return to pre-impact conditions, e.g., low tolerance to change and low recoverability such as loss of access with no alternatives. Receptor is very high value or critical importance to local, regional or national economy or environment.
Medium	Receptor is generally vulnerable to the impacts and recoverability is slow or costly. Receptor is high value with reasonable contribution to local, regional or national economy or environment
Low	Receptor has moderate levels of recoverability. Receptor is medium value with small contributions to local, regional or national economy or environment
Negligible	Receptor is tolerant to change with no effect on its character. Receptor is of low value with little contributions to local, regional or national economy or environment

Table 18-13 - Criteria for Characterising the Magnitude of an Impact

Receptor sensitivity/value	Definition
High	Impact is of extended temporal or physical extent and of long-term duration (15+ years).
Medium	Impact is of moderate temporal or physical extent and of medium duration (7-15 years).
Low	Impact is of limited temporal or physical extent and of short duration (1-7 years).
Negligible	Impact is of negligible temporal or physical extent and temporary in duration (<1 year).

Table 18-14 - Significance Matrix

		Sensitivity			
		High	**Medium**	**Low**	**Negligible**
Negative magnitude	**High**	Major	Major	Moderate	Minor
	Medium	Major	Moderate	Minor	Minor
	Low	Moderate	Minor	Minor	Negligible

		Sensitivity			
		High	**Medium**	**Low**	**Negligible**
	Negligible	Minor	Minor	Negligible	Negligible
Beneficial magnitude	**Negligible**	Minor	Minor	Negligible	Negligible
	Low	Moderate	Minor	Negligible	Negligible
	Medium	Major	Moderate	Minor	Negligible
	High	Major	Major	Moderate	Minor

Preliminary Assessment of Cumulative Effects

18.9.12 At the current stage of the Projects (PEIR stage), design information for the Projects is insufficient to allow for a robust cumulative assessment to be undertaken. Furthermore, given the current position in relation to baseline data collection, with much of the environmental surveys still to be undertaken during 2025, the baseline identified at this PEIR stage cannot be taken as a complete picture of the potential presence and significance of sensitive receptors. Therefore, a cumulative assessment has not been undertaken at this stage. However, **Volume 1, Part 4, Chapter 28: Cumulative Effects** presents the long and short lists of 'other developments' which will be considered at the ES stage, and the methodology which allowed for the identification of these other developments, to allow consultation bodies to form a view and provide comment on the other developments included. The long list will be reviewed and if necessary, updated in the lead up to the ES as the Projects design further evolves and in response to any comments raised at statutory consultation.

18.9.13 A number of other activities within the study area have the potential to result in cumulative impacts on coastal and marine physical processes. In particular, aggregate extraction and marine disposal activities could result in sediment plumes which have the potential to interact with the sediment plumes arising from submarine cable installation for the English Offshore Scheme.

18.9.14 There are multiple licenced aggregate site agreements including Humber 1 to 4 which are located to the north of the draft Order Limits (with the boundary of Humber 4 600 m west of the draft Order Limits) and Off Saltfleet, Humber Estuary and Humber Overfalls to the south of the draft Order Limits. All of these sites are licenced until at least the end of 2029. Humber Overfalls borders the draft Order Limits for the EGL 3 Project between KP 15 and KP 23. In addition, there is an active dredge disposal site covering the array area and export cable corridor for the Hornsea 4 OWF. The Hornsea 4 OWF export cable corridor crosses the EGL 4 Project at KP 119 and the EGL 3 Project at KP 124.

18.9.15 Depending on the construction timelines and activities of these various projects there is the potential for cumulative impacts and the assessment of cumulative effects associated will be considered as part of the ES.

18.10 Preliminary Impact Assessment of Disturbance of Sub-Tidal Seabed Morphology

Construction

18.10.1 Seabed preparation and subsea cable installation activities have the potential to directly disturb the seabed morphology. While the English Offshore Scheme has been routed to avoid seabed features such as sandbanks, sandwaves and notable bathymetric depressions as far as practical there are some sections where sandwave clearance and cable protection would still be required. In addition, indirect effects associated with scour around cable protection could also occur.

18.10.2 Seabed clearance Discrete sections of the English Offshore Scheme may require pre-sweeping of mobile sandwaves. Such pre-sweeping would ensure that that the cable burial machine would not topple or tilt during installation and that they could reach the desired burial depth reducing the risk of cable exposure during operation.

18.10.3 The mere presence of sandwaves indicates an active and dynamic environment. Following pre-sweeping, new sandwaves can therefore be expected to form so that any change in bedforms would only be temporary. A study of seabed dynamics and morphology undertaken on behalf of Ørsted energy to estimate restoration of seabed morphology after construction of the Race Bank OWF found that in the areas of high sediment mobility surveyed the seabed was found to be fully, or almost fully, recovered (>75% recovery in all areas) within the one to two years between the post trenching survey in 2016 to 2017 and the subsequent survey in 2018.

18.10.4 The **sensitivity** of sandwaves is considered **low** as the temporary nature of the proposed works are not likely to influence the overall form and function of the bedform system which can be expected to recover through natural sediment transport processes in the short to medium term. Sandwave recovery would be aided by the deposition of dredged material upstream of the extraction site, where feasible. Therefore, the **magnitude** of the impact is considered N**egligible**, and the **significance** of effect is assessed as **Negligible** and **Not Significant**.

18.10.5 As the evidence on timescales for recovery is limited at present, the draft Order Limits have been designed to avoid the requirement for sandwave clearance in the Holderness Offshore MCZ.

18.10.6 Other seabed preparation activities including displacement of seabed debris and boulder removal during grapnel runs and boulder clearance activities would cause potentially permanent disturbance to the seabed bathymetry. The **sensitivity** to such change is assessed as **Negligible.** Seabed disturbance of this kind would be very localised and despite the potential permanent nature of the change, the **magnitude** of the impact is considered **Negligible** and the effect is assessed as **Negligible** and **Not Significant**.

Cable Protection

18.10.7 In areas where cables are buried, trenches would be back-filled so that the seabed is returned to its baseline state (i.e., the change in bathymetry would be temporary).

18.10.8 Where burial cannot be achieved, cable protection would be required. The areas where burial cannot be achieved include areas of hard substrate and areas where the English Offshore Scheme crosses other infrastructure (e.g., cables or pipelines).

18.10.9 The footprint of cable protection (including infrastructure crossings) is calculated to be 0.915 km^2 for the EGL 3 Project and 1.135 km^2 for the EGL 4 Project.

18.10.10 In the instance of hard substrate, the addition of cable protection would not significantly alter the physical bed characteristics, although there would be a permanent change to bathymetry (at least for the lifetime of the English Offshore Scheme). These changes in bathymetry would be small relative to the baseline water depths, with berm heights of 1.5 m or less. The percentage change in water depth is expected to be of the order of 5% or less (assuming these areas are in water depths of more than 30 m). This will be confirmed on completion of the CBRAs and percentage changes in water depths will be reported within the ES.

18.10.11 In the instance of infrastructure crossings, the addition of cable protection in areas of softer sediments would lead to localised change in substrate. Rock protection for infrastructure crossings would cover an area of approximately 66,000 m^2 for the EGL 4 Project and 60,000 m^2 for the EGL 3 Project.

18.10.12 Where cable protection is used in areas of softer sediments, if the critical bed shear stress exceeds the threshold for motion (either as a result of near bed flow speeds or orbital wave motion reaching the bed), localised scouring could occur. To give an indication of which infrastructure crossings may be susceptible to scour, the baseline physical characteristics (including water depth and median grain size (d_{50}) informed by the English Offshore Scheme surveys and depth average spring and neap flow speeds based on the ABPmer Renewables Atlas) are summarised at each infrastructure crossing for the EGL 3 Project in **Table 18-15** as an example (the same calculations have been completed for the EGL 4 Project and will be presented in the ES). In addition, the critical depth average flow speed (i.e. the flow speed which would result in sediment transport) has been calculated based on Soulsby (1997) (Ref 47) and results are included in **Table 18-15.**

18.10.13 At ten EGL 3 infrastructure crossings and 15 EGL 4 infrastructure crossings, the peak spring flow speed exceeds the critical flow speed indicating that sediment transport could occur, potentially resulting in some scour. These are primarily the shallower infrastructure crossing locations (where depth is less than –15 m LAT). The peak spring tide flow speed also slightly exceeds the critical flow speed at two other crossing locations at around KP 84, where the d_{50} is less than 1 mm. In general, the peak neap flow speed does not exceed the critical flow speed except for three of the shallower infrastructure crossings for the EGL 4 Project, where the peak neap flow speed is 0.01 m/s faster than the critical flow speed.

18.10.14 Where wave motions reach the bed, wave induced sediment transport could occur and further increase the potential for scour. The near bed orbital wave velocity was calculated for 50^{th} percentile (p50) and 95^{th} percentile (p95) wave conditions for summer and winter using measured wave data from the Dowsing WaveNet site (which is located approximately 17 km southeast of KP 72, EGL 3). P50 orbital wave velocities were low (<0.05 m/s) at all infrastructure crossings where the peak spring flow speed was below the critical flow speed. Similarly, P95 summer orbital wave velocities were relatively low (<0.10 m/s) at all infrastructure crossings where the peak spring flow speed was below the critical flow speed. However, P95 winter orbital velocities were relatively high (order of 0.30 m/s) at approximately ten infrastructure crossings where the peak spring flow speeds are less than the critical flow speed, indicating that wave induced scour during winter storms could occur. All of these infrastructure crossings are inshore of the Outer Dowsing WaveNet site and the wave conditions applied are therefore likely to be higher than would occur.

18.10.15 Where possible, best practice would be used in the design of the rock protection to minimise scour, for example aligning rock berms parallel to the current direction where possible.

Table 18-15 – EGL 3 Infrastructure Crossings

KP	Depth (mLAT)	d50 (mm)	Peak spring speed (m/s)	Peak neap speed (m/s)	Critical flow speed (m/s)	Orbital wave speed (m/s) for winter p95 wave
13.7	-13.81	0.69	0.68	0.4	0.40	0.41
13.7	-13.81	0.69	0.68	0.4	0.40	0.41
14.9	-13.69	0.33	0.68	0.4	0.42	0.41
14.9	-13.69	0.33	0.68	0.4	0.42	0.41
15	-13.77	0.33	0.68	0.4	0.42	0.41
15.1	-13.76	0.33	0.68	0.4	0.42	0.41
15.1	-13.76	0.33	0.68	0.4	0.42	0.41
23.7	-8.16	4.8	0.68	0.41	0.47	0.62
41.7	-16.38	8.64	0.58	0.36	0.62	0.35
41.8	-16.04	17.52	0.58	0.36	0.76	0.36
42.2	-17.22	17.52	0.58	0.36	0.77	0.33
42.3	-17.63	17.52	0.58	0.36	0.77	0.33
42.4	-17.43	17.52	0.58	0.36	0.77	0.33
54.8	-20.58	8.72	0.52	0.32	0.64	0.28
54.9	-20.78	8.72	0.52	0.32	0.64	0.27
56.4	-22.69	6.52	0.5	0.29	0.60	0.25
56.5	-22.34	6.52	0.5	0.29	0.60	0.25
59	-25.59	7.18	0.5	0.29	0.62	0.21
64.8	-22.94	4.72	0.5	0.29	0.54	0.25
67.4	-45.48	4	0.5	0.29	0.57	0.09
67.5	-46.2	4	0.5	0.29	0.57	0.08
84.1	-29.31	0.81	0.5	0.29	0.44	0.18
84.2	-29.5	0.81	0.5	0.29	0.44	0.18
90.2	-33.67	0.68	0.44	0.25	0.46	0.15
109.4	-41	1.54	0.41	0.23	0.47	0.11
109.4	-41	1.54	0.41	0.23	0.47	0.11
119	-45	0.37	0.41	0.23	0.49	0.09
119	-45	0.37	0.41	0.23	0.49	0.09
119.1	-44	0.37	0.41	0.23	0.49	0.09
121	-45	0.32	0.41	0.23	0.50	0.09

KP	Depth (mLAT)	d50 (mm)	Peak spring speed (m/s)	Peak neap speed (m/s)	Critical flow speed (m/s)	Orbital wave speed (m/s) for winter p95 wave
123.8	-45.83	0.34	0.41	0.23	0.50	0.09
124.3	-45.64	0.33	0.41	0.23	0.50	0.09
124.7	-44.16	0.33	0.41	0.23	0.50	0.09
133.8	-50.65	0.24	0.45	0.25	0.52	0.07
135.5	-52.84	0.23	0.45	0.25	0.52	0.06
142.2	-52	0.26	0.45	0.25	0.52	0.07
144.8	-55	0.26	0.42	0.23	0.52	0.06
149.7	-54.21	0.24	0.42	0.23	0.52	0.06
150.5	-54.97	0.25	0.42	0.23	0.52	0.06
151.9	-54.58	0.25	0.42	0.23	0.52	0.06
152.4	-54.48	0.25	0.42	0.23	0.52	0.06
175.2	-65.25	0.24	0.35	0.21	0.54	0.04
179	-62.42	0.24	0.34	0.21	0.53	0.04
182	-62.51	0.22	0.34	0.21	0.54	0.04
184.3	-62.3	0.22	0.34	0.21	0.54	0.04
203.5	-65.65	0.22	0.28	0.16	0.54	0.04
203.5	-65.65	0.22	0.3	0.18	0.54	0.04
203.7	-66.65	0.22	0.28	0.16	0.54	0.04
217.7	-62.4	0.19	0.26	0.15	0.54	0.04
218.2	-62.56	0.19	0.25	0.15	0.54	0.04
218.8	-63.62	0.19	0.25	0.15	0.54	0.04
249	-81	0.12	0.25	0.15	0.57	0.02
251.2	-82.71	0.12	0.24	0.14	0.57	0.02
271.2	-79.54	0.14	0.24	0.13	0.57	0.02
290.5	-79.29	0.33	0.22	0.12	0.54	0.02
297.8	-69.11	0.39	0.21	0.11	0.52	0.03
303.4	-70.98	0.29	0.22	0.12	0.54	0.03
348.2	-71.14	0.32	0.22	0.11	0.53	0.03
560.5	-90.42	0.19	0.28	0.14	0.57	0.01
560.6	-92.11	0.19	0.28	0.14	0.57	0.01
560.6	-92.11	0.19	0.28	0.14	0.57	0.01
562.1	-81.86	0.19	0.28	0.14	0.56	0.02

18.10.16 Based on the information presently available, the sensitivity of subtidal morphology to change from cable protection is assessed as **Low.** Seabed disturbance would be localised and despite the potential permanent nature of the change, the **magnitude** of the impact is considered **Negligible** and the effect is assessed as **Negligible** and **Not Significant**.

18.10.17 Further assessment of the areas requiring cable protection will be undertaken within the ES.

HDD Exit Pits

18.10.18 A trenchless technique such as HDD would be used to connect the offshore cable to the onshore cable at landfall. The HDD exit point ('punch out') locations will depend on the outcome of further technical studies and design but is expected to be in water depths between -3 m and -12 m LAT at an indicative distance no more than 1.6 km seaward of MHWS. Excavated exit pits could be required at the punch out locations, each requiring up to 1,500 m^3 of sediment to be excavated (over an area of up to 75 m x 15 m per exit pit, with a total of four exit pits – two each for the EGL 3 Project and the EGL 4 Project). Excavation would either be by backhoe dredger or CFE. Ducts laid at punch out may require weighting using clump weights or rock bags. Once the cable is installed any weighting would be removed and material excavated for the exit pits would be used to backfill the pits (either manually or naturally). Peak spring flow speeds in this area are between 0.6 and 1 m/s (ABPmer, 2017 REF 18.6), and the median sediment grain size from samples collected during the marine characterisation survey is around 500 µm (medium to coarse sand). The excavated sediment would therefore be mobile under the action of spring tidal flows.

18.10.19 The **sensitivity** is assessed as **low** due to the dynamic nature of the seabed, with displaced sediment expected to be driven by natural wave and tidal action so that the bed is returned to baseline conditions within a series of typical spring-neap cycles (with the time to infill dependent on the volume of the exit pit). As such, any changes to subtidal morphology associated with the exit pits would be localised and temporary and the **magnitude** of impact is assessed to be **Negligible** and the **significance** of effect is assessed as **Negligible** and **Not Significant**.

18.10.20 Any changes to sub-tidal seabed morphology resulting from the installation of the subsea cables would be localised and temporary and would not result in a change to the baseline character. The **sensitivity** to change has been assessed as **Low** and the **magnitude** of the effect has been assessed as **Negligible**, and therefore the **significance** of the effect of changes to subtidal morphology is assessed as **Negligible** and **Not Significant**.

Operation

18.10.21 As the effects of pre-sweeping have been assessed to be Not Significant during construction. During operation any pre-sweeping required to facilitate a repair would be significantly less than that required for construction. The conclusions for construction are therefore valid for operation and the effects on subtidal morphology during operation continue to remain scoped out of the assessment.

Decommissioning

18.10.22 Once the cables have reached the end of their life it is anticipated that the cables and any cable protection would be removed, except for any parts of the cables or cable protection where it is considered preferable for them to remain *in situ* or it is not technically feasible for them to be removed. The seabed would be restored where reasonably possible and practical to the baseline condition.

18.10.23 The **sensitivity** of the site is likely to be unchanged from **low**, while the potential impacts of decommissioning are likely to be of similar or lower **magnitude** than for construction (i.e. assessed as **Negligible**. The **significance** of effect of changes to the subtidal morphology during decommissioning are therefore assessed as **Negligible** and **Not Significant.**

18.11 Preliminary Impact Assessment of Disturbance of Intertidal Morphology

Construction

18.11.1 A trenchless technique such as HDD, would be used to connect the offshore cable to the onshore cable at landfall. A total of four ducts (two each for the EGL 3 Project and the EGL 4 Project) would be installed from the Transition Joint Bay (TJB) which would be positioned above MHWS to a point below LAT. The exact punch out locations for HDD depend on the outcome of further technical studies and design but is expected to be at least -3 m LAT (i.e., in a subtidal location).

18.11.2 Given the location of the landfall within the Environment Agency renourishment scheme, the area is considered to be tolerant to changes in intertidal morphology and the **sensitivity** is assessed to be **Low**. The **magnitude** of change to intertidal morphology has been assessed as **Negligible**. Overall, it is concluded that the **significance** of effect of changes to intertidal morphology are **Negligible** and **Not Significant.**

Operation

18.11.3 Cable protection would be required at gas pipeline and cable crossings. Most of the areas requiring cable protection are likely to be located in water sufficiently far offshore and in sufficiently deep waters that no indirect effect on intertidal morphology would occur. However, there is one location where multiple pipeline crossings are required in relatively shallow depths (-11.9 m to -13.8 m LAT) and within relatively close proximity (8.5 km) of the shore.

18.11.4 To assess the potential for an indirect impact a Spectral Wave (SW) model was developed and applied (see **Volume 2, Part 3, Appendix 3.18.B Wave Modelling**). Results from the wave modelling assessment showed that the presence of the rock berms only resulted in localised and small magnitude changes in wave heights and directions and with no changes predicted for wave periods. Wave heights were locally increased over the rock berms (by around 0.06 m, equivalent to a 1% change) and reduced in the lee (by less than 0.02 m). No changes in wave height of more than 0.01 m were predicted to occur within 7 km of the coastline.

18.11.5 The **sensitivity** of the receptor is assessed as **Low.** The **magnitude** of impact on sediment transport along the coast is therefore **Negligible** and the **significance** of the effect of cable protection on intertidal morphology are assessed as **Negligible** and **Not Significant.**

18.11.6 This information will be reviewed on completion of the CBRAs to ensure that there are no more extensive nearshore areas where cable protection could influence wave processes and consequently alter near shore sediment transport and impact intertidal morphology.

Decommissioning

18.11.7 Once the cables have reached the end of their life it is anticipated that the cables and ducts would be removed. During decommissioning there would be no requirement for any temporary infrastructure in the intertidal area and therefore no potential to alter the nearshore flow and sediment regime.

18.11.8 The **sensitivity** of the site is likely to be unchanged from **Low,** while the potential impacts of decommissioning are likely to be of similar or lower **magnitude** than for construction (i.e. **Negligible**) and the effect of changes to the intertidal morphology are therefore assessed as **Negligible** and **Not Significant.**

18.12 Preliminary Impact Assessment of Temporary Increases in SSCs and Subsequent Deposition

Construction

18.12.1 Sediment suspended during installation of the subsea cables could result in temporary increases in SSC having an adverse effect on water quality. Subsequent deposition once material re-settles to the bed could result in smothering. There is also the potential for changes in seabed morphology, with a reduction in fines close to the disturbance site and with an increase in fines further away (due to the shorter settling times for coarser grained sediments).

18.12.2 A spreadsheet-based model has been applied to assess the potential dispersion of sediment plumes arising from activities during construction, including sandwave clearance, excavation of HDD exit pits and cable trenching operations. Additional details on the spreadsheet-based modelling approach and results are provided in **Volume 2, Part 3, Appendix 3.18.A Fine Sediment Modelling Spreadsheet.**

18.12.3 Settling velocities for releases at 5 m above the bed (for sediment releases associated with CFE) and releases at 35 m above the bed (for sediment releases from dredging with a TSHD) are provided along with settling distances for a range of peak flow speeds in **Table 18-16**.

18.12.4 The calculated settling distances indicate that only fine sands and silts will disperse beyond the draft Order Limits. Silt sized material will remain in suspension for much longer durations and could disperse significant distances from the site of sediment release.

18.12.5 The maximum dispersion distance is set to be the maximum tidal excursion associated with the peak flow speed. Typically, fine sediment particles will not travel in suspension beyond this maximum distance. However, for particles which remain in suspension for a long period of time and where there is either a notable tidal or non-tidal (surge) residual, sediment in suspension could travel beyond the maximum distances quoted. Given that dispersion processes will also act to dilute the concentration of silt carried in suspension, elevated SSC levels at such large distances would be greatly reduced compared to those in close proximity to the site of sediment release.

Table 18-16 - Estimated Settling Velocity For Different Size Sediment Grain Sizes And Associated Settling Times

Peak flow speed (m/s)	Fines (<63 µm)		V fine sand (125 µm)		Fine Sand (250 µm)		Medium sand (500 µm)	
	Settling time (hours)	Settling distance (km)	Settling time (hours)	Settling distance (km)	Settling time (hours)	Settling distance (km)	Settling time (hours)	Settling distance (km)
Release at 5 m above the bed								
1.35	0.5 to 400	2.2 to 17.5	0.1	0.7	<0.1	0.14	<0.01	<0.001
1		1.6 to 12.9		0.5		0.10		
0.5		1.3 to 6.5		0.3		0.05		
0.2		0.3 to 2.6		0.1		0.02		
Release at 35 m above the bed								
1.35	5 to 2850	16 to 17.5	1	4.7		0.9	0.1	0.3
1		11.7 to 12.9		3.5		0.7		0.2
0.5		5.8 to 6.5		1.8		0.4		0.09
0.2		2.3 to 2.6		0.7		0.1		0.04

18.12.6 The rate of fine sediment disturbance was estimated for each activity based on information on project design and results from the environmental surveys. The sediment release rates are summarised in **Table 18-16.** The following assumptions were applied when calculating the release rates:

- for sandwave clearance by dredging, rates assume that 50% of sediment dredged would be released in suspension near the surface (with the rest forming a dynamic plume which would settle straight to the bed); and
- for HDD exit pit excavation and cable installation, rates are based on a productivity of 1,500 m^3 per hour, assuming that 70% of all sediment disturbed would fall back into or directly adjacent to the trench.

18.12.7 The cable installation speed is expected to be highly variable with speeds in the range of 100 m/hour to 500 m/hour. The actual speed will depend on the sediment encountered (with lower speeds in sediments with a higher percentage of fines) and the type of plant used. The trench cross sectional area (CSA) has been calculated using the maximum trench width and depth for the EGL 4 Project, assuming a v-shaped trench. Achieving these trench dimensions at the expected installation speeds would require a productivity of 1,000 m3/hour to 5,000 m3/hour. Values at the lower end of this range provide a more realistic productivity rate that could be achieved, particularly in soils with a higher percentage of fines. The assessment is therefore based on an installation speed of 150 m/hour which still provides a conservative assessment of productivity rates, particularly where fine sediment fractions are high. Higher installation speeds would be achievable for much smaller trench dimensions, but the overall sediment disturbance rate is unlikely to exceed the values calculated based on the assumptions outlined.

18.12.8 In the near-field (within 5 to 10 m of the activity) sediment disturbed by construction activities would result in very high sediment concentrations, which would last while the activity resulting in the sediment disturbance persists. A large proportion of this sediment would settle back onto the seabed within the draft Order Limits (or where sediment is released in the case of sidecasting), with the actual amount depending on the grain size characteristics and the flow conditions.

18.12.9 As sediment in the plume is dispersed and deposited away from the site of the activity, sediment concentrations will reduce to much lower levels. The release rates detailed in **Table 18-16** were applied in the spreadsheet-based model to provide estimates of the maximum distance that increases in SSC would exceed 10 mg/l (also summarised in **Table 18-17**). The greatest impact distance was associated with trenching in the area where there was the highest percentage of fines and fastest flow, with peak SSC of more than 10 mg/l occurring up to 8 km from the point of release. Any exceedances of more than 10 mg/l will be of short duration beyond the draft Order Limits due to the relatively fast tidal flows. Beyond the distances for settling of very fine sands, sediment deposits will be very thin (order of mm’s or less).

Table 18-17 - Estimated Rate of Fine Sediment Release Associated with Different Activities

Location	Percentage Fines (%)	Dry sediment density (kg/m^3)	Release rate (kg/s)	Maximum distance where SSC> 10 mg/l (km)
Activity: Sandwave clearance				
KP 90	10	1,450	141.0	7.1
Activity HDD exit pit excavation				
KP 3	12	1,436	21.5	5.0
Activity: Trenching				
KP 10	42	1,190	62.5	8.0
KP 40	12	1,436	21.5	6.5
KP 150	5	1,500	9.6	2.8
KP 200	8	1,470	15.4	2.7
KP 230	60	1,000	75.0	5.2
KP 330	45	1,145	64.3	4.0

18.12.10 Based on the impact distances, cable trenching and exit pit excavation have the potential to increase SSC at both the Huttoft and Marsh Yard and Anderby bathing waters. However, tidal flows in the nearshore region are predominantly aligned with the coast and given that the excavation of the exit pit and the cable trenching will be constrained to water depths deeper than 3 m LAT, any sediment plume will most likely remain offshore of the bathing water sites.

18.12.11 The Environment Agency undertake regular beach renourishment in this region. This activity involves pumping large volumes of sediment and water into the intertidal region. Relative to the renourishment activity any sediment disturbance due to exit pit excavation and cable installation is smaller in scale both spatially and temporally.

18.12.12 KP 330 was selected as an area with a high percentage of fines in close proximity to the northeast of Farnes Deep HPMA. The ABPmer tidal renewables atlas shows flows to be orientated northsouth in this region so that for the section of the English Offshore Scheme which lies closest to the HPMA, any sediment plume will be advected along the cable route, rather than into the HPMA. For the section of the English Offshore Scheme to the south of the HPMA, some dispersion of the plume into the HPMA would be expected, although elevations would be of short duration (in the order of hours for each trench).

18.12.13 Based on these results, the **sensitivity** to change is considered to be **Low**, the **magnitude** of impact is **Negligible** and the significance of effect is assessed to be **Negligible** and **Not Significant**.

Operation

18.12.14 Cable protection placed on soft sediment could result in increases in SSC associated with scour. Any effect would be small and localised, and the potential for scour would be managed by aligning the cable protection with the flow direction where possible.

18.12.15 The **sensitivity** is unlikely to be changed from construction and is therefore assessed as **Low**. Impacts during any repair works will be of a smaller **magnitude** (due to the localised nature of repair works) when compared to impacts during construction (i.e. **Negligible**) and the effect of changes to the morphology are assessed as **Negligible** and **Not Significant.**

Decommissioning

18.12.16 The **sensitivity** is unlikely to be changed from **Low**. Potential impacts of decommissioning are likely to be of similar or lower **magnitude** than for construction (i.e. **Negligible**), with cables either pulled up and with some CFE potentially required in some areas to assist with cable removal. The effect of changes to the SSC and subsequent sedimentation during decommissioning are therefore assessed as **Negligible** and **Not Significant.**

18.13 Preliminary Impact Assessment of Modifications to Tidal and Wave Regimes and Associated Impacts to Morphological Features

Operation

18.13.1 Changes in depth from cable protection are typically small and localised, with depth reductions of up to 1.5 m over a crest width of 1 m.

18.13.2 Locations of cable and pipeline crossings, detailing KP, water depth, median sediment grain size and peak spring and neap flow speeds have been reviewed for the English Offshore Scheme (an example for the EGL 3 Project is provided in **Table 18-15.** Approximately two thirds of the crossing locations are in water depths of more than 30 m and as such this change is small relative to the total water depth (not more than 5% reduction in depth) and will not significantly alter flows or waves.

18.13.3 In some locations the infrastructure crossings are in relatively shallow water. In particular, there is an area of pipeline crossings at approximately KP15 where depths are shallower than -14 m LAT so that there is more than a 10% change in water depths. A SW model was developed and applied to assess the effects of cable protection required for these pipeline crossings on wave processes as detailed in **Section Construction** and **Volume 2, Part 3, Appendix 3.18.B.** The model results indicated very localised and small scale changes to the wave conditions. The effect of the cable protection on flows will be very localised around the berms (which are aligned almost parallel to the dominant flow direction).

18.13.4 Overall, the **sensitivity** of effect is considered **Negligible** and the **magnitude** is considered **Negligible** so that the **significance** is also assessed as **Negligible** and **Not Significant**.

Decommissioning

18.13.5 During decommissioning the seabed will be returned where reasonably possible and practical to the baseline condition. The **sensitivity** of the receptor and the **magnitude** of the change will be unchanged from that during operation (i.e. both **Negligible**). The effect of changes to tidal and wave regimes during decommissioning are therefore assessed as **Negligible** and **Not Significant.**

18.14 Preliminary Impact Assessment of Release of Contaminated Sediment

Construction

18.14.1 Seabed disturbance during construction has the potential to release contaminants like heavy metals and hydrocarbons held within seabed pore water back into suspension. However, results from sediment samples collected along the EGL 4 Project showed that the presence of contaminated sediment is minimal. All samples were below Cefas cAL1, except for Arsenic at a total of eight locations (out of 54 sites). All locations remained below AL2 as well as the NOAA ERM threshold for all tested substances. Some substances were found to reach the NOAA ERL threshold, which is higher than the Cefas cAL1. In particular, Nickel exceeded the ERL at a total of four sample locations, while Lead and Mercury exceeded the ERL at one site each. Although no results are presently available for samples collected along the EGL 3 Project, in view of the close proximity, similarity in sediment types and generally low contaminants in sediments from other samples in the region, the contaminant levels are expected to be similar for the EGL 3 Project samples as presented for the EGL 4 Project.

18.14.2 Water quality is classed as excellent at the local bathing water sites. This indicates that the natural and regular suspension of sediment due to currents and wave action in these areas is not linked to significant contaminant re-dissolution.

18.14.3 The **sensitivity** of the receptor is assessed as **low** and based on the generally low levels of contaminants it is considered that the **magnitude** of adverse effects on water quality is **Negligible** and it is concluded that the **significance** of effect of disturbance of contaminated seabed sediments is also **Negligible** and **Not Significant**.

18.14.4 This assessment will be confirmed once results from the EGL 3 survey become available (with results to be reported in the ES).

Operation

18.14.5 Impacts from unforeseen maintenance of the cable would be of smaller magnitude when compared to cable installation due to the isolated and targeted nature of the maintenance works (i.e. Negligible) while the sensitivity would be unchanged from Low. The effect of disturbance of contaminated seabed sediments during operation is therefore assessed as **Negligible** and **Not Significant.**

Decommissioning

18.14.6 Impacts during decommissioning would be of a similar **magnitude** when compared to construction (i.e. **Negligible**) while the **sensitivity** would be unchanged from **Low** and therefore the effect has been assessed as **Negligible** and **Not Significant**.

18.15 Preliminary Impact Assessment of Temperature Increases

Operation

18.15.1 During the operation of an HVDC cable, heat losses occur because of the resistance in the cable/conductor. This can cause localised heating of the surrounding environment (i.e., sediment for buried cables, or water in the interstitial spaces of external cable protection). There are no specific regulatory limits applied to temperature changes in the seabed, although a 2 °C change between seabed surface and 0.2 m depth is used as a guideline in Germany (Ref 18.51) The benchmark for sensitivity used by the Marine Evidence based Sensitivity Assessment (MarESA) is a 5 °C increase in temperature for one month, or 2 °C for one year.

18.15.2 The heat loss from the cable is related to the physical and thermal properties of the cables. To inform the assessment, a number of scenarios were modelled to evaluate the thermal performance of the cables, including directly buried in a bundle to differing depths and contained within a duct at the Anderby Creek Landfall at various depths. The calculations are presented in **Volume 2, Part 1, Appendix 1.4.B: EGL 3 Heat Calculations** and **Volume 2, Part 3, Appendix 1.4.C: EGL 4 Heat Calculations**. They show that for cables operating at full power, the temperature is raised in the immediate vicinity of the cable but reduces with distance. Assuming an ambient seabed temperature of 12 °C, seabed temperatures at 0.2 m immediately above the cables are estimated to be 13 - 14 °C, with the cables operating at maximum operating temperatures. The actual system is unlikely to reach these temperatures as the system would have to operate at full load continuously for an extended period of time (months/years) to meet these temperatures. In reality, the system will not be at full load for this long and therefore the temperature will fluctuate and it would unlikely reach these maximums. Although thermal effects would be long-term and occurring continuously for the operational lifetime of the English Offshore Scheme, the temperature increase is low level and likely to be only a few degrees higher than ambient at the shallow sediment depths (<20 cm). There is negligible capacity to heat the overlying water.

18.15.3 The **sensitivity** of the receptor is assessed as **low.** Due to natural seasonal changes in water temperature, a sediment temperature change of a few degrees higher than ambient is regarded as an insignificant temperature increase. Coupled with the fact that temperature changes will be isolated to immediately above the cables, the **magnitude** of the impact on sediments has been assessed as **Negligible**.

18.15.4 Therefore, the **significance** of effect of an increase in temperature on coastal and marine physical processes is assessed as **Negligible and Not Significant.**

18.16 Transboundary Effects

18.16.1 The EIA Regulations require an ES to consider the transboundary effects of a development (paragraph 5 of Schedule 4). Given the nature of the English Onshore Scheme and its proposed location, significant transboundary effects are unlikely as there are no pathways for effects to occur outside of the UK. Similarly, the English Offshore Scheme lies wholly in UK waters. Separate applications will be submitted to the relevant Statutory Authority for the Scottish Schemes. Where the English and Scottish Onshore and Offshore Schemes meet, collaborative environmental assessments will ensure impacts are fully assessed. As outlined in the Planning Inspectorate's Advice Note Twelve, the screening process for transboundary effects will be carried out by the Planning Inspectorate. Information to inform this screening assessment will be provided as part of the application for the DCO.

18.17 Further Work to be Undertaken

18.17.1 The information provided in this PEIR is preliminary, the final assessment of significant effects will be reported in the ES. This section describes the further work to be undertaken to support the coastal and marine physical processes assessment presented in the ES.

Baseline

18.17.2 The full CBRAs are yet to be completed. Once completed the assessment will be updated to include details on the locations where rock protection is required due to insufficient burial and infrastructure crossings.

18.17.3 While the project survey work has been completed, not all data were available for the PEIR. In particular, the contaminant results for samples collected along the EGL 4 Project are not yet complete.

18.17.4 With respect to the temporary quay, if the option is taken forward, further information would be gathered in respect to the marine processes within this area. Assessment would be included in the ES**.**

Assessment

18.17.5 The assessments undertaken for the PEIR will be reviewed following stakeholder consultation feedback, further design refinement and additional baseline information.

18.17.6 The following assessments will be updated if required:

- updated assessment of increases in SSC and subsequent deposition. This will be based on a refined version of the spreadsheet-based model applied for the assessment in the PEIR; and
- wave modelling assessment of impact of cable protection.

Further Environmental Measures

18.17.7 If stakeholder consultation feedback in response to this PEIR identifies the need for further design refinement, assessment or additional environmental measures, these will be detailed as part of the ES.

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