BERWICK BANK WIND FARM
ENVIRONMENTAL IMPACT ASSESSMENT REPORT

Volume 2, Chapter 7: Physical Processes

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EIA Report - Chapter 7
Final

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Prepared by:	**RPS**
Prepared for:	**SSE Renewables**
Checked by:	**Douglas Watson**
Accepted by:	**Ross Hodson**
Approved by:	**Sarah Edwards**

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7. PHYSICAL PROCESSES

7.1. INTRODUCTION

1. This chapter of the Offshore Environmental Impact Assessment (EIA) Report presents the assessment of the likely significant effects (as per the "EIA Regulations") on the environment of the Berwick Bank Wind Farm offshore infrastructure which is the subject of this application (hereafter referred to as "the Proposed Development") on physical processes. Specifically, this chapter considers the potential impacts of the Proposed Development seaward of Mean High Water Springs (MHWS) during the construction, operation and maintenance, and decommissioning phases.

2. Likely significant effect is a term used in both the "EIA Regulations" and the Habitat Regulations. Reference to likely significant effect in this Offshore EIA Report refers to "likely significant effect" as used by the "EIA Regulations". This Offshore EIA Report is accompanied by a Report to Inform Appropriate Assessment (RIAA) (SSER, 2022c) which uses the term as defined by the Habitats Regulations Appraisal (HRA) Regulations.

3. The assessment presented informs the following technical chapters and reports:

   - volume 2, chapter 8: Benthic Subtidal and Intertidal Ecology;
   - volume 2, chapter 9: Fish and Shellfish Ecology;
   - volume 2, chapter 10: Marine Mammals;
   - volume 2, chapter 17: Infrastructure and Other Users;
   - volume 2, chapter 19: Water Quality; and
   - volume 3, appendix 19: Water Framework Directive Report.

4. The assessment further informs the Marine Protected Area (MPA) Assessment (SSER, 2022b) and the RIAA (SSER, 2022c) for the Proposed Development, which accompany the Application.

5. This chapter summarises information contained within volume 3, appendix 7.1.

7.2. PURPOSE OF THIS CHAPTER

6. The primary purpose of the Offshore EIA Report is outlined in volume 1, chapter 1. 'Likely significant effect' is a term used in both the "EIA Regulations" and the "Habitat Regulations". Reference to likely significant effects in this Offshore EIA Report refers to 'likely significant effect' as used by the "EIA Regulations". This Offshore EIA report is accompanied by a Report to Inform Appropriate Assessment (RIAA) (SSER, 2022c) which uses the term as defined by the Habitats Regulations Appraisal (HRA) Regulations.

7. It is intended that the Offshore EIA Report will provide the Scottish Ministers, statutory and non-statutory stakeholders with sufficient information to determine the likely significant effects of the Proposed Development on the receiving environment.

8. In particular, this Physical Processes Offshore EIA Report chapter:

   - presents the existing environmental baseline established from desk studies, site-specific surveys, numerical modelling studies, and consultation with stakeholders;
   - identifies any assumptions and limitations encountered in compiling the environmental information;
   - presents the likely significant environmental impacts on physical processes arising from the Proposed Development and reaches a conclusion on the likely significant effects, based on the information gathered and the analysis and assessments undertaken;
   - refers to the design aspect of the assessment of the Proposed Development as described in volume 1, chapter 3 of the Offshore EIA Report which prescribes the provision of cable and scour; and
   - highlights any necessary monitoring and/or mitigation measures which are recommended to prevent, minimise, reduce or offset the likely significant effects of the Proposed Development on physical processes.

9. The physical processes modelling that has been undertaken to support this chapter is presented in volume 3, appendix 7.1 of the Application.

7.3. STUDY AREA

10. The physical processes study area for the Proposed Development is illustrated in Figure 7.1 and encompasses the:

    - Proposed Development array area (i.e. the area in which the wind turbines will be located);
    - Proposed Development export cable corridor;
    - intertidal area at landfall; and
    - seabed and coastal areas that may be influenced by changes to physical processes due to the Proposed Development, based on the outputs of the physical processes modelling which will encompass a wider domain including the Firth of Forth Banks Complex.

11. The physical processes study area was principally defined as one tidal excursion from the Proposed Development array area and would therefore encapsulate the distance suspended sediment is transported prior to being carried back on the returning tide. The area was then extended to include the banks within the Firth of Forth Banks Complex Nature Conservation Marine Protected Area (ncMPA) namely, Berwick Bank, Marr Banks, Montrose Bank and Scalp Banks along with Wee Bankie. It is however noted that the physical processes study area forms the focus for the assessment and that the numerical model extent was not limited to this region and would therefore also identify potential impacts beyond the physical processes study area.

7.3.1. INTERTIDAL AREA

12. The offshore topic of physical processes study area includes the intertidal area. This intertidal area overlaps with the onshore topic of Geology, Hydrology, Soils and Flood Risk (landward of Mean Low Water Springs (MLWS)).

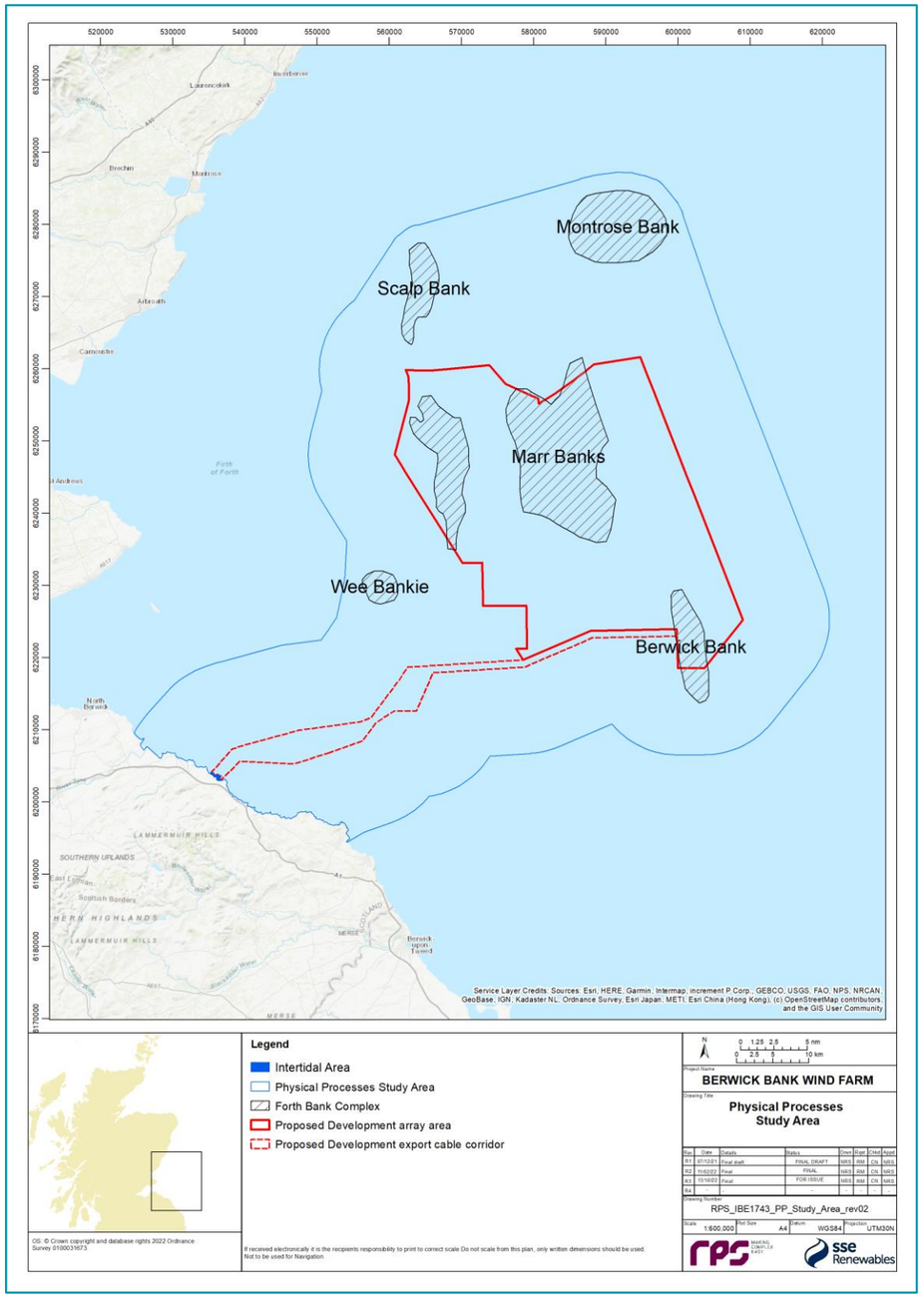


Figure 7.1: Physical Processes Study Area

7.4. POLICY AND LEGISLATIVE CONTEXT

13. Policy and legislation on renewable energy infrastructure is presented in volume 1, chapter 2 of the Offshore EIA Report. Policy specifically in relation to physical processes, is contained in the Sectoral Marine Plan for Offshore Wind Energy (SMP) (Scottish Government, 2020), the Scottish National Marine Plan (NMP) (Scottish Government, 2015) and the United Kingdom (UK) Marine Policy Statement (MPS) (HM Government, 2011). A summary of the policy provisions relevant to physical processes are provided in Table 7.1, with other relevant policy provisions set out in Table 7.2 and Table 7.3.

14. These are summarised here with further detail presented in volume 1, chapter 2.

15. All the policy and legislation provided in Table 7.1, Table 7.2 and Table 7.3 is also relevant to the intertidal area.

Table 7.1: Summary of SMP Policies Relevant to Physical Processes

Summary of SMP Provision	How and Where Considered in the Offshore EIA Report
SMP for Offshore Wind Energy	
• loss of/damage to marine and coastal habitats; • effects on subsea geology, sediments and coastal processes arising from changes in hydrodynamics and existing wave regimes; • effects on landscape and coastal characters and visual receptors; • loss of/damage to historic environment features and their settings; • effects on water quality; and • effects on ecological status.	Hydrodynamic modelling undertaken for physical processes assessment (refer to volume 3, appendix 7.1) and water quality assessment has been undertaken in volume 2, chapter 19 and volume 3, appendix 19.1. The procedures are considered within volume 1, chapter 3. Best practice techniques will be employed to ensure sediment mobilisation is minimised. Assessment of sediment dynamics undertaken using the hydrodynamic and spectral wave modelling, together with an understanding of the sediment regime. Refer to volume 3, appendix 7.1.

Table 7.2: Summary of NMP Policies Relevant to Physical Processes

Summary of NMP Provision	How and Where Considered in the Offshore EIA Report
Scottish NMP	
Sustainable development of offshore wind, wave and tidal renewable energy in the most suitable locations.	Refer to volume 1, chapter 4.
Marine planners and decision makers must ensure that renewable energy projects demonstrate compliance with EIA and HRA legislative requirements	Legislative requirements for offshore wind farms are considered within volume 1, chapter 2.
A strategic approach to mitigating potential impacts and cumulative impacts on the marine environment forms an integral part of marine planning and decision making, whilst issues arising in the coastal interface should align between marine and terrestrial processes.	A Cumulative Effect Assessment (CEA) has been undertaken and is outlined in section 7.12.

Summary of NMP Provision	How and Where Considered in the Offshore EIA Report
A changing climate may result in changes in extreme weather events which could create difficult operating conditions for offshore installations.	Baseline and post-construction physical processes were compared alongside extreme storm conditions to consider the wave climate detailed in volume 3 appendix 7.1.

Table 7.3: Summary of Other Policies Relevant to Physical Processes

Summary of Policy	How and Where Considered in the Offshore EIA Report
UK MPs	
Offshore wind farm (fixed) foundation designs are likely to influence hydrodynamics and consequent sediment movement. This includes potential scouring of sediments around the bases of wind turbines.	Predicted changes to the tidal current, wave climate, littoral currents and sediment transport are assessed in volume 3, appendix 7.1. Scour protection is included within the design as outlined in the Project Description volume 1, chapter 3.

7.5. CONSULTATION

16. The physical processes Road Map was a 'live' document which has been used as a tool to facilitate early engagement with stakeholders and subsequent engagement throughout the pre-application phase of the Proposed Development including on agreeing to scope impacts out of the assessment, and/or agreeing the level of assessment which will be presented for impacts, so that the focus in the EIA submission documents is on likely significant environmental effects as required by the EIA Regulations.

17. The physical processes Road Map (up to date at the point of Application) is presented as volume 3, appendix 8.2 and documents meetings and discussion points. At the request of MS-LOT[1], an audit document (Audit Document for Post-Scoping Discussions (volume 3, appendix 5.1) has been produced to document discussions on key issues, post-receipt of the Berwick Bank Wind Farm Scoping Opinion (MS-LOT, 2021).

18. A summary of the key issues raised during consultation activities undertaken to date specific to physical processes for the Proposed Development is presented in Table 7.4. Further relevant consultation feedback is also presented together with how these issues have been considered in the production of this Physical Processes Offshore EIA Report chapter. Further detail is presented within volume 1, chapter 5.

Table 7.4: Summary of Key Consultation of Relevance to Physical Processes

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
Relevant Consultation to Date			
November 2020	MS-LOT 2020 Berwick Bank Scoping Report response	Use of Road Map process to present modelling methodology.	Presented in Road Map 1 September 2021 and Road Map 3 March 2022 detailed in volume3, appendix 8.2.
		Suggested use of MSS reports and datasets.	Informed baseline physical processes and defined designated areas - Joint Nature Conservation Committee (JNCC) mapper.
		Requested validation of numerical modelling to be included in the assessment.	Calibration data is presented in volume 3, appendix 7.1. This includes field data relating to parameters such as water level, tidal current and wave climate.
		Consideration of cumulative impacts.	Presented in section 7.12.
		Due consideration should be taken of Bathing Waters.	Bathing waters are identified within the physical processes study area (Figure 7.4) and further assessment is undertaken in with regards to other users in volume 2, chapter 17 and water quality in volume 2, chapter 19.
November 2020	MSS 2020 Berwick Bank Scoping Report response	Suggested use of MSS reports and datasets.	Informed baseline physical processes and defined designated areas - JNCC mapper.
		Suggested use of suspended particulate matter (SPM) data and validation of numerical models.	Presented in volume 3, appendix 7.1
		Scour protection/embedded mitigation should be included.	Scour protection is an integral part of the design as defined by the Project description outlined in volume 1, chapter 3. It is included within the assessment within the context of impacts due the presence of the infrastructure
November 2020	NatureScot 2020 Berwick Bank Scoping Report response	Consideration to be taken of changes to physical processes on Firth of Forth Banks Complex ncMPA particularly; shelf banks and mounds, offshore subtidal sands and gravel and moraines representative of the Wee Bankie.	This indeed forms part of the physical processes investigation, presented in section 7.11.

[1] Meeting on 26 April 2022 between MS-LOT, RPS and the Applicant

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		Coastal recession, beach lowering and cable exposure should be included.	The Project has committed to installing the offshore export cables at the landfall using trenchless technologies (e.g. Horizontal Directional Drilling (HDD)) (see volume 1, chapter 3. Consequently, given that the open cut trench technique for cable burial is no longer a design consideration, potential risks relating to cable exposure due to coastal recession and beach lowering are significantly reduced. The final detailed design work will include consideration of predicted coastal recession including due to climate change in order to prevent cable exposures at landfall.
		Scour protection/embedded mitigation should be included.	Scour protection is an integral part of the design as defined by the Project description outlined in volume 1, chapter 3. It is included within the assessment within the context of impacts due the presence of the infrastructure.
		Cumulative impacts from neighbouring wind farms.	These are presented in section 7.12.
November 2020	SFF 2020 Berwick Bank Scoping Report response	Suggested use of MSS reports and datasets	Informed baseline physical processes and defined designated areas - JNCC mapper.
		Suggested use of SPM data and validation of numerical models.	Presented in volume 3, appendix 7.1.
		Scour protection should be scoped into the study.	Scour protection is an integral part of the design as defined by the Project description outlined in volume 1, chapter 3. It is included within the assessment within the context of impacts due the presence of the infrastructure.
Consultation on the Proposed Development			
September 2021	Marine Scotland Road Map Meeting 1 (volume 3, appendix 8.2)	Clarification of scour protection assessment required.	Scour protection is an integral part of the design as defined by the Project description outlined in volume 1, chapter 3. It is included within the assessment within the context of impacts due the presence of the infrastructure.
September 2021	NatureScot Road Map Meeting 1 (volume 3, appendix 8.2)	Highlighted the Dynamic Coast Resource.	This data informed baseline physical processes.
		Assessment of Firth of Forth Banks Complex ncMPA and cumulative effects should be included.	Section 7.11 and section 7.12 respectively.
		Beach morphology and cable exposure should be considered.	The Project has committed to installing the offshore export cables at the landfall using trenchless technologies (e.g. Horizontal Directional Drilling (HDD)) (see Project Description volume 1, chapter 3. Consequently, given that the open cut trench technique for cable burial is no longer a design consideration, potential risks relating to cable exposure due to coastal recession and beach lowering also no longer require consideration.
October 2021	Scottish Fishermen's Federation (SFF) Scoping response	Transboundary impacts should not be scoped out of the assessment.	Transboundary effects were not anticipated however they were not scoped out of the assessment and are summarised in section 7.13.
October 2021	NatureScot Scoping response	Turbot Bank ncMPA and Southern Trench ncMPA should be screened out on the basis of distance.	This is the case, the physical processes study area is described in section 7.3.
		The Firth of Forth Banks Complex ncMPA is a composite site and the assessment should be undertaken with respect to the presence and extent of the important features contained within them.	The physical processes assessment is undertaken with respect to applicable site features (i.e. offshore subtidal sands and gravels, shelf banks and mounds and moraines) as detailed in section 7.11.
		Scour protection/embedded mitigation should be considered.	Scour protection is an integral part of the design as defined by the Project description outlined in volume 1, chapter 3. It is included within the assessment within the context of impacts due the presence of the infrastructure.
		Cable burial depth should be informed by coastal recession to provide adaption to climate change.	Due to the removal of open cut trench technique for cable burial at landfall, potential risks relating to cable exposure due to coastal recession and beach lowering are significantly reduced. Final detailed design will account for the potential coastal recession over the lifetime of the project.
		Caisson foundations, with the greatest footprint represent the worst case option.	This is indeed the case the maximum design scenario for each design aspect is outlined in Table 7.9.
		Inclusion of summary tables of cumulative impacts should be considered.	These are provided in Table 7.20.
October 2021	Natural England	Coastal processes chapter will need to demonstrate indirect impacts do not extend to English Special Protection Areas (SPAs) and Special Areas of Conservation (SACs).	The physical processes study, detailed in volume 3, appendix 7.1, determined the extent of impacts in relation to receptors. This chapter makes an assessment of the likely significant effects in EIA terms on the qualifying interest feature(s) of these sites as described within volume 2, chapters 8, 9 and 10.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		Baseline and potential increased pressures should be quantified to enable in-combination effects to be assessed.	This is the basis of the physical processes study and associated assessment.
October 2021	British Telecommunications (BT)	Purple lines reserved for radio links on the mainland.	Physical processes study area, Figure 7.1, outline changed to blue to avoid confusion.
October 2021	Scottish Environmental Protection Agency (SEPA)	Due consideration should be taken of Bathing Waters.	Bathing waters are identified within the physical processes study area (Figure 7.4) and further assessment is undertaken in with regards to other users in volume 2, chapter 17 and water quality in volume 2, chapter 19.
		Dredged material should be disposed of at an offshore sea disposal site and work should be carried out in line with best dredging practices.	No dredged material is proposed to be removed from the Proposed Development area.
December 2021	Coast to Coast Surf School email communication.	Requested clarification on origin of wave impact data.	Modelling of wave impacts for the Proposed Development is detailed in volume 3, appendix 7.1. Cumulative assessments were undertaken with respect to the Neart na Gaoithe Offshore Wind Farm (Intertec Metoc 2011).
February 2022	MS-LOT Berwick Bank Wind Farm Scoping Opinion	Seabed levelling or removal of substances from on or under the seabed (including dredging and 'grapnel runs') will require consideration in the Offshore EIA Report.	Seabed levelling is included within the physical processes modelling, volume 3, appendix 7.1 and assessment, section 7.11.
		Recommended consideration of the additional data sources identified in the advice from Marine Scotland Science (MSS). In addition, the recommended that as part of the Applicant's Road Map process, there be further discussion and agreement on the relevant datasets to be used for the hydrodynamic model.	The additional datasets highlighted were included within the study as detailed in volume 3, appendix 7.1. The Road Map process presented the evidence base, baseline and receptors and valuable feedback was provided. Additional information on modelling datasets and approaches was presented at follow-up Road Map Meeting 3 (March 2022).
		Sediment scour and physical change must be fully addressed by the Applicant in the Offshore EIA Report.	Scour protection is an integral part of the design as defined by the Project description outlined in volume 1, chapter 3. It is included within the assessment within the context of impacts due the presence of the infrastructure.
		In relation to hydrodynamic and hydro-sedimentary modelling, further discussion on the methodology is required and recommend this is undertaken through the Applicant's Road Map process to enable agreement on spatial and temporal scope, nature of outputs including how they are presented and key modelling assumptions.	The Road Map process was used to present the evidence base, baseline and receptors and valuable feedback was provided. Additional information on modelling datasets and approaches was presented at follow-up Road Map Meeting 3 (March 2022).
		Full consideration and assessment of the potential impacts upon the Firth of Forth Banks Complex ncMPA must be included in the EIA Report, including consideration of the 3 composite sites within the ncMPA.	Feedback on the assessment approach to physical processes with regard to each aspect of the Firth of Forth Banks Complex ncMPA has been incorporated into the assessment, section 7.11.
		In relation to mitigation and potential monitoring, highlight the MSS advice with regards to the consideration of scour and suspended sediment monitoring.	Operation and maintenance phase activities will include the routine inspection of installation, including wind turbine foundations as described in volume 1, chapter 3.
		The Offshore EIA Report should include consideration of any effects on the water quality of the bathing water from the activities associated with the construction, operation and maintenance of the Proposed Development, these may vary depending on the chosen construction method for the cable landfall.	Bathing waters are identified within the physical processes study area (Figure 7.4) and further assessment is undertaken in with regards to other users in volume 2, chapter 17 and water quality in volume 2, chapter 19.
February 2022	MSS Berwick Bank Offshore Wind Farm Scoping Opinion	Suggested additional datasets. The Copernicus Marine Service (https://marine.copernicus.eu/), including the Atlantic European North West Shelf - Ocean Physics Analysis and Forecast at 1.5 km and 7 km resolution. The European Centre for Medium-range Weather Forecast (ECMWF) also host the ERA5 atmospheric model data.	The Danish Hydraulic Institute (DHI) datasets employed have been successfully implemented in the region for other unrelated projects. The principal source of wind and wave data was derived from the ECMWF database with validation using monitoring datasets as detailed in volume 3, appendix 7.1.

Date	Consultee and Type of Consultation	Issue(s) Raised	Response to Issue Raised and/or Where Considered in this Chapter
		Suggested additional datasets. Scottish Shelf Model for climatological hydrodynamic model output, including water current velocities, water elevations and temperature and salinity fields The MSS Oceanography group also have a 3D Finite Volume Community Ocean Model (FVCOM) of the Firth of Forth and Tay region, with around 100 m node spacing close to the coast. For bathymetry Seabed Mapping Data Service. https://seabed.admiralty.co.uk/	The Scottish Shelf model was a useful reference (highlighted within the Road Map processes). Model bathymetry was derived from Marine Environmental Data Information Network (MEDIN)/INSPIRE datasets these datasets are available from a number of sources including European Marine Observation and Data Network (EMODnet) and the Admiralty site noted. Further detail is provided in volume 3, appendix 7.1.
		The Firth of Forth Banks Complex ncMPA offers protection to offshore subtidal sands and gravels and their associated biological communities, it would be prudent to include these sediment features as a receptor.	This indeed forms part of the physical processes investigation, section 7.11.
		Suggested and recommended that the applicant considers monitoring scour around the wind turbine foundations, in addition to the cable route. Advise it would be prudent to consider monitoring of suspended sediments and bed features, at least within the Firth of Forth Banks Complex ncMPA. This may not be necessary, depending on the outcome of the modelling work during the EIA stage.	Operation and maintenance phase activities will include the routine inspection of installation, including wind turbine foundations as described in volume 1, chapter 3. Potential increases in suspended sediment concentrations (SSC) due to installation activities is included in the physical processes modelling and used to inform pathway disciplines assessments and recommendations.
		Suggested analysis on how current speeds and stratification may be changed by the large number of structures being installed. Recommends that the applicant considers if the large number of wind turbines may change the near-sea-surface wind velocities.	The impact of the influence of structures within the water column was assessed throughout a range of both tidal and meteorological conditions using 2D modelling (volume 3, appendix 7.1). The localised nature of the changes in tidal currents (wake effects) indicated that effects on stratification and mixing would therefore be limited.
April 2022	NatureScot and JNCC Road Map Meeting 3 (volume 3, appendix 8.2)	Suggested model results were presented as 'heat maps' and the inclusion of the degree of uncertainty alongside the modelling results as well as limitations with the modelling approach.	In volume 3, appendix 7.1 'heat maps' are provided for suspended sediment and deposition. Section 7.7.3 details data limitations and where appropriate uncertainty of results is presented in this chapter.
		Suggested that calculations for scour protection should take it into account secondary scour around any scour protection included.	Modelled scenarios used for the assessment of effects account for scour protection. As such scour protection and secondary scour protection is accounted for within the assessment of effects.
		The Offshore EIA Report should include; if the sand waves are active, reforming *in situ* or migrating, and an indication of how fast sand waves develop and migrate when active.	The baseline modelling undertaken indicates evidence of sand wave activity and therefore recovery would be expected although the modelling is not detailed enough to place a time frame on the recovery period from seabed preparation activities. Wallingford (2012) carried out a study on bedform migration using historic geophysical surveys within the Seagreen 1 development area. This study indicated that seabed sediments were mobile and prone to accretion and the underlying bedforms were stable. Reiterating the idea that sand wave recover is expected and likely to occur over prolonged periods (i.e. many years). Following further stakeholder engagement, a monitoring commitment is included under the Project Environmental Monitoring Plan (EMP) as detailed in Table 7.15.
		Consideration on trenched cable being exposed due to the dynamics of migrating sand waves. With the potential for protection of the cables using armour.	The open cut trench technique for cable burial is no longer a design consideration at landfall, and potential risks relating to cable exposure due to coastal recession and beach lowering are significantly reduced. The final detailed design work will include consideration of predicted coastal recession including due to climate change in order to prevent cable exposures at landfall.
April 2022	NatureScot and JNCC email communication	The issues raised during Road Map Meeting 3, detailed above, were provided within an email communication.	The responses noted above were provided via email August 2022.

7.6. METHODOLOGY TO INFORM BASELINE

7.6.1. DESKTOP STUDY

19. As described in paragraphs 10 and 11, the Proposed Development array area and physical processes study area are shown in Figure 7.1.

20. Information on physical processes within the physical processes study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 7.5 and Table 7.6 respectively. The baseline was characterised by a combination of literature review of the reports and

numerical modelling using the datasets. Full details of the analysis undertaken to develop the physical processes baseline is provided in the Physical Processes Technical Report (volume 3, appendix 7.1).

Table 7.5: Summary of Key Desktop Reports

Title	Source	Extent	Year	Author
00338 SSE Berwick Bank Lot 1 and 2 Operations and Results Report	SSE Renewables	Proposed Development area	2021	XOCEAN Ltd.
Seagreen 2 and 3 Windfarm Zones Geophysical Survey – Final Survey Results Report – Export Cable Route.	SSE Seagreen Wind Energy Limited	Proposed Development area	2020	Fugro
Seagreen 2 and 3 and ECR Windfarm Zone Geophysical Survey – Final Survey Results Report – Seagreen 2 and Seagreen 3.	SSE Seagreen Wind Energy Limited	Proposed Development area	2020	Fugro
Suspended Sediment Climatologies around the UK	Centre for Environment, Fisheries and Aquaculture Science (Cefas)	UK Waters	2016	Cefas
Firth of Forth Zone Development – Metocean Study.	Seagreen Wind Energy	Former Firth of Forth Zone	2012	Fugro
Appendix E3 – Geomorphological Assessment. Seagreen Wind Energy.	http://marine.gov.scot/datafiles/lot/SG_FoF_alpha-bravo	Seagreen area	2012	HR Wallingford
Coastal Processes Assessment for Neart na Gaoithe Offshore Wind Farm Technical Report.	http://nngoffshorewind.com/files/offshore-environmental-statement	Former Firth of Forth Zone	2011	Intertek METOC
Climatology of Surface and Near-bed Temperature and Salinity on the North-West European Continental Shelf for 1971–2000	https://data.marine.gov.scot/dataset	UK Waters	2009	Berx, B, Hughes, S.
Coastal Cells in Scotland: Cell 1 - St Abb's Head to Fife Ness.	http://www.dynamiccoast.com/resources	Scottish Waters	2000	Ramsay and Brampton
Firth of Forth and Tay Developers Group, Collaborative Oceanographic Survey, Specification and Design. Work Package 1. Review of existing information.	Firth of Forth and Tay Developers Group	Former Firth of Forth Zone	2009	HR Wallingford

Table 7.6: Summary of Key Resources

Source	Coverage	Data Provision
MEDIN	UK Waters	Bathymetry data
ECMWF	European Waters which include Scottish Waters	Historic and contemporary pressure, wind speed and wave datasets.
EMODnet	European Waters which include Scottish Waters	Bathymetry, geology; and seabed substrate and classifications
Cefas Offshore observation data	UK Waters	Salinity, seawater temperature and turbidity.
Cefas Climatology Data (Cefas, 2016) (https://data.cefas.co.uk/view/18133)	UK Waters	SSC
British Oceanographic Data Centre (BODC) UK tide gauge network. Database of current observation	UK Waters	Tidal levels, current speed and current direction.
United Kingdom Hydrographic Office (UKHO) - Published Charts and Tide tables	UK Waters	Charts 1407 1:200000 and 175 1:75000 incorporating tidal diamonds with current stream data.
Summary of Seagreen Firth of Forth Metocean Surveys to Date (Intertek Metoc, 2012)	Former Firth of Forth Zone	Wave data, current data, water level data, seawater temperature and turbidity.
Firth of Forth Zone Development: Metocean survey (Fugro GEOS, 2011)	Former Firth of Forth Zone	Metocean data.
UK Round 3 Offshore Wind Farm Zone 2 Firth of Forth: Wave Height Spells for Survey Operability (Metoc, 2010)	Former Firth of Forth Zone	Metocean data.
Dynamic Coast (https://www.dynamiccoast.com)	Scottish Waters	Coastal change maps and resources.
Dynamic Coast 2 (https://www.crew.ac.uk/dynamic-coast and https://www.dynamiccoast.com/webmaps)	Scottish Waters	Coastal erosion.
JNCC mapping data (https://jncc.gov.uk/mpa-mapper/)	UK Waters	Spatial data for marine protected areas incl. SPAs, Sites of Special Scientific Interest (SSSI) and conservation zones.
Marine Science Scotland Scottish Shelf model (http://marine.gov.scot/information/wider-domain-scottish-shelf-model, https://data.marine.gov.scot/dataset/climatology-surface-and-near-bed-temperature-and-salinity-north-west-european-continental and Berx 2009)	UK Waters, including The North Sea and English Channel	Climatology: temperature, salinity and current speed characteristics.
Marine Scotland mapping data (https://marinescotland.atkinsgeospatial.com/nmpi/)	Scottish Waters	Spatial data for physical characteristics, metocean, climate change, bathing waters and marine activities.

7.6.2. IDENTIFICATION OF DESIGNATED SITES

21. All designated sites within the physical processes study area and qualifying interest features that could be affected by the construction, operation and maintenance, and decommissioning phases of the Proposed Development were identified using the three-step process described below:

- Step 1: All designated sites of international, national, and local importance within the physical processes study area were identified using a number of sources. These included the Marine Scotland website (http://marine.gov.scot/), the Atlas of Marine Protection website (https://mpatlas.org/) and JNCC resources (https://jncc.gov.uk/mpa-mapper/).
- Step 2: Information was compiled on the relevant geomorphological/coastal features for each of these sites.
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - a designated site directly overlaps with the Proposed Development array area or Proposed Development export cable corridor and therefore has the potential to be directly affected by the Project; or
  - sites and associated features were located within the physical processes study area for impacts associated with the Project and therefore have the potential to be indirectly affected by the Proposed Development.

7.6.3. SITE-SPECIFIC SURVEYS

22. To inform the Offshore EIA Report for the Proposed Development, site-specific surveys were undertaken. A summary of the surveys undertaken used to inform the physical processes assessment of effects is outlined in Table 7.7.

Table 7.7: Summary of Site-Specific Survey Data

Title	Extent of Survey	Overview of Survey	Survey Contractor	Date	Reference to Further Information
Geophysical Survey	Proposed Development export cable corridor	Geophysical study to establish bathymetry, seabed geology, morphology and sediments	XOCEAN Ltd.	2021	XOCEAN (2021)
Benthic subtidal survey	Proposed Development array area and export cable corridor	Grab sampling with chemical analysis and particle sieve analysis	Ocean Ecology Ltd.	2021	See volume 3, appendix 8.1
Geophysical survey	Proposed Development array area and export cable corridor	Geophysical study to establish bathymetry, seabed geology, morphology and sediments	Fugro	2020	Fugro (2020a) and Fugro (2020b)

7.7. BASELINE ENVIRONMENT

7.7.1. OVERVIEW OF BASELINE ENVIRONMENT

23. A summary of the physical processes baseline environment is provided in the following sections. Full details of the analysis undertaken to develop the physical processes baseline is provided in the Physical Processes Technical Report (volume 3, appendix 7.1), which includes information on model development, resolution, calibration, and the modelling techniques implemented to develop the baseline characteristics.

Bathymetry

24. The Proposed Development array area lies within the Firth of Forth Banks Complex ncMPA; in particular the bathymetry is influenced by two bank features. The large-scale morphological bank features of Marr Banks and the northern extent of the Berwick Bank, whilst the physical processes study area also includes Montrose Bank, Scalp Bank and Wee Bankie as shown in Figure 7.1.

25. Seabed levels across the Proposed Development array area vary from a minimum depth of 32.8 m below Lowest Astronomical Tide (LAT) to the north of the western central part of the Proposed Development array area to a maximum depth of circa 68.5 m below LAT in the east of the banks. The Proposed Development export cable corridor has a relatively variable bathymetry ranging from the low water mark to a depth of 69.8 m below LAT. Along the Proposed Development export cable corridor which extends to the western margin of the Berwick Bank, the bathymetry is influenced by a gently sloping seafloor topography to a depth of 60 m below LAT, as illustrated in Figure 7.2.

Hydrography

26. The Proposed Development array area has an average tidal range of 3.25 m as published by Admiralty (UKHO) at Dunbar. This port is one of a number in the proximity of the physical processes study area and was used as a calibration point alongside several other reference points taken across the model domain, as detailed in volume 3 appendix 7.1.

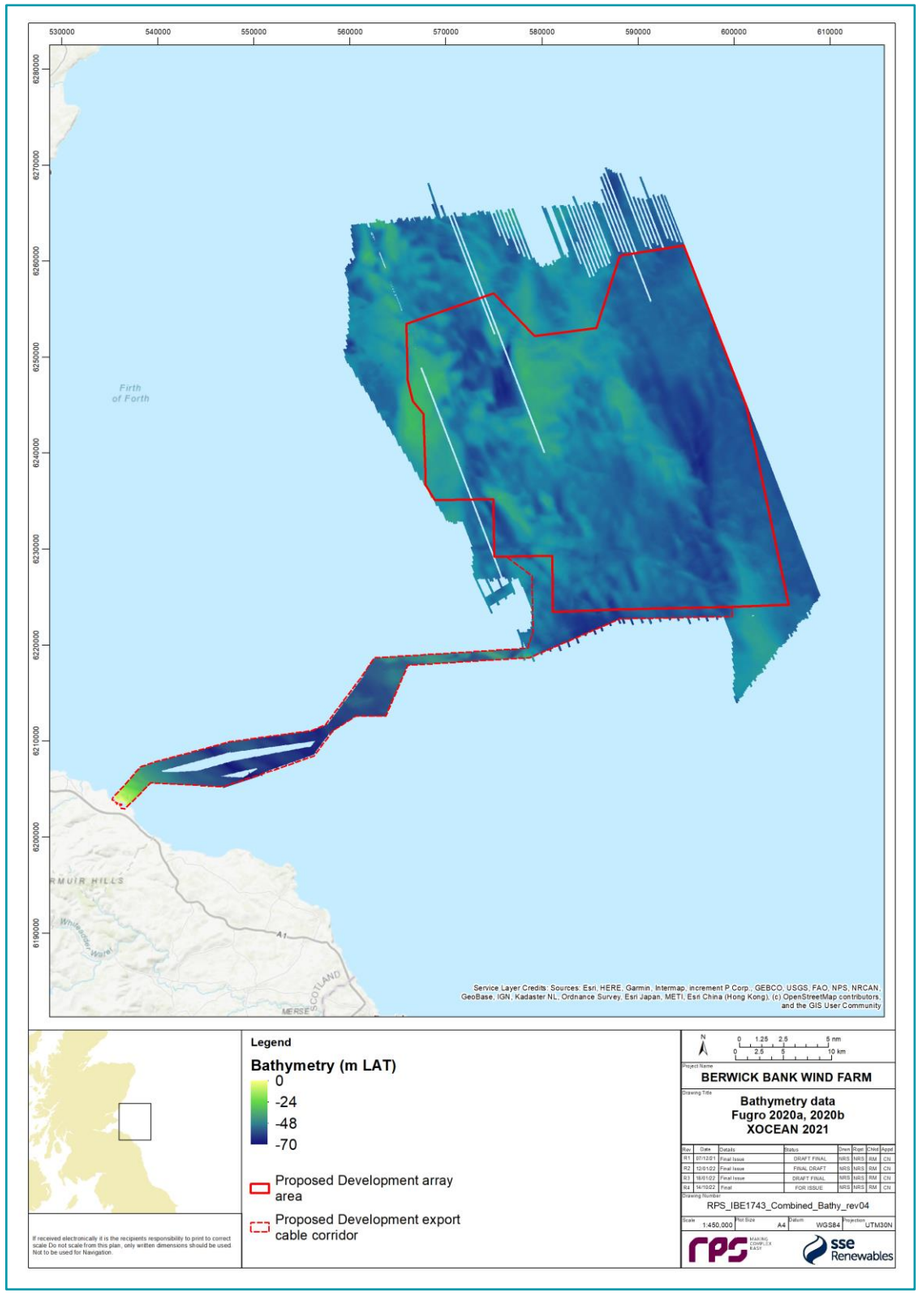


Figure 7.2: Bathymetric Survey Fugro 2020 and XOCEAN 2021

27. Across the offshore wind farm area, the tidal current floods to the south and ebbs to the north. The flows are relatively weak with tidal current speeds typically between 0.5 m/s and 0.6 m/s during peak flood: with ebb currents being of a similar magnitude.

Wave climate

28. Characteristic of the northern North Sea, waves are generated by either local winds or from remote winds (swell waves). At the centre of the Proposed Development array area, the largest proportion of waves approach from the northerly sectors, typically combined wind and swell for the North Sea. However, a wave field can also develop from the east of the Proposed Development array area as there is a sufficient fetch length.

29. The largest waves approaching the Proposed Development array area are from the north; through the north-east and easterly sectors the associated waves become less common with lower wave heights for the same return periods. Further detail on the wave climate analysis is provided in volume 3 appendix 7.1.

Littoral currents

30. Littoral currents are driven by tides, waves, and meteorological events. The littoral currents were modelled from the northerly sector during a one in one year storm event, resulting in the increase of currents on the peak flood tide to 0.5 m/s to 0.7 m/s and reducing to 0.4 m/s to 0.6 m/s during the peak ebb within the Proposed Development array area. With the largest and most prevalent waves approaching from the north, these waves cause an increase in currents during the flood tide and decrease on the ebb tide.

Sedimentology

31. The seafloor morphology of the Proposed Development array area includes large scale banks (known as the Marr Banks and the Berwick Bank), arcuate ridges, incised valleys, relic glacial lakes, channels and bedforms. Seabed substrate within the Proposed Development array area ranged from coarse gravel, shelly gravel with boulder, mix sediments with patchy coarse material or boulders and muddy sand. Including several distinct features such as isolated/clustered boulders, areas of sand waves, ripples/mega ripples and trawl marks, however the majority of the area is featureless.

32. The underlying sediments identified in the Proposed Development export cable corridor were coarse sediments with cobbles, boulders, rock outcroppings, sand, fine sand and muddy sand as illustrated in Figure 7.3. The Proposed Development export cable corridor recorded very few morphological features such as high rises or ridges and is described as smooth.

33. The landfall location for the Proposed Development export cable corridor is on the East Lothian coast, at Skateraw. The Skateraw landfall area is a 1.7 km stretch bordering the intertidal area comprised of a foreshore which is mostly made up of rock with areas of sand deposits, where the top of the beach is lined with a mixture of sand, pebbles, and small boulders. The seabed morphology comprises a rocky undulating Carboniferous platform with patches of megarippled sands where sediment has accumulated within larger channels. Extending offshore, the undulating rocky seabed becomes flatter, with areas of sediment with boulders interpreted as sediment overlaying rock.

Sediment transport

34. Within the Proposed Development array area, the residual current speeds are low resulting in low sediment transport rates. Residual currents are the net flow over a full tidal cycle and drive the sediment transport. Along the coastline the sediment transport rates are several orders of magnitude higher than in areas of offshore banks. During the tidal cycle, the bed levels are reduced along ripples but increase to previous

levels on the return tide. At peak currents, changes in bed level can be in the order of a fraction of a millimetre per day which signifies that the bed area is mobile however it is considered stable. During storms approaching from the north, the residual current and subsequent sediment transport increases during flood tides.

35. The physical processes study area largely coincides with Scottish Coastal Sub-cell l a - St Abb's Head to North Berwick (Ramsay and Brampton, 2000). There are two main sources of beach material, those resulting from erosion of sandstone cliffs and glacially derived sands and gravels. The Ramsay and Brampton (2000) study states that in general most of the beach systems are largely self-contained in terms of sediment movements and there is little interaction or movement of beach sediment along this coast; hence no significant present day longshore drift gives rise to long-term erosion or accretion. Periodic storm damage will occur on most of the 'soft' coastal edges due to the exposed nature of the coastline, but this sediment is generally retained within the immediate beach system. This is corroborated by more recent Dynamic Coast 2 results (https://www.dynamiccoast.com/) which predict isolated pockets of erosion along the coastline of the physical processes study area under the Future Erosion 2050 High Emissions Scenario associated with soft cliff embayments.

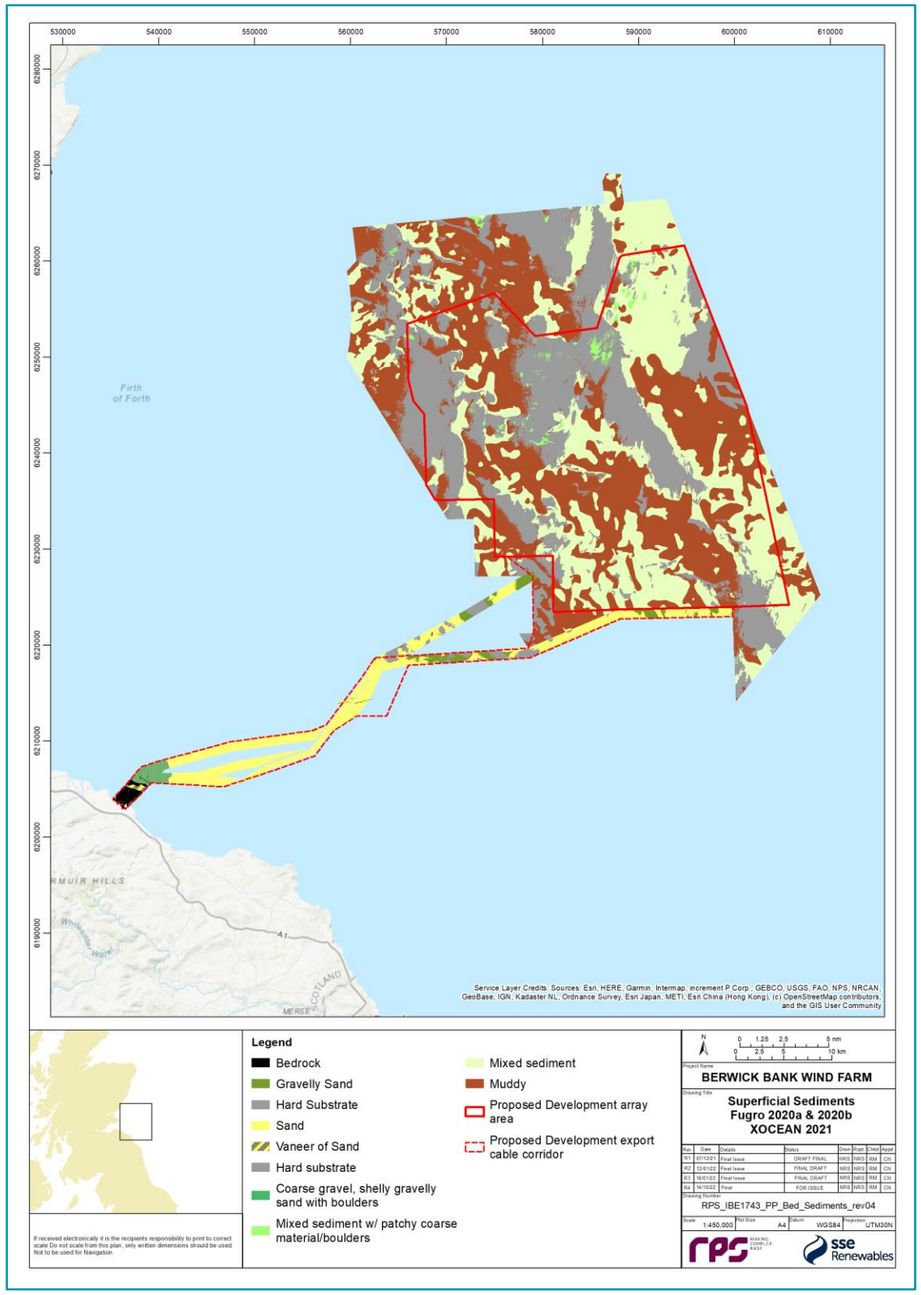


Figure 7.3: Sediment Classification Fugro 2020 and XOCEAN 2021

Suspended sediments

36. SSC are regulated by tidal currents and intensify during wind-driven storm events throughout the water column. SSC levels have a seasonal pattern due to the seasonality of storm events. Monitoring nearshore and just to the south of the Skateraw landfall site, recorded typical SSC levels of <5 mg/l, however as expected during storm events this increased to above 100 mg/l corresponding with increased wave heights.

37. Within the Proposed Development array area, the non-algal SPM was estimated to be on average 0 mg/l to 1 mg/l between 1998 and 2015 (Cefas, 2016). As for the SSC, the SPM levels display a seasonal pattern with heightened levels during winter months and are regulated by tidal currents.

Designated sites

38. Designated sites and relevant qualifying interest features identified for the Physical Processes Offshore EIA Report chapter are described in Table 7.8 and presented in Figure 7.4. This includes sites and features for which physical processes are examined within the Physical Processes Offshore EIA Report chapter.

Table 7.8: Designated Sites and Relevant Qualifying Interest Features for the Physical Processes Chapter

Designated Site	Closest Distance to Proposed Development Array Area (km)	Closest Distance to Proposed Development Export Cable Corridor (km)	Relevant Qualifying Interest Feature(s)
Firth of Forth Banks Complex ncMPA (555560478)	0	0	• Ocean quahog *Arctica islandica* aggregations; • Offshore subtidal sands and gravels; • Shelf banks and mounds; and • Moraine representative of the Wee Bankie Key Geodiversity Area.
Berwickshire and North Northumberland Coast SAC (UK0017072)	34.25	3.97	• Grey seal *Halichoerus grypus* [1364] (Annex II species that are a primary reason for selection of this site). Annex I habitats that are a primary reason for selection of this site: • Reefs [1170]; • Sea caves [8330]; • Intertidal mudflats and sandflats [1140]; and • Shallow inlets and bays [1160].
Berwickshire Coast (intertidal) SSSI (169684)	38.48	6.31	• Rocky shore and • Sea caves
St Abb's Head to Fast Castle SSSI (135177)	33.47		• Coastal Geomorphology of Scotland; • Guillemot *Uria aalge* (breeding); • Kittiwake *Rissa tridactyla* (breeding); • Maritime cliff; • Old Red Sandstone Igneous; and • Seabird colony (breeding).
Pease Bay Coast SSSI (135371)	45.43	3.85	• Lower Carboniferous [Dinantian - Namurian (part)]; • Maritime cliff; and • Silurian - Devonian Chordata.
Barns Ness Coast SSSI (135160)	46.06	0	• Lower Carboniferous [Dinantian - Namurian (part)]; • Saltmarsh; • Sand dunes; and • Shingle.
Firth of Forth SSSI (169840) included within the Firth of Forth SPA (UK9004411)	50.29	6.0	• Arthropoda (excluding insects and trilobites); • Beetle assemblage; • Carboniferous - Permian Igneous; • Coastal Geomorphology of Scotland; • Lower Carboniferous [Dinantian - Namurian (part)]; • Lowland neutral grassland; • Mineralogy of Scotland; • Maritime cliff; • Mudflats; • Northern brown argus butterfly *Aricia artaxerxes*; • Palaeozoic Palaeobotany; • Permian - Carboniferous Fish/Amphibia; • Quaternary of Scotland; • Saline lagoon; • Saltmarsh; • Sand dunes; • Transition grassland; • Upper Carboniferous [Namurian (part) - Westphalian]; and • Vascular plant assemblage.
Bathing Water Sampling Locations			Current Classification
Eyemouth [UKS7616022]	39.20	15.42	Sufficient
Coldingham [UKS7616055]	39.68	12.86	Excellent
Pease Bay [UKS7616041]	45.06	6.76	Excellent
Thorntonloch [UKS7616059]	46.00	1.6	Excellent

Designated Site	Closest Distance to Proposed Development Array Area (km)	Closest Distance to Proposed Development Export Cable Corridor (km)	Relevant Qualifying Interest Feature(s)
Whitesands [UKS7616062]	47.87	2.5	Excellent
Dunbar (East) [UKS7616018]	49.65	5.67	Excellent
Dunbar (Bellhaven) [UKS7616017]	49.72	9.96	Good
Seacliff [UKS7616082]	51.22	14.62	Excellent

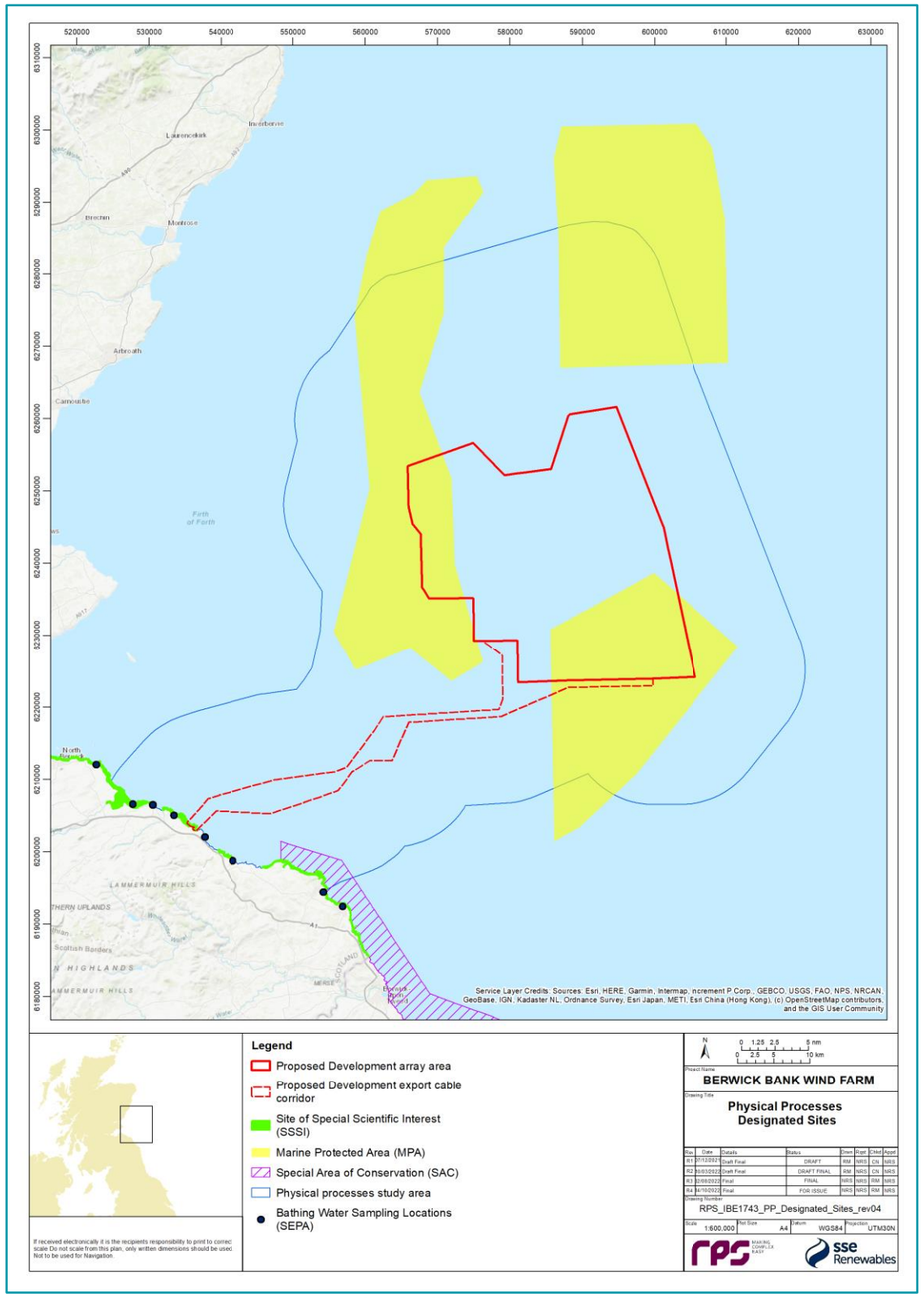


Figure 7.4: Physical Processes Designated Sites

7.7.2. FUTURE BASELINE SCENARIO

39. The EIA Regulations require that a "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort, on the basis of the availability of environmental information and scientific knowledge" is included within the Offshore EIA Report.

40. If the Proposed Development does not come forward, an assessment of the future baseline conditions has also been carried out and is described within this section.

41. The baseline environment for physical processes is not static and will exhibit a degree of natural change over time. Such changes will occur with or without the Proposed Development in place due to natural variability. Future baseline conditions would be altered by climate change resulting in sea level rise and increased storminess. This is unlikely to have the effect of significantly altering tidal patterns and sediment transport regimes offshore at the Proposed Development array area. The return period of the wave climates would be altered (e.g. what is defined as a 1 in 50 year event may become a 1 in 20 year event) as deeper water would allow larger waves to develop. There is, however, a notable degree of uncertainty regarding how future climate change will impact prevailing wave climates within the North Sea and beyond.

7.7.3. DATA LIMITATIONS

42. The physical processes study area has been the focus of study for both academic and government institutions. Additionally, considerable data collection campaigns have been undertaken by the Applicant of both the Proposed Development and other offshore wind farms in the locality. Although some physical processes are complex and inter-related, there is a considerable amount of data available. It is therefore considered that the data employed are robust and sufficient for the purposes of the assessment of effects presented.

7.8. KEY PARAMETERS FOR ASSESSMENT

7.8.1. MAXIMUM DESIGN SCENARIO

43. The maximum design scenarios identified in Table 7.9 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. These scenarios have been selected from the details provided in volume 1, chapter 3 of the Offshore EIA Report. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (PDE) (e.g. different infrastructure layout), to that assessed here, be taken forward in the final design scheme.

44. The results of the physical processes study, particularly the numerical modelling output detailed in volume 3 appendix 7.1, will be used to support and inform the following Offshore EIA Report chapters:

- volume 2, chapter 8: Benthic Subtidal and Intertidal Ecology;
- volume 2, chapter 9: Fish and Shellfish Ecology;
- volume 2, chapter 10: Marine Mammals;
- volume 2, chapter 17: Infrastructure and Other Users;
- volume 2, chapter 19: Water Quality;
- volume 3, appendix 19.1: Water Framework Directive Report; and
- the MPA Assessment (SSER, 2022b).

Table 7.9: Maximum Design Scenario Considered for Each Impact as Part of the Assessment of Likely Significant Effects on Physical Processes

Potential Impact	Phase[2]			Maximum Design Scenario	Justification
	C	O	D		
Increased SSC and associated deposition on physical features as a result of the following activities: • seabed preparation; • foundation installation; • cable installation; • maintenance activity; and • decommissioning.	✓	✓	✓	**Construction Phase** *Seabed preparation* Seabed preparation activities may include boulder and sand wave clearance. For the offshore cable routes, sand waves may be cleared to a width of 25 m, average height 5 m and clearance along circa 20% of the Proposed Development export cable corridor length (174.4 km) and 30% of inter-array and offshore substation platform (OSP)/Offshore convertor station platform interconnector cables (395.7 km). Modelling and assessment assumed a dredge and disposal technique is used to redistribute material the within the Proposed Development application boundary. *Foundation installation* Where drilling is required as part of the installation of piled jacket foundations, SSC will be elevated. Modelling was undertaken to quantify increases in SSC for drilling events at locations across the Proposed Development array area to encompass a range of dispersion characteristics with 2 concurrent drilling events comprising the greatest volume of material released into the water column. Drilling of foundations associated with the 179 wind turbine array with 2 x 5.5 m piles per leg and 4 legs per foundation. Drilling undertaken for 20% of total 80 m depth (estimated at 16 m) with a rate of 0.5 m/h. Drilling may be required for 10% of wind turbine foundations. Drilling associated with up to 5 OSPs, 4 piles of 3.5 m diameter are associated with each of the 8 legs, with 4 per foundation requiring drilling to 20% depth (i.e. 12 m). Drilling associated with 2 Offshore convertor station platforms 4 piles of 4 m diameter are associated with each of the 8 legs, with 4 per foundation requiring drilling to 20% depth (i.e. 12 m). *Cable installation* Inter-array cables 1,225 km, offshore cable route 872 km and OSP/Offshore convertor station platform interconnector 94 km. Installation using jet trenching which mobilises material from a 3 m deep 2 m wide trench. Modelling assumes that the cable routes extend over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column). Modelling assumes that the full 3 m^3 of material is released into the water column for each metre of trenching undertaken. Offshore export cables installation at the Skateraw landfall will be undertaken using trenchless technologies (e.g. HDD). **Operation and Maintenance Phase** *Cable repair and reburial* Project lifetime 35 years Ten inter-array cable repair events of up to 3,000 m each and 10 inter-array cable reburial events of up to 1,000 m each over the lifetime of the Project. Four export and interconnector cable repair events and 4 export and interconnector cable reburial events of up to 1,000 m each, over the lifetime of the Project.	*Seabed preparation* Site clearance activities may be undertaken using a range of techniques, the suction hopper dredging and disposal has the potential to cause the greatest increase in suspended sediment and largest plume extent as material is released near the water surface. The fate and transport of this material will be largely dependent on the tidal current at the time of works and the nature of the material. Modelling was undertaken for a representative stretch of sand wave clearance over a range of tidal conditions as boulder clearance will result in minimal increases in SSCs. *Foundation installation* Drilling may be required at 10% of site locations therefore more locations are associated with the 307 wind turbine array, however each drilling event would release less material (20% depth of each 60 m pile). Similarly drilling releases greater volumes of material in each installation event than other types of foundations such as suction caissons and would result in higher SSC and larger sediment plumes. The overall total release is less than the 179 wind turbine array (20% depth of each 80 m pile). Piles relating to OSPs/Offshore convertor station platform have a greater number of legs and are smaller in diameter and require less drilling depth than 179 wind turbine array infrastructure to be assessed and therefore the modelled scenarios will provide an upper envelope of SSC for each drilling event. *Cable installation* Cable routes include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route therefore the assessment provides the upper bound in terms of suspended sediment and dispersion potential. In reality ploughing (and to a certain extent jetting) moves material rather than bringing it fully into suspension therefore the assumption that the seabed is fluidised presents the maximum design scenario. The inter-array modelling was carried out for a section of an indicative cable route which would have the widest impact, (i.e. where the tidal currents are strongest and material brought into suspension will be carried the furthest). Interconnector cable trenching characteristics are the same as those for inter-array cable trenching therefore magnitude of impacts are quantified within the indicative section of trenching modelled. Offshore export cables trenching modelling assumes sediment release along the Proposed Development export cable corridor to the nearshore point at which a continuous rock outcrop is encountered. *Cable repair and reburial* These limited activities would disturb a much smaller volume of material for each repair/reburial event than simulated for the installation stage.

[2] C = Construction, O = Operation and maintenance, D = Decommissioning

Potential Impact	Phase[2] C	Phase[2] O	Phase[2] D	Maximum Design Scenario	Justification
				Decommissioning Phase It is anticipated that all structures above the seabed level will be completely removed. The intention is to cut off piled structures at an agreed depth below the seabed. It is proposed to remove all export, inter-array and inter-connector cables and scour protection where possible and appropriate to do so.	Therefore, modelled construction scenarios may be used to infer potential impacts. *Decommissioning* The decommissioning phase would be undertaken using similar techniques and equipment as the commissioning phase. Therefore, activities such as the removal of cables would have similar impacts in terms of increased SSC as those quantified in the modelling and assessed for the construction phase.
Presence of infrastructure may lead to changes to tidal currents, wave climate, littoral currents and sediment transport resulting in changes to the following: • sediment transport pathways; • bank morphology; and • beach morphology.	✓	✓	✓	**Construction Phase** During the construction phase the changes will gradually increase as the infrastructure is installed, reaching the maximum scenario at completion. The maximum design scenario in terms of the presence of infrastructure would be on the completion of construction (i.e. that experienced during the operation and maintenance phase). **Operation and Maintenance Phase** Model bathymetry and bed sediment maps were altered to represent the presence of infrastructure, scour protection and cable protection for an indicative array. *Wind turbines* 179 wind turbine installations with 20 m caisson foundations diameter with a total footprint of 12,240 m^2 per unit with scour protection 2 m in height and 80 m diameter. Additionally, structures with 4 legs per site with 5 m diameter spaced 60 m apart at the seabed were included through the water column to model associated influence on wave climate and tidal currents from the 179 wind turbine array. *OSPs*/Offshore convertor station platform Eight OSPs/Offshore Converter Stations each with 6 jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 6,206 m^2 footprint per unit. The 6 legs of 4 m diameter spaced 40 m apart at the seabed were also included within the water column to model associated influence on wave climate and tidal currents. Additionally, 2 Offshore convertor station platforms each with 8 jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 12,559 m^2 footprint per unit. The 8 legs of 5 m diameter spaced 80 m apart at the seabed were also included within the water column for each unit. *Cable protection* Inclusion of cable protection (armouring) along 15% of the inter-array, OSP/Offshore convertor station platform interconnector and offshore cable routes, of up to 3 m in height and 20 m width. Additionally, 78 inter-array cable crossings 3.5 m in height, 21 m wide and 30 m in length and 16 offshore export cables crossings 3.5 m in height, 21 m wide and 40 m in length. **Decommissioning Phase** It is anticipated that all structures above the seabed will be removed. In areas where the removal of scour protection, cables and cable protection is not possible or appropriate these will be left *in situ*.	*Wind turbines* The 179 wind turbine array comprises the largest wind turbines at each location. Caisson foundations have the largest footprint at each wind turbine in terms of scour protection and provide the greatest influence on tides, currents, waves and ultimately sediment transport. The 179 wind turbines also have a greater footprint over the site as a whole rather than the more numerous smaller design options. *OSPs/Offshore convertor station platforms* The selected option provides both the greatest footprint per OSP/Offshore convertor station platform and the largest overall footprint giving the greatest potential influence on sediment transport pathways. *Cable protection* Modelling was undertaken with armouring along the inter-array and offshore cable routes – identified by the regions with the largest sediment transport rates, limited burial depths and cable crossings. *Decommissioning* Following decommissioning changes physical processes would be of lesser magnitude than operation and maintenance phase as no structures would remain in the water column with wind turbines cut off and therefore not an influence on wave climate and tidal currents. Additionally, only those scour and cable protection structures not possible or practical to be removed would continue to influence sediment transport pathways.

7.8.2. IMPACTS SCOPED OUT OF THE ASSESSMENT

45. The physical processes Road Map (see volume 3, appendix 8.2) has been used to facilitate stakeholder engagement on topics to be scoped out of the assessment.

46. On the basis of the baseline environment and the Project Description outlined in volume 1, chapter 3 of the Offshore EIA Report, one impact is proposed to be scoped out of the assessment for physical processes. This was either agreed with key stakeholders through consultation as discussed in volume 1, chapter 5, or otherwise, the impact was proposed to be scoped out in the Berwick Bank Wind Farm Offshore Scoping Report (SSER, 2021a) and no concerns were raised by key consultees. Where discussions with consultees took place after the publication of the Berwick Bank Wind Farm Scoping Opinion (MS-LOT, 2022), these are audited in the Audit Document for Post-Scoping Discussions (volume 3, appendix 5.1).

47. This impact is outlined, together with a justification for scoping it out, in Table 7.10.

Table 7.10: Impact Scoped Out of the Assessment for Physical Processes (Tick Confirms the Impact is Scoped Out)

Potential Impact	Phase[3]			Justification
	C	O	D	
Changes to seabed morphology due to depressions left by jack-up vessels.	✓	✓	✓	The potential for jack-up vessel spud-cans to affect the sediment regime has been scoped out of the assessment. Jack-up footprint depressions would likely only persist temporarily after jack-up operations have been completed and that these would infill over time. It is not anticipated that jack-up vessel footprints will have implications for the sediment transport regime.

7.9. METHODOLOGY FOR ASSESSMENT OF EFFECTS

7.9.1. OVERVIEW

48. The physical processes assessment of effects has followed the methodology set out in volume 1, chapter 6 of the Offshore EIA Report. Specific to the physical processes EIA, the following guidance documents have also been considered:

- Guidelines in the use of metocean data through the lifecycle of a marine renewables development, Construction Industry Research and Information Association (CIRIA) C666, ABPmer Ltd *et al.,* (2008);
- Guidance on Environmental Impact Statement (EIS) and Natura Impact Statement (NIS) Preparation for Offshore Renewable Energy Projects, Department of Communications, Climate Action and Environment, (2017);
- Guidance on Marine Baseline Ecological Assessments and Monitoring Activities for Offshore Renewable Energy Projects Parts 1 and 2 (April 2018);
- Collaborative Offshore Wind Energy Research into the Environment (COWRIE) - Coastal Process Modelling for Offshore Wind Farm Environmental Impact Assessment, Lambkin *et al*. (2009);
- Advice to Inform Development of Guidance on Marine, Coastal and Estuarine Physical Processes Numerical Modelling Assessments. Natural Resources Wales (NRW) Report No 208, 139pp, NRW, Pye, K., Blott, S.J. and Brown, J. (2017); and
- Guidance on Best Practice for Marine and Coastal Physical Processes Baseline Survey and Monitoring Requirements to inform EIA of Major Development Projects, NRW Report No: 243, 119 pp, NRW, Cardiff, Brooks, AJ., Whitehead, PA., Lambkin, DO. (2018).

7.9.2. CRITERIA FOR ASSESSMENT OF EFFECTS

49. Physical processes are not generally receptors in themselves; they may be a pathway by which coastal features may be impacted or form a pathway for indirect impacts on other receptors. For example, increases in suspended sediments during the construction phase may lead to the deposit of these sediments and smothering of benthic habitats. For this impact, the magnitude of the potential changes has been assessed, with the sensitivity of the receptors to these changes and the significance of effects assessed within volume 2, chapter 8, chapter 9, chapter 10 and chapter 17.

50. A full assessment of effects has however been provided for the hydrodynamic regime and the sediment transport regime, which have been identified as potentially sensitive physical processes receptors. Sediment transport is driven by a combination of tidal flow and wave climate, therefore, as each of these processes are intrinsically linked, the assessment was undertaken collectively.

51. The process for determining the significance of effects is a two stage process that involves defining the magnitude of the potential impacts and the sensitivity of the receptors. This section describes the criteria applied in this chapter to assign values to the magnitude of potential impacts and the sensitivity of the receptors. The terms used to define magnitude and sensitivity are based on those which are described in further detail in volume 1, chapter 6 of the Offshore EIA Report.

52. The criteria for defining magnitude in this chapter are outlined in

[3] C = Construction, O = Operation and maintenance, D = Decommissioning

Table 7.11. In determining magnitude within this chapter, each assessment considered the spatial extent, duration, frequency and reversibility of impact and these are outlined within the magnitude section of each assessment of effects (e.g. a duration of hours or days would be considered for most receptors to be of short term duration, which is likely to result in a low magnitude of impact).

Table 7.11: Definition of Terms Relating to the Magnitude of an Impact

Magnitude of Impact	Definition
High	Change in physical processes which results in the loss of a coastal feature, (e.g. blockage of sediment pathway resulting in loss of spit (Adverse)).
	Change in physical processes which results in the creation of a coastal feature, (e.g. reduction in wave climate giving rise to dune formation (Beneficial)).
Medium	Alteration of physical processes which effects the rate at which a coastal feature is maintained (e.g. reduction in accretion rate (Adverse)).
	Alteration of physical processes which effects the rate at which a coastal feature is developing (e.g. reduction in erosion rate (Beneficial)).
Low	Variation in physical processes which maintains the coastal feature (e.g. localised change in sediment pathway which does not destabilise bank).
Negligible	Imperceptible variation in physical process (e.g. in the order of natural variability).

53. The criteria for defining sensitivity in this chapter are outlined in Table 7.12.

Table 7.12: Definition of Terms Relating to the Sensitivity of the Receptor

Value (Sensitivity of the Receptor)	Description
Very High	Coastal feature forms vital part of a wider scale system which is scarce and non-recoverable.
High	Coastal feature forms part of a wider scale system and is non-recoverable.
Medium	Coastal feature has limited potential for recovery.
Low	Coastal features of local scale and recoverable.
Negligible	Coastal feature adaptable to changes in physical processes.

54. The significance of the effect upon physical processes is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in Table 7.13.

55. In cases where a range is suggested for the significance of effect, there remains the possibility that this may span the significance threshold (i.e. the range is given as minor to moderate). In such cases the final significance conclusion is based upon the author's professional judgement as to which outcome delineates the most likely effect. Where professional judgement is applied to quantify final significance from a range, the assessment will set out the factors that result in the final assessment of significance. These factors may include the likelihood that an effect will occur, data certainty and relevant information about the wider environmental context

56. For the purposes of this assessment:

- a level of residual effect of moderate or more will be considered a ‘significant’ effect in terms of the EIA Regulations; and
- a level of residual effect of minor or less will be considered ‘not significant’ in terms of the EIA Regulations.

57. Effects of moderate significance or above are therefore considered important in the decision-making process, whilst effects of minor significance or less warrant little, if any, weight in the decision-making process.

Table 7.13: Matrix Used for the Assessment of the Significance of the Effect

Sensitivity of Receptor	Magnitude of Impact			
	Negligible	**Low**	**Medium**	**High**
Negligible	Negligible	Negligible to Minor	Negligible to Minor	Minor
Low	Negligible to Minor	Negligible to Minor	Minor	Minor to Moderate
Medium	Negligible to Minor	Minor	Moderate	Moderate to Major
High	Minor	Minor to Moderate	Moderate to Major	Major
Very High	Minor	Moderate to Major	Major	Major

7.10. MEASURES ADOPTED AS PART OF THE PROPOSED DEVELOPMENT

58. As part of the Project design process, a number of measures have been proposed to reduce the potential for impacts on physical processes (see Table 7.14). As there is a commitment to implementing these measures, they are considered inherently part of the design of the Proposed Development and have therefore been considered in the assessment presented in section 7.11 (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development.

Table 7.14: Designed In Measures Adopted as Part of the Proposed Development

Designed In Measures Adopted as Part of the Proposed Development	Justification
Scour protection	There is the potential for scouring of seabed sediments to occur due to interactions between metocean regime (wave, sand and currents) and foundations or other seabed structures. This scouring can develop into depressions around the structure the use of scour protection around offshore structures and foundations will be employed, as described in detail in volume 1, chapter 3. The scour protection has been included in the modelled scenarios used within the assessment of effects.
Cable burial depth	There is a potential for cable exposure to occur due to interactions between metocean regime (wave, sand and currents). The sediment transport can lead to exposure of cables and infrastructure, the use of a cable burial depth alongside the cable installation strategy should provide sufficient depth to avoid exposure.

7.11. ASSESSMENT OF SIGNIFICANCE

59. The potential effects arising from the construction, operation and maintenance and decommissioning phases of the Proposed Development are listed in Table 7.9, along with the maximum design scenario against which each impact has been assessed. An assessment of the likely significance of the effects of the Proposed Development on the physical processes receptors caused by each identified impact is given below.

INCREASED SUSPENDED SEDIMENT CONCENTRATIONS AND ASSOCIATED DEPOSITION ON PHYSICAL FEATURES AS A RESULT OF SEABED PREPARATION, FOUNDATION INSTALLATION AND CABLE INSTALLATION

60. Increased SSCs and associated deposition may arise due to the installation of the wind turbines and OSP/Offshore convertor station platform foundations, the installation and/or maintenance of inter-array cables and the offshore export cables. This impact is relevant to the construction, operation and maintenance phases of the Proposed Development and may cause indirect impacts to receptors.

61. The following scenarios were investigated:

- site preparation activities – sand wave clearance to facilitate cable installation;
- drilled pile installation – across the range of hydrodynamic conditions;
- inter-array/interconnector cable installation (with the same characteristics) – for a zone of sandy seabed sediment; and
- offshore export cables installation – through sandy seabed sediment.

62. Modelling was undertaken related to the maximum design scenario as outlined in Table 7.9 with the detail of the assessment provided in volume 3, appendix 7.1.

Construction Phase

Magnitude of Impact

63. The installation of infrastructure within the offshore wind farm and Proposed Development export cable corridor may lead to increased SSCs and associated deposition. The maximum design scenario is for the drilled installation of up to 179 x 24 MW with two 5.5 m piles per leg and four legs per foundation. Drilling may be required for 10% of the piles to an estimated depth of 16 m in each case. Included is the installation of seven OSPs/Offshore convertor station platform comprising of five High Voltage Alternating Current (HVAC) with six legs supported by up to four piles of 3.5 m diameter per leg and two HVDC platforms with eight legs supported on up to four 4 m diameters piles. The drilling depth for OSPs/Offshore convertor station platforms may be up to 12 m or 20% depth, not all piles will require drilling. Four drillings may be required per foundation for HVAC and HVDC OSPs/Offshore convertor station platforms. For the installation of inter-array cables (1,225 km) and offshore export cables (1,272 km) a trench of up to 2 m in width and 3 m in depth may be excavated.

64. The modelled scenarios used a drilling depth 20% greater than the maximum design scenario for piled jacket foundations of wind turbines to provide a worst case scenario and examined a range of locations across the Proposed Development array area with two concurrent drilling operations at adjacent locations. The drilled pile installations are anticipated to generate plumes with a suspended sediment level of <10 mg/l. These levels would be localised and only persist for short period, a couple of tidal cycles. Concentrations within the plume envelope are much lower, typically <1 mg/l a short distance (<1 km) from the discharge locations. Following the cessation of drilling the turbidity levels reduce within a few hours as tidal currents reduce. Some of the finer material associated with the drilling process is re-suspended during

periods of increased tidal currents on successive tides as it is redistributed but turbidity levels remain low. The sedimentation beyond the immediate drilling location is indiscernible. This is due to the relatively slow drilling rate (0.5 m/hour), allowing the fine sediment to be widely dispersed while the larger material settles at the release point due to the limited current speed.

65. For the inter-array cable installation, the sediment plumes are much larger than those for the drilled pile installation. The reason for this is twofold, firstly there is a large amount of sediment initially mobilised (582,000 m^3 of material from the trench); and secondly when there was elevated tidal currents on successive tides there was more available material to be remobilised over the extended period of installation. Peak plume concentrations are highest at around 500 mg/l with the sediment settling during slack water becoming resuspended in the form of an amalgamated plume. The greatest sedimentation of 30 mm depth occurs at the trench site, with sediment depths reducing moving away from the trench but remaining in the sediment cell and retained in the sediment transport system.

66. Following the completion of drilled foundations, the turbidity levels will return to baseline within a couple of tidal cycles. It would however be anticipated that spring tides following the works may mobilise and redistribute unconsolidated seabed material deposited at the end of the construction phase; this material will therefore be incorporated into the existing transport regime. Following installation, the native seabed material settles close to where it is mobilised and remains *in situ*. This would be expected as the baseline modelling indicated that sediment transport potential is limited across the Proposed Development array area. The sedimentation is concentrated along the installation route as material effectively returns to the site from where it was disturbed. Sedimentation depths of <0.001 mm arise beyond the immediate vicinity of the trench the day after drilling cessation and therefore would be indiscernible from the existing seabed sediment.

67. Modelling was undertaken to quantify sediment plumes associated with offshore export cables installation to the trenchless technique (e.g., HDD) transition, where circa 400,000 m^3 of material may be mobilised. It is noted that trenchless (e.g., HDD) punch out excavation will also occur with the volume of material mobilised being 250 m^3, therefore as an independent activity is not significant and in the context of the assessment is encompassed in the final 20 m of the trenching activity. Offshore export cables installation shows a higher variability in suspended sediment concentration due to the change in hydrography along the Proposed Development export cable corridor. Average levels of SSC range between 50 mg/l and 500 mg/l with the level dropping to background levels on the slack tide. At the selected Skateraw landfall site some material migrates into the sediment cell however it would be insufficient to impact the beach morphology, increasing baseline levels of sediment by <3 mm along the coast off Torness Point and typically far less along the shoreline which is redistributed on successive tides flowing cable installation.

68. The PDE includes the provision of site preparation/sand wave clearance activities which have the potential to increase SSCs in the construction phase with associated sedimentation. The clearance width would be 25 m wide corridor to facilitate cable installation with an average depth of 5 m for the offshore cable corridor and a depth of 1.3 m for the inter-array/interconnector cables, with a clearance dredging rate of 10,000 m^3/h and a 3% spill of material.

69. In practice, plough dredging which mobilises a much smaller amount of sediment into suspension at the seabed and has reduced sediment plume concentrations and extents compared to other types of dredging activities may be undertaken. However, the modelling simulated the use of a suction hopper dredger to remove material from the crest of sand waves and deposit on material in a trough, resulting in higher quantification of sedimentation compared to the plough dredging.

70. The impact of increased suspended sediment levels and associated sedimentation is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility. It would not be of sufficient magnitude to alter the hydrodynamic regime or offshore bank or beach morphology. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA directly whilst affecting the remaining receptors indirectly. The magnitude is therefore, considered to be low for the receptors within the ncMPA and negligible for other receptor groups.

Sensitivity of the Receptor

71. The Proposed Development partially overlaps with the Firth of Forth Banks Complex ncMPA (Figure 7.4). The Firth of Forth Banks Complex ncMPA is a composite site with Berwick and Marr Banks lying within the Proposed Development array area, whilst Scalp and Montrose Banks, and the Wee Bankie lie within the wider physical processes study area. These banks are comprised of the following designated features; offshore subtidal sands and gravels, shelf banks and moulds and habitat to aggregations of ocean quahog *Arctica islandica* and moraine formations. Both offshore subtidal sands, gravels and ocean quahog are Priority Marine Features (PMFs) in Scotland's seas and considered of conservation importance. The sedimentation identified is localised and composed of native material therefore the structure and function of the designated features is of low vulnerability and recoverable. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be low.

72. Much of the Berwickshire and North Northumberland Coast SAC lies seaward of MHWS with designated features such as reefs, submerged/partially submerged sea caves, intertidal mudflats/sandflats and shallow inlets and bays. The Berwickshire Coast SSSI is comprised of rocky shore and sea cave features. These areas are extensive and would recover from the low magnitude of impact from sedimentation as no material reaches the intertidal zone from nearshore cabling. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be negligible.

73. St Abb's Head to Fast Castle SSSI is characterised for its geomorphological coastal interests in particular the spectacular assemblage of rock coast landforms including clefts, gullies, geos, caves, stacks, reefs and skerries. These rock landforms would recover from the low magnitude of impact from sedimentation as no material reaches the intertidal zone from nearshore cabling. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be negligible.

74. Pease Bay SSSI is designated on sea cliffs which provide exposures of a continuous succession of Upper Devonian and Lower Carboniferous strata which is of national and international importance. These rocky outcrop areas would recover from the low magnitude of impact from sedimentation as typically no material reaches the intertidal zone from nearshore cabling. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be negligible.

75. The Firth of Forth SSSI is comprised of features such as mudflat, sand dune, saltmarsh and sea cliffs. The area is expansive and would recover from the low magnitude of impact from sedimentation as typically no material reaches the intertidal zone from nearshore cabling. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be negligible.

76. Barns Ness Coast SSSI contains a variety of coastal features such as saltmarsh, sand dunes and shingle. Geologically comprised of lower carboniferous limestone of interest because it is rich in fossils and due to the succession between Scottish and Northumberland carboniferous limestone. The Skateraw landfall site for the offshore export cables borders this SSSI, however, as the trenchless technique has been selected and typically <3 mm of sedimentation reaches the coastline from nearshore cabling to the south of the SSSI off Torness Point. The sensitivity of the receptor to changes as a result of seabed preparation, foundation installation and cable installation is therefore considered to be negligible.

77. Bathing water quality is measured in terms of biological levels and due to the low potential influx of native sediment into the bathing waters of the intertidal zone the level of vulnerability would be low and recoverable. It is expected that the sensitivity of the receptor to changes because of seabed preparation, foundation installation and cable installation is therefore considered to be negligible.

Significance of the Effect

78. During the installation of the wind turbines in the Firth of Forth Banks Complex ncMPA, the sediment plumes are <5 mg/l and do not persist or result in discernible sedimentation. However, these sediment concentrations do not extend as far south as Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI and St Abb's Head to Fast Castle SSSI.

79. Sediment plumes associated with the inter-array and interconnector cable installation creates plumes on average <100 mg/l, highest during the release (of material) phase however these plume concentrations do not persist in the Firth of Forth Banks Complex ncMPA and do not reach Montrose Bank to the north. Sedimentation is typically <5 mm beyond the immediate vicinity of the installation and less than one tenth of this value in the wider domain and would therefore not affect composite banks beyond the development area (i.e. limited to Berwick and Marr Banks). These plumes do not extend to any of the other designated sites with sediment concentrations settling to background levels within the Proposed Development.

80. In terms of the Firth of Forth Banks Complex ncMPA, the structure of the offshore subtidal sands and gravels would remain unchanged as the deposition is of native material and the supporting hydrodynamic processes are not altered by the minimal level of bathymetric change as a result of the construction phase sediment releases. Similarly, shelfs, banks and mound features would remain stable and supporting hydrodynamics processes for ocean quahog colonisation remain unaffected.

81. Offshore export cables trenching routes do not pass through either of the designated sites Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, Barns Ness SSSI or St Abb's Head to Fast Castle SSSI. Although plumes resulting from the offshore export cables trenching may reach the outer extent of the Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI. This increase sediment entering the sediment cell causes sediment thickness of <3 mm at the coast off Torness Point adjacent to the offshore export cables trenching operations however this material is native to the sediment cell and will therefore not affect geodiversity.

82. The Skateraw landfall for the offshore export cables borders the Barns Ness Coast SSSI. Within the intertidal zone the offshore export cables will be installed using trenchless technology. Therefore, similar to the other designated sites the increased sedimentation from the offshore export cables installation causes little or no sedimentation in the intertidal zone which would be insufficient to affect beach morphology.

83. Within the Firth of Forth Banks Complex ncMPA the magnitude of the impact on receptors is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Secondary Mitigation and Residual Effect

84. In general, no physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms. The Project design has determined that the method to be employed at landfall is trenchless technologies.

Operation and Maintenance Phase

Magnitude of Impact

85. Operation and maintenance activities within the Proposed Development array area and Proposed Development export cable corridor may lead to increases in SSC and associated sediment deposition.

86. The maximum design scenario is for up to ten inter-array cable repair and reburial events, including four offshore export cables repair and reburial events over the 35 year lifetime of the project (Table 7.9). Using similar methods as those for cable installation activities (i.e. trenching/jetting, with trench width up to 2 m and trench depth up to 3 m).

87. In each case the length of the repair or reburial activity may be up to 3 km; therefore, the magnitude of the impacts would be a fraction of those quantified for the construction phase. In the case of the offshore export cables the total length of works would be c. 1 km of the length assessed for the construction phase with events being undertaken over the course of the 35 year project lifetime. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired however the entire length has been quantified under the construction phase scenario discussed above.

88. The impact is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA directly and other receptors indirectly to a much lesser degree than the construction phase. The magnitude is therefore, considered to be negligible.

Sensitivity of the Receptor

89. The sensitivity of receptors to changes in suspended sediments concentration and sedimentation remains low, the same as for all construction phases. The significance of the effects will however be reduced as the works are limited to intermittent, discrete repair activities.

Significance of the Effect

90. Within the Firth of Forth Banks Complex ncMPA the magnitude of the impact on receptors is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Secondary Mitigation and Residual Effect

91. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

Decommissioning Phase

92. As per the maximum design scenario (Table 7.9), during the decommissioning phase it is anticipated that all structures above the seabed level will be completely removed wherever possible. The intention is to cut off piled structures at an agreed depth below the seabed. It is proposed to remove all export, inter-array and inter-connector cables and scour protection where possible and appropriate to do so.

Magnitude of Impact

93. During decommissioning cables would be removed by similar processes as undertaken during installation therefore increases in SSC would be of a similar form and magnitude. Following decommissioning, changes in suspended sediments concentration and sedimentation would return to baseline levels as it is anticipated that all structures above the seabed level will be completely removed and no further activities resulting in seabed disturbance would be undertaken.

94. The impact of increased suspended sediment levels and associated sedimentation during removal of infrastructure is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility. It would not be of sufficient magnitude to alter the hydrodynamic regime or offshore bank or beach morphology. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA directly whilst affecting the remaining receptors indirectly. The magnitude is therefore, considered to be low for the receptors within the ncMPA and negligible for other receptor groups.

Sensitivity of the Receptor

95. As with the construction phase, in response to sedimentation which has been identified as localised and composed of native material therefore the structure and function of the designated features is of low vulnerability and recoverable. The sensitivity of the ncMPA (direct) to changes as a result of decommissioning activity, removal of export, inter-array and inter-connector cables and scour protection where possible is therefore considered to be low. It is expected that the sensitivity of the other receptors (indirect) to decommissioning activity, removal of export, inter-array and inter-connector cables and scour protection where possible is therefore considered to be negligible.

Significance of the Effect

96. Within the Firth of Forth Banks Complex ncMPA the magnitude of the impact on receptors is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Secondary Mitigation and Residual Effect

97. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

PRESENCE OF INFRASTRUCTURE MAY LEAD TO CHANGES TO TIDAL CURRENTS, WAVE CLIMATE, LITTORAL CURRENTS AND SEDIMENT TRANSPORT

98. The presence of infrastructure may lead to changes to tidal currents, wave climate, littoral currents, and sediment transport principally during the operation and maintenance phase of the Proposed Development and following decommissioning associated with residual infrastructure. Infrastructure will undergo detailed design in line with best practice. Should cable protection be required in the nearshore region circa 500 m offshore of LAT, with minimum water depths of 6 m, suitable protection measures would be employed, such as concrete mattresses. These would be of limited height circa 30-60 cm to have negligible impact on tidal flow and profiled to allow any existing baseline sediment transport pathways to be maintained.

99. Modelling was undertaken using the maximum design scenario as outlined in Table 7.9 including the presence of scour protection as outlined in the project description (volume 1, chapter 3 of the Offshore EIA Report). The detail of the numerical modelling underpinning the assessment is provided in volume 3, appendix 7.1. The magnitude of the impact is detailed in this section along with the assessment of the effect of changes to physical processes on relevant receptors.

Construction Phase

100. An assessment has been carried out with and without the presence of infrastructure. With changes to tidal currents, wave climate, littoral currents, and sediment transport and associated potential impacts ranging from the baseline environment (no presence of infrastructure) to the operation and maintenance phase (maximum design scenario) as assessed in the following section. Based on this, it can be inferred that during the construction phase there will be gradual changes to tidal currents, wave climate, littoral currents and sediment transport as infrastructure is introduced into the environment. The significance of effect taken at the end of construction (the same as the operation and maintenance phase described below) will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Operation and Maintenance Phase

Magnitude of Impact

101. The presence of infrastructure within the Proposed Development may lead to changes in tidal currents, wave climate, littoral currents, and sediment transport during the operation and maintenance phase of the Proposed Development. The maximum design scenario in terms of hydrographic impacts is for up to 179 wind turbines with four legs at 5 m diameter spaced 60 m apart at seabed with scour protection at each 20 m caisson leg foundation of 2 m in height and 80 m diameter covering a total footprint of 12,240 m^2 per unit.

102. Additionally, the maximum design scenario includes eight HVAC offshore station platforms/Offshore Converter Platformseach with six jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 6,206 m^2 footprint per unit. The six legs of 4 m diameter spaced 40 m apart at the seabed were also included within the water column to model associated influence on wave climate and tidal currents. Similarly, two HVDC offshore converter station platforms each with eight jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 12,559 m2 footprint per unit. The eight legs of 5 m diameter spaced 80 m apart at the seabed were also included. The modelling

was undertaken with 15% of the cable length having 3m height protection, this protection was placed along sections of the cable where the bed is rock outcrops and trenching would not be possible.

103. The results of the modelling indicated that peak tidal flows are redirected in the immediate proximity of structures by a maximum variation of 1 cm/s at 200 m which constitutes as less than 2% of the peak flow and reduces significantly with distance from the structures. These changes are also limited to the immediate Proposed Development array area which may have a direct impact on the hydrodynamic regime and persist for the entire lifecycle of the Proposed Development. However, they would be imperceptible beyond the immediate vicinity of the offshore wind farm area and would be reversible on decommissioning. The limited nature of these changes would not influence the hydrodynamic regime which underpins offshore bank morphology and is the supporting process for aspects of the Firth of Forth Banks Complex ncMPA, in particular Berwick and Marr Banks, including shelfs, banks and mounds and the environment for ocean quahog aggregations.

104. Examination of a one in one year storm from the northernly sector (of greatest influence of approaching storms) shows the deflection of waves by the structures result in a reduction in the lee and increases where the waves had been deflected either side of each structure. Changes in the wave height were in the order of 2 cm equating to <1% of the baseline significant wave height. For a 1 in 20 year storm event, the pattern is similar however the change in wave height at the structures is 2 cm to 4 cm and due to the larger baseline associated with the return period the overall impact on the wave climate is less obvious.

105. Sediment transport is driven by a combination of tidal currents and wave conditions, the magnitude of these has been individually quantified as described above. For a one in one year storm from 000° during the flood tide the wave climate is in concert with tidal flow reducing the tidal flow on the lee side of the structure further. However, during the ebb flow, the wave climate and tidal flow are in opposition reducing the magnitude of the littoral current. With the presence of infrastructure, wave climate causes a small reduction in the magnitude of flow whilst there is little difference between the magnitude of littoral current flow and the tidal flows. Changes in magnitude compared to baseline current flow are ±5% which would not be sufficient to disrupt beach and offshore bank morphological processes or destabilise coastal features.

106. Residual currents are effectively the driver of sediment transport and therefore any changes to residual currents would have a direct impact on sediment transport which would persist for the lifecycle of the Proposed Development. However, if the presence of the foundation structures does not have a significant influence on either tide or wave conditions (see assessment of effects presented above for changes in tidal currents and changes to wave climate and littoral current) they cannot therefore have a significant effect on the sediment transport regime. For completeness, the residual current and sediment transport was simulated with the foundations in place. The maximum change in residual current and sediment transport is circa ±15% within close proximity to the structure (i.e. as a result of the scour protection). Changes in the residual current and sediment transport reduce with increasing distance from the wind turbines towards baseline levels.

107. The hydrodynamic regime is highly variable through tidal cycles and due to meteorological conditions, with the scale of the impact being well within the natural variation. The changes to tidal currents, wave climate, littoral currents, and sediment transport are insignificant in terms of the hydrodynamic regime and would not alter beach and offshore bank morphological processes. Effects on tidal current and wave climate would be reversible on decommissioning (i.e. following removal of the wind turbines).

108. The impact is predicted to be of local spatial extent, long term duration, continuous and of high reversibility. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA both directly and indirectly whilst other receptors are affected indirectly. The magnitude is therefore, considered to be low within the ncMPA and negligible at coastal and intertidal receptors.

Sensitivity of the Receptor

109. The Firth of Forth Banks Complex ncMPA is a composite site which include the following designated features; offshore subtidal sands and gravels, shelf banks and moulds and provide habitat to aggregations of ocean quahog. The hydrodynamic regime forms the supporting process for these marine features. Due to the localised and limited changes in tides, waves, littoral currents, and sediment transport, the Firth of Forth Banks Complex ncMPA is deemed to be of low vulnerability and recoverable as the area is extensive. The sensitivity of this is therefore considered to be low.

110. The Berwickshire and North Northumberland Coast SAC mostly lies below the HWM with designated features such as reefs, submerged/partially submerged sea caves, intertidal mudflats/sandflats and shallow inlets and bays. Similarly, Berwickshire Coast SSSI is intertidal with features including sea caves and the rocky shore. These areas are vast and would recover from the low magnitude of impact from hydrodynamic changes which do not reach the intertidal zone. This receptor is therefore deemed to be of low vulnerability to changes in tides, waves, littoral currents, and sediment transport and is therefore considered to be negligible.

111. St Abb's Head to Fast Castle SSSI is characterised for its geomorphological coastal interests in particular the spectacular assemblage of rock coast landforms including clefts, gullies, geos, caves, stacks, reefs and skerries. No erosion of rock formations is expected due to the negligible changes in hydrodynamics away from the Proposed Development. The sensitivity of the receptor to changes in tides, waves, littoral currents, and sediment transport is therefore considered to be negligible.

112. Pease Bay SSSI is designated on sea cliffs which provide exposures of a continuous succession of Upper Devonian and Lower Carboniferous strata which is of national and international importance. No undercutting of cliffs or erosion is expected due to the negligible changes in hydrodynamics away from the Proposed Development. The sensitivity of the receptor to changes in tides, waves, littoral currents, and sediment transport is therefore considered to be negligible.

113. The Firth of Forth SSSI is comprised of features such as mudflat, sand dune, saltmarsh, and sea cliffs. Changes in the hydrodynamics are indiscernible at this distance from the Proposed Development. This receptor is therefore deemed to be of low vulnerability to changes in tides, waves, littoral currents, and sediment transport and is therefore considered to be negligible.

114. Barns Ness Coast SSSI contains a variety of coastal features such as saltmarsh, sand dunes and shingle. Due to the negligible changes in hydrodynamics away from the Proposed Development in the intertidal zone, the sensitivity of the receptor to changes in tides, waves, littoral currents, and sediment transport is therefore considered to be negligible.

115. Bathing water quality is measured in terms of biological levels and due to the distance from the Proposed Development site, it is expected that the sensitivity of the receptor to changes in tides, waves, littoral currents, and sediment transport is therefore considered to be negligible.

Significance of the Effect

116. Changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure do not extend to Firth of Forth SSSI, Barns Ness Coast SSSI, Pease Bay SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire SSSI or St Abb's Head to Fast Castle SSSI but do extend to the Firth of Forth Banks Complex ncMPA.

117. Post construction tidal velocity is limited to the vicinity of the wind turbines and changes in magnitude are maximum of 1 cm/s and in the lee of the structure the peak flow is reduced by 2% which decreases further moving away from the structure.

118. Similarly, the wave climate reduces in the lee of the structure by less than 1% of baseline significant wave heights increasing either side of the wind turbine. Changes are concentrated on the specific location of the wind turbine and do not extent beyond the Proposed Development area. Diminutive changes are observed with the littoral current flow due to the installation of the wind farm. Offshore bank and beach morphology would not be influenced by changes of this magnitude.

119. In terms of the Firth of Forth Banks Complex ncMPA, the limited and localised changes to hydrography seen in relation to the Berwick and Marr Banks, would not result in changes to the hydrodynamic regime or sediment composition. The structure of the offshore subtidal sands and gravels would remain unchanged. Similarly, shelfs, banks and mound features would remain stable and supporting hydrodynamics processes for ocean quahog colonisation remain unaffected.

120. Overall, the magnitude of the impact on the Firth of Forth Banks Complex ncMPA is deemed to be low and overall the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Secondary Mitigation and Residual Effect

121. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms

Decommissioning Phase

Magnitude of Impact

122. Following decommissioning, changes to physical processes would be of far less magnitude than the operation and maintenance phase, as no structures would remain in the water column to influence wave climate and tidal currents. Additionally, only those scour and cable protection structures not possible or practical to be removed would continue to influence sediment transport pathways. The magnitude is therefore, considered to be negligible.

Sensitivity of the Receptor

123. As with the operation and maintenance phase, in response to localised changes in tides, waves, littoral currents, and sediment transport, the Firth of Forth Banks Complex ncMPA is deemed to be of low vulnerability and recoverable as the area is extensive. The sensitivity of this is therefore considered to be low. Overall, the magnitude of the impact is deemed to be negligible and the sensitivity of the Firth of Forth Banks Complex ncMPA is considered to be low.

Significance of the Effect

124. Within the Firth of Forth Banks Complex ncMPA the magnitude of the impact on receptors is deemed to be low, and the sensitivity of the receptor is considered to be low. The effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Secondary Mitigation and Residual Effect

125. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms

Proposed monitoring

126. The project description (volume 1, chapter 3) includes routine inspection and geophysical surveys of wind turbine and OSP/Offshore convertor station platform foundations. Also export, offshore and inter-array cable burial and protection will be inspected and surveyed as part of the maintenance programme. Proposed monitoring relevant to physical processes also involves the recovery of sand waves to contribute to the body of knowledge on the influence of offshore energy development (see Table 7.15).

Table 7.15: Proposed Monitoring and the Method of Implementation

Potential Environmental Effect	Monitoring Commitment	Means of Implementation
Recovery of sand waves	Monitoring of the recovery of sand waves, at a representative number of locations where sand wave clearance activity has taken place, within the Firth of Forth Banks Complex MPA. Monitoring will be undertaken as part of wider Project pre- and post-construction geophysical surveys and are likely to involve a combination of multibeam echosounder and high resolution side scan sonar. The approach to monitoring sand wave recovery within the MPA will be discussed post consent and agreed with MS-LOT in consultation with the SNCBs.	Monitoring Commitments are recorded in the Enhancement, Mitigation and Monitoring Commitments (volume 3, appendix 6.3). Detailed monitoring commitments will be agreed post-consent and included in the Project Environmental Monitoring Plan (PEMP).

7.12. CUMULATIVE EFFECTS ASSESSMENT

7.12.1. METHODOLOGY

127. The CEA assesses the impact associated with the Proposed Development together with other relevant plans, projects and activities. Cumulative effects are therefore the combined effect of the Proposed Development in combination with the effects from a number of different projects, on the same receptor or resource. Refer to volume 1, chapter 6 for detail on CEA methodology.

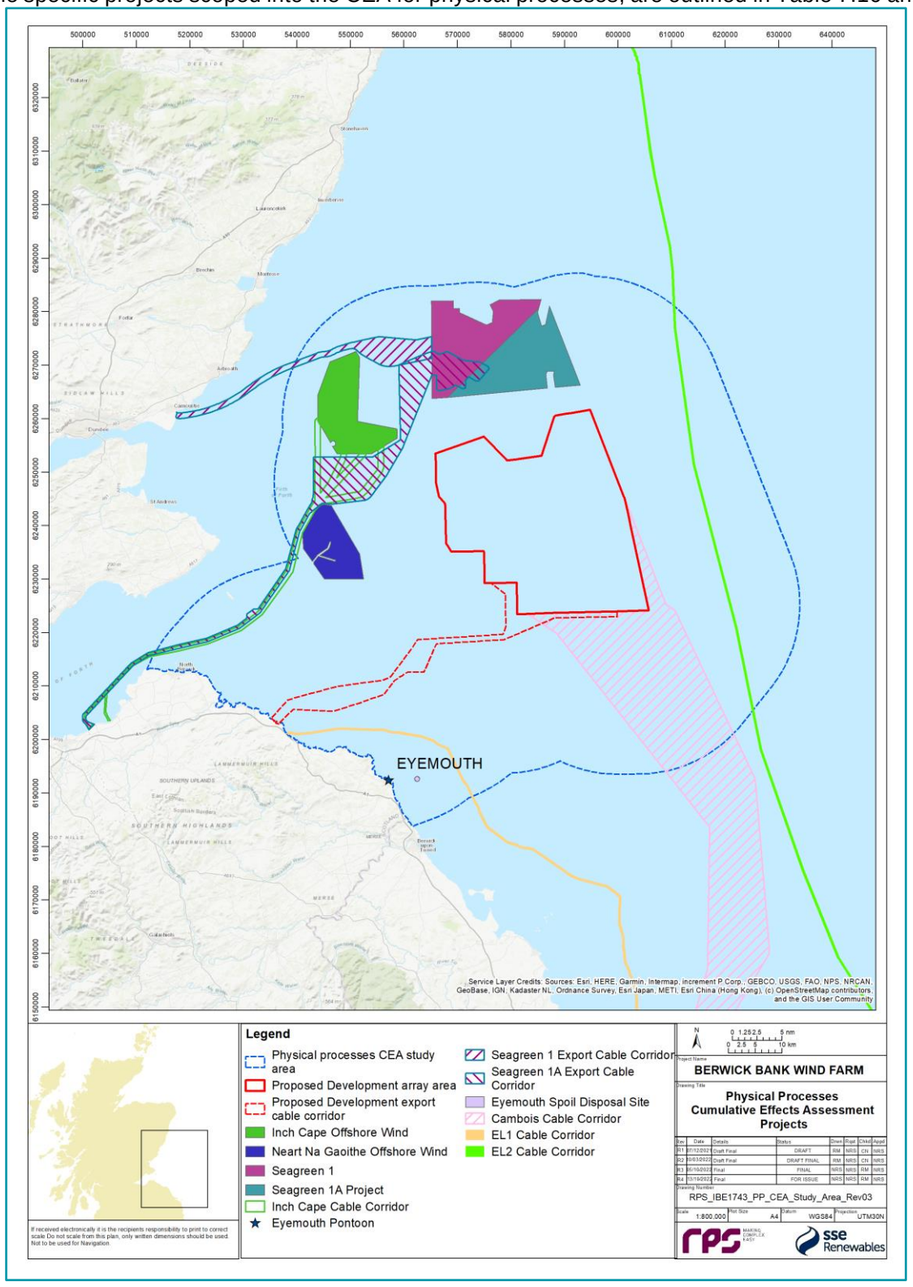
128. The projects and plans selected as relevant to the CEA presented within this chapter are based upon the results of a screening exercise (see volume 3, appendix 6.3 of the Offshore EIA Report). Volume 3, appendix 6.4 further provides information regarding how information pertaining to other plans and projects

is gained and applied to the assessment. Each project or plan has been considered on a case by case basis for screening in or out of this chapter's assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved.

129. In undertaking the CEA for the Proposed Development, it is important to bear in mind that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside the Proposed Development. Therefore, a tiered approach has been adopted. This provides a framework for placing relative weight upon the potential for each project/plan to be included in the CEA to ultimately be realised, based upon the project/plan's current stage of maturity and certainty in the projects' parameters. The tiered approach which will be utilised within the Proposed Development CEA employs the following tiers:

- tier 1 assessment – Proposed Development (Berwick Bank Wind Farm offshore) with Berwick Bank Wind Farm onshore;
- tier 2 assessment – All plans/projects assessed under Tier 1, plus projects which became operational since baseline characterisation, those under construction and those with consent and submitted but not yet determined;
- tier 3 assessment – All plans/projects assessed under Tier 2, plus those projects with a Scoping Report; and
- tier 4 assessment – All plans/projects assessed under Tier 3, which are reasonably foreseeable, plus those projects likely to come forward where an Agreement for Lease (AfL) has been granted.

130. The specific projects scoped into the CEA for physical processes, are outlined in Table 7.16 and presented in



131. Figure 7.5. The projects scoped in, fall within the physical processes CEA study area (Figure 7.5) which is defined by two tidal excursions (a 20 km buffer around the Project Development array area and export cable corridor) in order to assess the interaction of sediment plumes from the Proposed Development and surrounding projects.

132. The range of potential cumulative impacts that are identified and included in Table 7.17, is a subset of those considered for the Proposed Development alone. This is because some of the potential impacts identified and assessed for the Proposed Development alone, are localised and temporary in nature. It is considered therefore, that these potential impacts have limited or no potential to interact with similar changes associated with other plans or projects. These have therefore been scoped out of the cumulative effects assessment.

133. Similarly, some of the potential impacts considered within the Proposed Development alone assessment are specific to a particular phase of development (e.g. construction, operation and maintenance or decommissioning). Where the potential for cumulative effects with other plans or projects only have potential to occur where there is spatial or temporal overlap with the Proposed Development during certain phases of development, impacts associated with a certain phase may be omitted from further consideration where no plans or projects have been identified that have the potential for cumulative effects during this period.

134. The physical processes CEA study area for the Proposed Development extends to MHWS whilst the Onshore EIA extend to MLWS however, due to the proposed use of trenchless technology at landfall, there are no cumulative impacts anticipated relating to the intertidal zone. In each of the projects relating to offshore cables, changes to metocean, bathymetry and sediment transport were scoped out of their respective EIA. Therefore, these aspects are not included in the cumulative assessment of changes to tidal currents, wave climate, littoral currents and sediment transport due to the presence of infrastructure. However, construction phase increases in SSCs due to cable installation are included.

135. Intermittent operations, such as the use of offshore disposal sites, have been included in the cumulative assessment. These activities, although potentially in their operation and maintenance phase, are not included within the background assessment as they are not continual and therefore do not contribute to background conditions in a consistent manner.

Table 7.16: List of Other Developments Considered Within the CEA for Physical Processes

Development	Status	Distance from Proposed Development Array Area (km)	Distance from Proposed Development Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development
Tier 1							
Offshore Wind Projects and Associated Cables							
No Tier 1 aspects of relevance identified within the physical processes CEA study area.							
Tier 2							
Offshore Wind Projects and Associated Cables							
Inch Cape Offshore Wind Farm – 15680	Consented	19.0	39.0	Inch Cape Offshore Wind Farm is consented for up to 72 wind turbines at a capacity of 1,000 MW.	2023-2025	2026 onwards	Project construction phase overlaps with Proposed Development construction phase. Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Neart na Gaoithe Offshore Wind – 66600019	Under construction	16.0	15.0	Neart na Gaoithe Offshore Wind Farm is consented for up to 75 wind turbines at a capacity of 450 MW.	2020-2022	2023 onwards	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Seagreen 1	Under construction	5.0	35.0	Seagreen 1 Offshore Wind Farm consists of up to 114 wind turbines at a capacity of 1,075 MW.	2020-2023	2024 onwards	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Seagreen 1A Project	Consented	5.0	36.0	Seagreen 1A Offshore Wind Farm is consented for up to 36 wind turbines with no capacity limit.	2023-2025	2026 onwards	Project construction phase overlaps with Proposed Development construction phase. Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Seagreen 1A Export Cable Corridor	Consented	6.0	28.0	Cable	2023-2024	2025 onwards	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Oil and Gas Activities							
No Oil and Gas Projects identified within the physical processes CEA study area.							
Aggregate Extraction							
No Aggregate Extraction Projects identified within the physical processes CEA study area.							
Disposal Sites							
Eyemouth – FO0080	Operational	35.0	17.0	Dredged material disposal site	Not Applicable (N/A)	Ongoing	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Subsea Cables (Telecommunications and Interlinks)							
Eastern Link 1	Marine Licence Application	28.0	2.0	Scotland to England Green Link	2025-2027	2028 onwards	Project construction phase overlaps with Proposed Development construction phase.

Development	Status	Distance from Proposed Development Array Area (km)	Distance from Proposed Development Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development
							Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Eastern Link 2	Marine Licence Application	14.0	21.0	Scotland to England Green Link	2025-2029	2028 onwards	Project construction phase overlaps with Proposed Development construction phase. Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Coastal Protection							
No Coastal Protection Projects identified within the physical processes CEA study area.							
Tier 3							
Offshore Wind Projects and Associated Cables							
Cambois connection	Pre-planning Application	0	0	Cable	2028-2031	2031 onwards	Project construction phase overlaps with Proposed Development operation and maintenance phase. Project operational phase overlaps with Proposed Development construction and operation and maintenance phases
Shipping and Navigation							
Eyemouth - Pontoon	Application	34.1	15.0	Floating Pontoon to serve Neart na Gaoithe maintenance facility	2022	2022 onwards	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Tier 4							
No Tier 4 Projects identified within the physical processes CEA study area.							

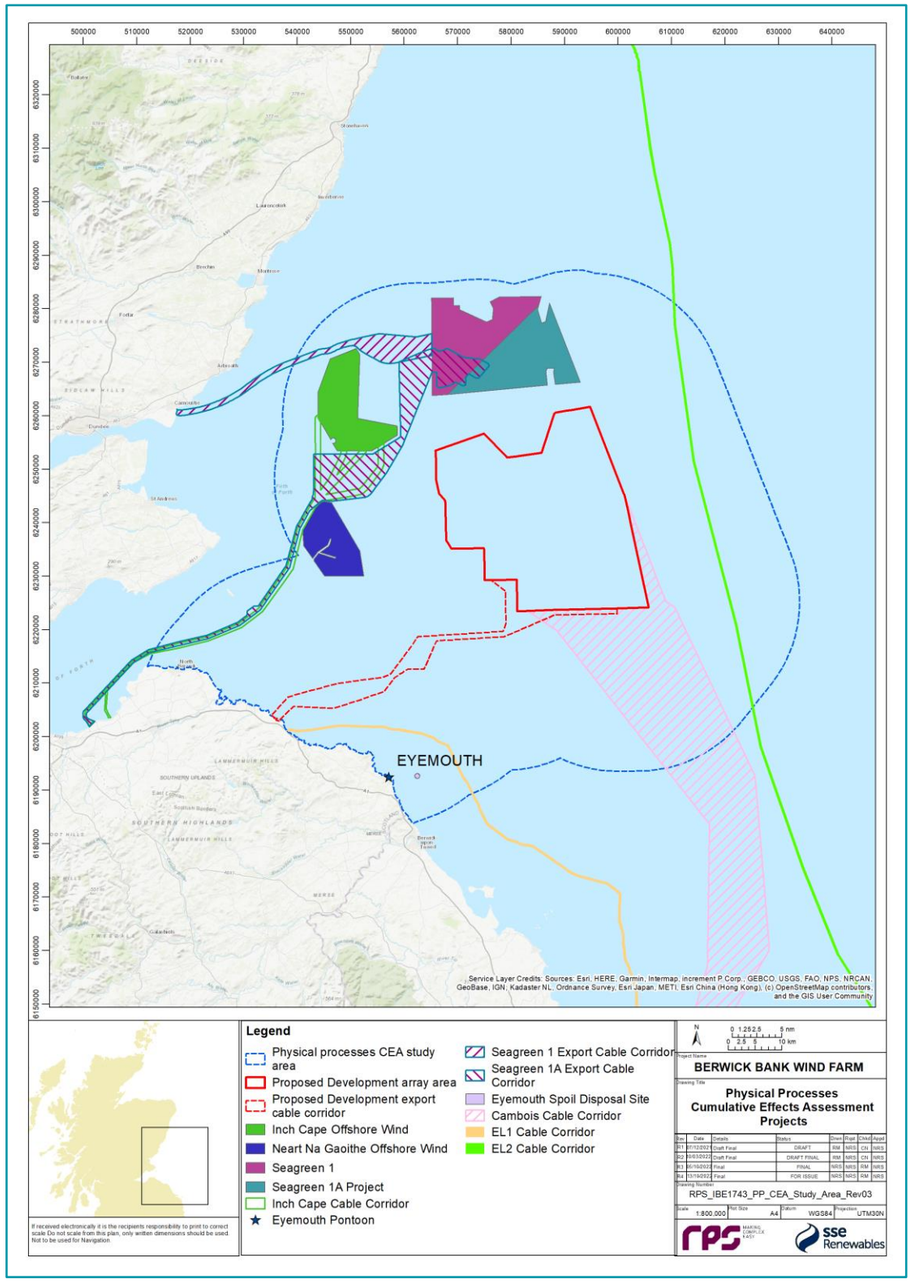


Figure 7.5: Other Developments Screened into the Cumulative Effects Assessment for Physical Processes

7.12.2. MAXIMUM DESIGN SCENARIO

136. The maximum design scenarios identified in Table 7.17 have been selected as those having the potential to result in the greatest effect on an identified receptor or receptor group. The cumulative effects presented and assessed in this section have been selected from the details provided in volume 1, chapter 3 of the Offshore EIA Report as well as the information available on other projects and plans (see volume 3, appendix 6.4), to inform a 'maximum design scenario'. Effects of greater adverse significance are not predicted to arise should any other development scenario, based on details within the PDE (e.g. different wind turbine layout), to that assessed here, be taken forward in the final design scheme.

Table 7.17: Maximum Design Scenario Considered for Each Impact as part of the Assessment of Likely Significant Cumulative Effects on Physical Processes

Potential Cumulative Impact	Phase[4]			Tier	Maximum Design Scenario
	C	O	D		
Increased SSCs and associated deposition on physical features as a result of the following activities: • seabed preparation; • foundation installation; • cable installation; • maintenance activity; and • decommissioning.	✓	✓	✓	2	**Construction Phase** • construction and maintenance of Inch Cape Offshore Wind Farm. • maintenance of Neart na Gaoithe Offshore Wind Farm. • maintenance of Seagreen 1 Offshore Wind Farm. • construction and maintenance of Seagreen 1A Offshore Wind Farm. • maintenance of Seagreen 1A Export Cable Corridor. • use of Eyemouth disposal site. • construction of the Proposed Development. • construction of Eastern Link 1. • construction of Eastern Link 2. **Operation and Maintenance Phase** • maintenance of Inch Cape Offshore Wind Farm. • maintenance of Neart na Gaoithe Offshore Wind Farm. • maintenance of Seagreen 1 Offshore Wind Farm. • maintenance of Seagreen 1A Offshore Wind Farm. • maintenance of Seagreen 1A Export Cable Corridor. • use of Eyemouth disposal site. • maintenance of the Proposed Development. • maintenance of Eastern Link 1. • maintenance of Eastern Link 2. **Decommissioning Phase** • decommissioning of Inch Cape Offshore Wind Farm. • decommissioning of Neart na Gaoithe Offshore Wind Farm. • decommissioning of Seagreen 1 Offshore Wind Farm. • decommissioning of Seagreen 1A Offshore Wind Farm. • decommissioning of Seagreen 1A Export Cable Corridor. • use of Eyemouth disposal site. • decommissioning of the Proposed Development. • decommission of Eastern Link 1. • decommission of Eastern Link 2.

[4] C = Construction, O = Operation and maintenance, D = Decommissioning

Potential Cumulative Impact	Phase[4] C	Phase[4] O	Phase[4] D	Tier	Maximum Design Scenario
	✓	✓	✓	3	**Construction Phase** • tier 2 Projects. • construction of Cambois connection Cable. **Operation and Maintenance Phase** • tier 2 Projects. • maintenance of Cambois connection Cable. **Decommissioning Phase** • tier 2 Projects. • decommission of Cambois connection Cable.
Presence of infrastructure may lead to changes to tidal currents, wave climate, littoral currents and sediment transport resulting in changes to the following: • sediment transport pathways; • bank morphology; and • beach morphology.	✓	✓	✓	2	**Construction Phase** • Inch Cape Offshore Wind Farm 72 devices *in situ.* • Neart na Gaoithe Offshore Wind 75 devices *in situ.* • Seagreen 1 Offshore Wind 114 devices *in situ.* • Seagreen 1A Offshore Wind 36 devices *in situ.* • baseline up to Proposed Development of 179 devices with 20 m caisson foundations with associated scour protection and 10 OSPs/Offshore convertor station platform and associated cable protection as outlined in Table 7.9. **Operation and Maintenance Phase** • Inch Cape Offshore Wind Farm 72 devices *in situ.* • Neart na Gaoithe Offshore Wind 75 devices *in situ.* • Seagreen 1 Offshore Wind 114 devices *in situ.* • Seagreen 1A Offshore Wind 36 devices *in situ.* • Proposed Development of 179 devices with 20 m caisson foundations with associated scour protection and 10 OSPs/Offshore convertor station platform and associated cable protection as outlined in Table 7.9. **Decommissioning Phase** • Inch Cape Offshore Wind Farm residual structures. • Neart na Gaoithe Offshore Wind residual structures. • Seagreen 1 Offshore Wind residual structures. • Seagreen 1A Offshore Wind residual structures. • Potential residual structures from the Proposed Development of 179 devices with 20 m caisson foundations with associated scour protection and 10 OSPs/Offshore convertor station platform and associated cable protection as outlined in Table 7.9.

Potential Cumulative Impact	Phase[4]			Tier	Maximum Design Scenario
	C	O	D		
	✓	✓	✓	3	**Construction Phase** • tier 2 projects. • Eyemouth Pontoon *in situ*. **Operation and Maintenance Phase** • tier 2 projects. • Eyemouth Pontoon *in situ*. **Decommissioning Phase** • tier 2 projects. • Eyemouth Pontoon in situ.

7.12.3. CUMULATIVE EFFECTS ASSESSMENT

137. An assessment of the likely significance of the cumulative effects of the Proposed Development upon physical processes receptors arising from each identified impact is given in the following sections.

INCREASED SUSPENDED SEDIMENT CONCENTRATIONS AND ASSOCIATED DEPOSITION ON PHYSICAL FEATURES AS A RESULT OF SEABED PREPARATION, FOUNDATION INSATLLATION AND CABLE INSTALLATION

138. Increased SSCs and associated deposition on physical features may arise due to the seabed preparation, installation of the wind turbines and OSP/Offshore convertor station platform foundations, the installation and/or maintenance of inter-array cables and offshore export cables. Should the other projects cited take place concurrently with the Proposed Development construction or maintenance, there is potential for cumulative increased turbidity levels.

Tier 2

Construction phase

Magnitude of impact

139. The magnitude of the increase in SSCs and associated deposition arising from the installation of wind turbines and OSP/Offshore convertor station platform foundations, inter-array cables and offshore export cables during the construction phase, has been assessed as negligible to low for the Proposed Development alone, as described in section 7.11 with the greatest impacts due to installation of inter-array cabling within the Firth of Forth Banks Complex ncMPA.

140. The construction phase of the Proposed Development coincides with the construction phase for the Seagreen 1A Offshore Wind Farm. It is noted that these are due for completion in the third quarter of 2025 with the installation of wind turbines being undertaken in the final months. Therefore, the installation of cables and foundations for this project will not coincide with the Proposed Development construction phase. The Inch Cape Offshore Wind Farm will be in the final year of construction, being programmed to overlap for a period with the installation of the offshore export cables. The offshore export cable corridor for Inch Cape is located to the east of the Proposed Development, beyond the Forth Banks Complex ncMPA and should trenching activities be undertaken simultaneously the sediment plumes would not interact with those from the Proposed Development.

141. During the Proposed Development's construction phase, the Neart na Gaoithe Offshore Wind Farm and the Seagreen 1A Export Cable Corridor will be in operational phase and maintenance activities may result in increased SSCs, however these activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development.

142. The CEA considers sea disposal of dredged material at the Eyemouth disposal site, located 31 km and 16.5 km from the Proposed Development array area and export cable corridor respectively. If offshore cable installation and dredge material disposal coincided both resultant plumes would be advected on the tidal currents, they would travel in parallel, and not towards one another, and are unlikely to interact in the event that offshore cable installation coincides with the use of the licensed sea disposal site.

143. The Eastern Link 1 Cable has Scottish landfall near Thorntonloch Beach, East Lothian. The landfall installation is proposed to be trenchless techniques (e.g. HDD) and although it is not yet confirmed which subsea trenching techniques will be used to install the cables, it is anticipated that mechanical ploughing or cutting and/or water jetting or Mass Flow Excavation (MFE) techniques will be used at different points along the route, in response to the seabed sediment conditions. Installation of the cables into soft sediments will seek to achieve a target burial depth of at least 1.5 m to 2 m and below the depth of mobile sediments depending on the nature of the seabed and potential hazards. The scheme is located 1.8 km from the Firth of Forth Banks Complex ncMPA therefore may be impacted indirectly however, significant impacts of sediment plumes arising from cable laying activities are not anticipated. These installation parameters are similar to those for the offshore export cables installation and therefore the magnitude of the impact on the MPA receptors is anticipated to be low whilst at the coastal receptors this would be negligible.

144. The Eastern Link 2 Cable runs to the east of the Proposed Development, skirting the Firth of Forth Banks Complex ncMPA. For the extent of the overlap with the Proposed Development CEA study area this is an offshore marine cable. The preferred subsea cable protection method is burial through trenching. It is not yet confirmed what subsea trenching equipment will be used to install the cables; however, it is anticipated similar methods to those proposed for Eastern Link 1 may be required, but this is dependent on the seabed conditions present within the Proposed Development export cable corridor: It is anticipated that the magnitude of the impact on the ncMPA would be low whilst at the coastal receptors not be affected.

145. The cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. The additional impact of the cumulative projects is negligible therefore the predicted impacts on the Firth of Forth Banks Complex ncMPA remains low, and negligible for the remaining coastal and intertidal receptors.

Sensitivity of the receptor

146. As with the Proposed Development, the sensitivity of the Firth of Forth Banks Complex ncMPA, comprising offshore subtidal sands and gravels, shelf banks and mounds and habitat to aggregations of ocean quahog is of low sensitivity to low magnitude intermittent changes in SSCs and sedimentations. The coastal receptors such as maritime cliffs and saltmarshes associated with the Firth of Forth SSSI and Barns Ness Coast SSSI are of negligible sensitivity and the magnitude is negligible.

Significance of the effect

147. The cumulative effect will therefore be of **negligible to minor** adverse significance for the Firth of Forth Banks Complex ncMPA receptors and of **negligible** adverse significance for the coastal receptors (Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI) which is not significant in EIA terms.

Further mitigation and residual effect

148. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

Operation and maintenance phase

Magnitude of impact

149. The magnitude of the increase in SSCs and associated deposition arising from the installation of wind turbines and OSP/Offshore convertor station platform foundations, inter-array cables and offshore export cables during the operation and maintenance phase, has been assessed as negligible to low for the Proposed Development alone, as described in section 7.11. With impacts relating to maintenance work within the Firth of Forth Banks Complex ncMPA.

150. The projects cited within the construction phase cumulative assessment such as Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm and Seagreen 1A Offshore Wind Farm will all be within the

operation and maintenance phases therefore, as previously, maintenance activities may result in increased SSCs, however these activities would be of limited spatial extent and frequency. The cumulative impacts would therefore be of a lesser magnitude (i.e. also negligible).

151. Potential cumulative impacts may relate to maintenance and reburial of the offshore export cables coinciding with the use of the Eyemouth disposal site. Maintenance activities are both intermittent and of smaller scale than the construction phase and therefore any potential cumulative impacts are less likely to occur and be of a smaller scale.

152. The cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. The additional impact of the cumulative projects is negligible therefore the predicted impacts on the Firth of Forth Banks Complex ncMPA remains low, and negligible for the remaining coastal and intertidal receptors.

Sensitivity of the receptor

153. As with the Proposed Development, the sensitivity of the Firth of Forth Banks Complex ncMPA, comprising offshore subtidal sands and gravels, shelf banks and mounds and habitat to aggregations of ocean quahog is of low sensitivity to low magnitude intermittent changes in suspended sediment concentration and sedimentations. The coastal receptors such as maritime cliffs and saltmarshes associated with the Firth of Forth SSSI and Barns Ness Coast SSSI are of negligible sensitivity and the magnitude is negligible.

Significance of the effect

154. The cumulative effect will therefore be of **negligible to minor** adverse significance for the Firth of Forth Banks Complex ncMPA receptors and of **negligible** adverse significance for the coastal receptors (Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI) which is not significant in EIA terms.

Further mitigation and residual effect

155. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms

Decommissioning phase

156. As per the maximum design scenario (Table 7.9), during the decommissioning phase it is anticipated that all structures above the seabed level will be completely removed, depending on seabed mobility. The intention is to cut off piled structures at an agreed depth below the seabed. It is proposed to remove all export, inter-array and inter-connector cables and scour protection where possible and appropriate to do so.

Magnitude of impact

157. Following decommissioning, changes in suspended sediments concentration and sedimentation would be of lesser magnitude than the operation and maintenance phase, it is anticipated that all structures above the seabed level will be completely removed, depending on seabed mobility.

158. During the decommissioning of the Proposed Development there is potential for a cumulative impact from the decommissioning of other offshore wind farms on similar project timelines (Neart na Gaoithe, Seagreen 1, Inch Cape and Seagreen 1A). However, any potential increase in SSC would be advected on tidal currents running in parrallel and not overlap with each other this impact would be localised and of a lesser magnitude than the construction phase.

159. The impact of increased suspended sediment levels and associated sedimentation is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility. It would not be of sufficient magnitude to alter the hydrodynamic regime or offshore bank or beach morphology. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA directly whilst affecting the remaining receptors indirectly. The magnitude is therefore, considered to be **low** for the receptors within the ncMPA and **negligible** for other receptor groups.

Sensitivity of the receptor

160. As with the construction phase, in response to sedimentation which has been identified as localised and composed of native material therefore the structure and function of the designated features is of low vulnerability and recoverable. The sensitivity of the ncMPA (direct) to changes as a result of decommissioning activity, removal of export, inter-array and inter-connector cables and scour protection where possible is therefore considered to be **low**. It is expected that the sensitivity of the other receptors (indirect) to decommissioning activity, removal of export, inter-array and inter-connector cables and scour protection where possible is therefore considered to be **negligible**.

Significance of the effect

161. The effect will, therefore, be of **negligible to minor** significance, which is not significant in EIA terms for the Firth of Forth Banks Complex ncMPA. For coastal and intertidal receptors such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI the effects will be of **negligible** significance, which is not significant in EIA terms.

Further mitigation and residual effect

162. No physical processes mitigation is considered necessary because the predicted impact in the absence of mitigation is not significant in EIA terms. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms

Tier 3

Construction phase

Magnitude of impact

163. During the construction phase of the Proposed Development there is the potential for cumulative impacts with three Tier 3 cable installations. The Cambois connection is a 170 km cable route extending southwards from the Proposed Development array area at Berwick Bank, it will therefore directly impact the Firth of Forth Banks Complex ncMPA complex. Scoping indicates the project will consist of four cables installed in 2 m wide trenches up to 3 m in depth. Installation techniques may include the use of a jet trencher, deep jet trencher, mechanical trencher, cable plough (displacement and non-displacement) and mass flow excavator (MFE), as ground conditions dictate. Site preparation will be required, such as boulder clearance, sand wave clearance, grapnel run will be needed in advance of cable installation as part of the 24 month construction programme. These installation parameters are similar to those of the Proposed Development and therefore the magnitude of the impact on the ncMPA receptors is anticipated to be low whilst at the coastal receptors this would be negligible.

Sensitivity of the receptor

164. The sensitivity of the Firth of Forth Banks Complex ncMPA, comprising offshore subtidal sands and gravels, shelf banks and mounds and habitat to aggregations of ocean quahog is of low sensitivity to low

magnitude intermittent changes in SSCs and sedimentations. The coastal receptors such as maritime cliffs and saltmarshes associated with the Firth of Forth SSSI and Barns Ness Coast SSSI are of negligible sensitivity and the magnitude is negligible.

Significance of the effect

165. The cumulative effect will therefore be of **negligible to minor** adverse significance for the Firth of Forth Banks Complex ncMPA receptors and of **negligible** adverse significance for the coastal receptors (Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI) which is not significant in EIA terms.

Further mitigation and residual effect

166. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms

Operation and maintenance phase

Magnitude of impact

167. During the operation and maintenance phase of the Proposed Development there is the potential for cumulative impacts with three Tier 3 cable installations. The CEA for the Cambois connection is based on information presented in the Scoping Report submitted in October 2022 (SSER, 2022e). The Cambois connection is a 170 km cable route extending southwards from the Proposed Development array area, it will therefore directly impact the Firth of Forth Banks Complex ncMPA. Scoping indicates the project will consist of four cables installed in 2 m wide trenches up to 3 m in depth. Installation techniques may include jet trenching or MFE techniques as ground conditions dictate. Site preparation will be required, such as boulder and sand wave clearance as part of the 24 month construction programme. These installation parameters are similar to those of the Proposed Development and therefore the magnitude of the impact on the ncMPA receptors is anticipated to be low whilst at the coastal receptors this would be negligible.

168. The Cambois connection, Eastern Link 1 and Eastern Link 2 Cables will all be operational when the Proposed Development reaches the operation and maintenance phase. Therefore, as previously, maintenance activities may result in increased SSCs, however these activities would be of limited spatial extent and frequency. The cumulative impacts would therefore be of a lesser magnitude.

169. The cumulative impact is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility. The additional impact of the cumulative projects is low to negligible therefore the predicted impacts on the Firth of Forth Banks Complex ncMPA remains low, and negligible for the remaining receptors.

Sensitivity of the receptor

170. The sensitivity of the Firth of Forth Banks Complex ncMPA, comprising offshore subtidal sands and gravels, shelf banks and mounds and habitat to aggregations of ocean quahog is of low sensitivity to low magnitude intermittent changes in suspended sediment concentration and sedimentations. The coastal receptors such as maritime cliffs and saltmarshes associated with the Firth of Forth SSSI and Barns Ness Coast SSSI are of negligible sensitivity and the magnitude is negligible.

Significance of the effect

171. The cumulative effect will therefore be of **negligible to minor** adverse significance for the Firth of Forth Banks Complex ncMPA receptors and of **negligible** adverse significance for the coastal receptors (Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI) which is not significant in EIA terms.

Further mitigation and residual effect

172. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

Decommissioning phase

173. As per the maximum design scenario (Table 7.9), during the decommissioning phase it is anticipated that all structures above the seabed level will be completely. The intention is to cut off piled structures at an agreed depth below the seabed. It is proposed to remove all export, inter-array and inter-connector cables and scour protection where possible and appropriate to do so.

Magnitude of impact

174. During the decommissioning phase, 170 km cable route of the Cambois connection would be removed by similar processes as undertaken during installation therefore increases in SSC would be of a similar form and magnitude directly impact the Firth of Forth Banks Complex ncMPA complex. Following decommissioning, changes in suspended sediments concentration and sedimentation would return to baseline levels as it is anticipated that all structures above the seabed level will be completely removed and no further operation to disturb the seabed would be required.

175. The impact of increased suspended sediment levels and associated sedimentation is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility. It would not be of sufficient magnitude to alter the hydrodynamic regime or offshore bank or beach morphology. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA directly whilst affecting the remaining receptors indirectly. The magnitude is therefore, considered to be low for the receptors within the ncMPA and negligible for other receptor groups.

Sensitivity of the receptor

176. As with the construction phase, in response to sedimentation which has been identified as localised and composed of native material therefore the structure and function of the designated features is of low vulnerability and recoverable. The sensitivity of the ncMPA (direct) to changes as a result of decommissioning activity, removal of export, inter-array and inter-connector cables and scour protection where possible is therefore considered to be low. It is expected that the sensitivity of the other receptors (indirect) to decommissioning activity, removal of export, inter-array and inter-connector cables and scour protection where possible is therefore considered to be negligible.

Significance of the effect

177. For the Firth of Forth Banks Complex ncMPA, the effect will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For coastal and intertidal receptors such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI the effects will be of **negligible** adverse significance, which is not significant in EIA terms.

Further mitigation and residual effect

178. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

PRESENCE OF INFRASTRUCTURE MAY LEAD TO CHANGES TO TIDAL CURRENTS, WAVE CLIMATE, LITTORAL CURRENTS AND SEDIMENT TRANSPORT

Tier 2

Construction phase

179. Assessment of the Proposed Development was carried out with and without the presence of infrastructure. It can be inferred that during the construction phase there will be gradual changes to tidal currents, wave climate, littoral currents and sediment transport as infrastructure is built. With changes occurring from the baseline environment (no presence of infrastructure) to the operation and maintenance phase maximum design scenario. This would also be the case for the Offshore Wind Farm developments under construction during this period (i.e. Inch Cape, Seagreen 1 and Seagreen 1A). Although, as previously noted, construction of subsea elements such as foundations and cable installation will be largely completed prior to commencing the construction phase of the Proposed Development. The significance of effect taken at the end of construction (the same as the operation and maintenance phase) will, therefore, be of **negligible to minor** adverse significance, which is not significant in EIA terms. For intertidal and coastal areas such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI, the magnitude of impacts is negligible giving rise to effects of **negligible** adverse significance, which is not significant in EIA terms.

Operation and maintenance phase

Magnitude of impact

180. The magnitude of increased infrastructure leading to changes in the hydrodynamic environment and sediment transport during the operation and maintenance phase has been assessed as negligible to minor for the Proposed Development alone for the receptors within the Forth Banks Complex ncMPA and negligible for the intertidal and coastal receptors (section 7.11). The construction of Seagreen 1, Inch Cape and Neart na Gaoithe Offshore Wind Farms are due to be completed prior to the operation and maintenance phase of the Proposed Development.

181. The Neart na Gaoithe Offshore Wind Farm EIA Report (Mainstream Renewable Power Ltd, 2012) included a comprehensive numerical modelling study which incorporated modelling of the cumulative impacts of the offshore wind farms within the physical processes CEA study area for the Proposed Development (Intertek METOC, 2011).

182. The modelling and assessment for Neart na Gaoithe included Neart na Gaoithe, Inch Cape, Seagreen in addition to the Proposed Development (which is referred to in the documentation as Seagreen Phase 2 and Phase 3). Within said modelling, the Proposed Development was modelled with 725 wind turbines each with an 8 m tower diameter relating to 6 MW wind turbines. The Proposed Development however incorporates a maximum of 307 14 MW wind turbine which is significantly less than the scenario modelled and therefore the impacts would, in reality, be less than those reported. The impact of multiple developments on tidal currents was predicted by the study to be low and localised to the near field of each development.

183. The Neart na Gaoithe study also showed that with all offshore wind farms *in situ*, the cumulative effect on the wave climate is low (< 3% average significant wave height) but the effect on wave climate has a larger extent than a single offshore wind farm. The cumulative effect from the combined wind farm developments on sediment transport processes is low, resulting in a 1% to 3% exceedance in the typical critical bed shear stress. Changes are within the immediate vicinity of each of the developments and it is not expected that there would be changes to the far field sediment regimes.

184. The cumulative impact is predicted to be of local spatial extent, long term duration, continuous and high reversibility. It is predicted that the impact will affect the Firth of Forth Banks Complex ncMPA directly with a low magnitude and other intertidal and coastal receptors such as Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI indirectly with a negligible magnitude.

Sensitivity of the receptor

185. The cumulative effects of the presence of infrastructure from multiple offshore wind farm developments *in situ*, operating and maintained concurrently does not further impact the Firth of Forth Banks Complex ncMPA or other receptors, more than a single development due to the impacts of infrastructure typically reserved to the vicinity of the developments.

Significance of the effect

186. The cumulative effect will therefore be of **negligible to minor** adverse significance for the Firth of Forth Banks Complex ncMPA receptors, such as shelf, banks and mounds, and of **negligible** adverse significance for the coastal receptors, such as maritime cliffs and saltmarshes, which is not significant in EIA terms.

Further mitigation and residual effect

187. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

Decommissioning phase

Magnitude of impact

188. The magnitude of any residual infrastructure which cannot be removed leading to changes in the hydrodynamic environment and sediment transport during the decommissioning phase, has been assessed as negligible for the Proposed Development alone, in section 7.11.

189. The offshore wind farm developments considered within the operation and maintenance phase of the Proposed Development have a similar lifespan and would therefore also be in the decommissioning phase with residual infrastructure remaining (such as only those scour and cable protection structures not possible or practical to be removed). Decommissioning activity from the multiple developments would have a negligible magnitude of impact on tidal currents, wave climate and sediment transport, the effects of which would not overlap with other developments as documented in the Neart na Gaoithe EIA Report (Mainstream Renewable Power Ltd, 2012).

190. The cumulative impact is predicted to be of local spatial extent, long term duration, and highly reversibility. It is predicted that the impact will affect the receptor Firth of Forth Banks Complex ncMPA directly with a low magnitude and other receptors within the Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI indirectly with negligible magnitude.

Sensitivity of the Receptor

191. The cumulative effects of the decommissioning of the wind farm infrastructure from multiple offshore wind farm developments *in situ* does not further impact the Firth of Forth Banks Complex ncMPA or other

receptors, more than a single development due to the impacts of decommissioning typically reserved to the vicinity of the developments.

Significance of the effect

192. The cumulative effect will therefore be of **negligible** adverse significance for the Firth of Forth Banks Complex ncMPA receptors and of **negligible** adverse significance for the coastal receptors, which is not significant in EIA terms.

Further mitigation and residual effect

193. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

Tier 3

Construction phase

Magnitude of impact

194. The Eyemouth Pontoon is a floating structure sited within Gunsgreen Basin purposed to support the Neart na Gaoithe Offshore Wind Farm and would therefore be decommissioned when no longer in use. Although the development lies within the physical processes CEA study area, due to the diminutive scale and location, no impacts were predicted from the installation, operation and decommissioning of the pontoon to the assessed receptors.

Sensitivity of the receptor

195. The Eyemouth Pontoon would not contribute to impacts on receptors therefore the cumulative effect will therefore be of **negligible to minor** significance for the Firth of Forth Banks Complex ncMPA receptors and negligible for the Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI coastal receptors.

Significance of the effect

196. Due to the **negligible** adverse significance of the Eyemouth Pontoon on the Firth of Forth Banks Complex ncMPA receptors and the **negligible** adverse significance for the coastal receptors, the is not significant in EIA terms.

Further mitigation and residual effect

197. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms

Operation and maintenance phase

Magnitude of impact

198. As with the construction phase, the Eyemouth Pontoon has no impact on the assessed receptors.

Sensitivity of the Receptor

199. The Eyemouth Pontoon would not contribute to impacts on receptors therefore the cumulative effect will therefore be of **negligible to minor** significance for the Firth of Forth Banks Complex ncMPA receptors and negligible for the Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI coastal receptors.

Significance of the effect

200. Due to the **negligible** adverse significance of the Eyemouth Pontoon on the Firth of Forth Banks Complex ncMPA receptors and the **negligible** adverse significance for the coastal receptors, which is not significant in EIA terms.

Further mitigation and residual effect

201. No physical processes mitigation is considered necessary because the likely effect in the absence of further mitigation (beyond the designed in measures outlined in section Table 7.14) is not significant in EIA terms.

Decommissioning Phase

Magnitude of impact

202. As with both the operation and maintenance phase and construction phase, the Eyemouth Pontoon has no impact on the assessed receptors.

Sensitivity of the receptor

203. The Eyemouth Pontoon would not contribute to impacts on receptors therefore the cumulative effect will therefore be of **negligible to minor** significance for the Firth of Forth Banks Complex ncMPA receptors and negligible for the Firth of Forth SSSI, Berwickshire and North Northumberland Coast SAC, Berwickshire Coast SSSI, Pease Bay SSSI, St Abb's Head to Fast Castle SSSI and Barns Ness SSSI coastal receptors.

Significance of the effect

204. Due to the **negligible** adverse significance of the Eyemouth Pontoon on the Firth of Forth Banks Complex ncMPA receptors and the **negligible** adverse significance for the coastal receptors, which is not significant in EIA terms.

Further mitigation and residual effect

205. No physical processes mitigation is considered necessary because the predicted impact in the absence of mitigation is not significant in EIA terms.

7.12.4. PROPOSED MONITORING

206. No additional physical processes monitoring to assess the predictions made within the CEA is considered necessary. The project description (volume 1, chapter 3) includes routine inspection and geophysical surveys of wind turbine and OSP/Offshore convertor station platform foundations. Also, offshore export cables, inter-array and interconnector cables burial and protection will be inspected and surveyed as part of the maintenance programme. A commitment has also been made to monitor sand wave recovery following seabed clearance activities to verify the findings of the assessment in concert with Stakeholder agreement.

7.13. TRANSBOUNDARY EFFECTS

207. A screening of transboundary impacts has been carried out and has identified that there were no likely significant transboundary effects with regard to physical processes from the Proposed Development upon the interests of other European Economic Area (EEA) States. MS-LOT agreed via Scoping that the transboundary impacts of marine physical processes receptors can be scoped out of any further assessment within the Offshore EIA Report however SFF requested that these be included.

208. During the construction and maintenance phases suspended sediment plumes associated with the installation of foundations, inter-array and offshore export cables do not migrate more than 20 km from the extent of the Proposed Development. Any changes to tidal current, wave climate or associated sediment transport are limited in both magnitude and extent during the operation and maintenance phase. The wave climate shows the widest effect but does not extend northwards of Aberdeen or south of Amble. Furthermore, the potential for cross-border impacts with England has also been considered, as although Scotland and England have different regulatory systems, impacts on English receptors are considered cross-border rather than transboundary. It is worth noting the Proposed Development array area is adjacent to the English marine border. It was concluded that there are no changes in physical processes east of the Greenwich Prime Meridian (Longitude 0º) hence no potential for significant transboundary effects.

7.14. INTER-RELATED EFFECTS (AND ECOSYSTEM ASSESSMENT)

209. A description of the likely inter-related effects arising from the Proposed Development on physical processes is provided in volume 3, appendix 18.1 of the Offshore EIA Report. For physical processes, the following potential impacts have been considered within the inter-related assessment:

- increased SSCs and associated deposition on physical features; and
- changes to tidal currents, wave climate, littoral currents and sediment transport.

210. Table 7.18 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of the Proposed Development and also the inter-related effects (receptor-led effects) that are predicted to arise for physical processes receptors.

211. As previously noted, effects on physical processes also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- Benthic Subtidal and Intertidal Ecology:
  - increased SSC; and
  - sediment deposition.
- Fish and Shellfish Ecology:
  - increased SSC; and
  - sediment deposition.
- Marine Mammals:
  - changes to tidal current and wave climate;
  - increased SSC; and
  - sediment deposition.
- Infrastructure and Other Users:
  - increased SSC; and
  - changes to tidal current and wave climate.

Table 7.18: Summary of Likely Significant Inter-Related Effects on the Environment for Physical Processes from Individual Effects Occurring across the Construction, Operation and Maintenance and Decommissioning Phases of the Proposed Development and from Multiple Effects Interacting Across all Phases (Receptor-led Effects)

Description of Impact	Phase			Likely Significant Inter-Related Effects
	C	O	D	
Increased SSCs and associated deposition on physical features	✓	✓	✓	Increases in SSC during construction phase would not extend into the operation and maintenance phase. Similarly, those increases which occur in the operation and maintenance phase due to maintenance activities would not extend to decommissioning.
Changes to tidal currents, wave climate, littoral currents and sediment transport	✓	✓	✓	Changes to tidal currents and wave climate due to structures relate to the same structures within the construction, operation and decommissioning phases. The decommissioning phase structures are only those remaining bed structures, such as scour and cable protection, not possible or practical to be removed, thus resulting in a lesser magnitude of the same impact.
Receptor Led Effects				
Firth of Forth Banks Complex ncMPA: During principally the operation and maintenance phase increased SSCs and associated deposition on physical features may occur due to maintenance activities; this would coincide with changes to tidal currents, wave climate, littoral currents and sediment transport due to the presence of the structures. Maintenance activities are sporadic, with the impacts predicted to be of local spatial extent, short term duration and intermittent. These would not be significant in EIA terms.				

7.15. SUMMARY OF IMPACTS, MITIGATION MEASURES, LIKELY SIGNIFICANT EFFECTS AND MONITORING

212. Information on physical processes within the physical processes study area was collected through a detailed desktop review of existing studies and datasets. These are summarised in Table 7.5 and Table 7.6 respectively. The baseline was characterised by a combination of literature review of the reports and numerical modelling using the datasets. Full details of the analysis undertaken to develop the physical processes baseline is provided in volume 3, appendix 7.1.

213. Table 7.19 presents a summary of the potential impacts, mitigation measures and the conclusion of likely significant effects on physical processes in EIA terms. The assessment was undertaken for the Proposed Development as described in volume 1, chapter 3 of the Offshore EIA Report. The impacts assessed included increased SSCs and associated deposition as a result of seabed preparation, foundation installation, cable installation, maintenance activity and decommissioning. Additionally, potential changes to tidal flows, wave climate and sediment transport due to the presence of the Proposed Development were also assessed.

214. The Firth of Forth Banks Complex ncMPA is a composite site with Berwick and Marr Banks lying within the Proposed Development area, whilst Scalp and Montrose Banks, and the Wee Bankie lie within the wider physical processes study area. These banks are comprised of the following designated features; offshore subtidal sands and gravels, shelf banks and moulds and habitat to aggregations of ocean quahog and moraine formations.

215. Sediment plumes associated with the array installation phase give rise to increased SSCs however these do not persist in the Firth of Forth Banks Complex ncMPA and do not reach Montrose Bank to the north. Sedimentation is limited to immediate vicinity of the installation and would therefore not affect composite banks beyond the development area (i.e. limited to Berwick and Marr Banks). These plumes do not extend

to any of the other designated sites with sediment concentrations settling to background levels within the Proposed Development area.

216. In terms of the Firth of Forth Banks Complex ncMPA, the structure of the offshore subtidal sands and gravels would remain unchanged as the deposition is of native material and the supporting hydrodynamic processes are not altered by the minimal level of bathymetric change as a result of the construction phase sediment releases. Similarly, shelfs, banks and mound features would remain stable and supporting hydrodynamic processes for ocean quahog colonisation remain unaffected.

217. The offshore export cables trenching corridor does not pass through designated areas, although plumes resulting from the offshore export cables trenching may reach the outer extent of designated sites. The Firth of Forth SSSI is comprised of features such as mudflat, sand dune, saltmarsh and sea cliffs. Barns Ness Coast SSSI contains a variety of coastal features such as saltmarsh, sand dunes and shingle. The Skateraw landfall site for the offshore export cables borders this SSSI, however, as the trenchless technique has been selected and sedimentation from nearshore cabling occurs off Torness Point. This increase sediment material is native to the sediment cell and will therefore not affect geodiversity. The increased sedimentation from the offshore export cables installation causes little or no sedimentation in the intertidal zone which would be insufficient to affect beach morphology.

218. Changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are experienced in Firth of Forth Banks Complex ncMPA, however changes are concentrated on the specific location of the wind turbine and do not extent beyond the Proposed Development area. Diminutive changes are observed with the littoral current flow due to the installation of the wind farm. Offshore bank and beach morphology would not be influenced by changes of this magnitude. The limited and localised changes to hydrography seen in relation to the Berwick and Marr Banks, would not result in changes to the hydrodynamic regime or sediment composition. The structure of the offshore subtidal sands and gravels would remain unchanged. Similarly, shelfs, banks and mound features would remain stable and supporting hydrodynamic processes for ocean quahog colonisation remain unaffected. Overall, it is concluded that there will be no likely significant effects arising from the Proposed Development during the construction, operation and maintenance or decommissioning phases.

219. presents a summary of the potential cumulative effects, mitigation measures and the conclusion of likely significant effects on physical processes in EIA terms. The cumulative assessment included the potential impacts due to adjacent offshore wind farm installations, marine cable installations along with other projects within a 20 km radius. The cumulative effects assessed include increased suspended sediment, sediment deposition and potential changes to littoral currents and sediment transport. Overall, it is concluded that there will be no likely significant cumulative effects from the Proposed Development alongside other projects/plans.

220. As no likely significant effects were determined, either from the Proposed Development or cumulatively with other projects, no additional mitigating measures have been proposed. However, a commitment has been made to undertake monitoring of sand wave recovery following seabed clearance activities to add to the body of knowledge on the impact of offshore energy infrastructure. Additionally, the project description (volume 1, chapter 3) includes routine inspection and geophysical surveys of wind turbine and OSP/Offshore convertor station platform foundations. Also, offshore export cables, inter-array and interconnector cables burial and protection will be inspected and surveyed as part of the maintenance programme. No potential transboundary impacts have been identified in regard to effects of the Proposed Development.

Table 7.19: Summary of Potential Environmental Effects, Mitigation and Monitoring

Description of Impact	Phase			Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Residual Effect	Proposed Monitoring
	C	O	D						
Increased SSCs and associated deposition on physical features as a result of the following activities: • seabed preparation; • foundation installation; • cable installation; • maintenance activity; and • decommissioning.	✓	✓	✓	Low	Low - Firth of Forth Banks Complex ncMPA – (offshore subtidal sands and gravels; shelf bank and mounds; moraines and habitat to aggregations of ocean quahog)	Negligible to Minor	None	N/A	Monitoring of the recovery of sand waves, at a representative number of locations where sand wave clearance activity has taken place, within the Firth of Forth Banks Complex MPA. Monitoring will be undertaken as part of wider Project pre- and post-construction geophysical surveys and are likely to involve a combination of multibeam echosounder and/or high-resolution side scan sonar. The approach to monitoring sand wave recovery within the MPA will be discussed post consent and agreed with MS-LOT in consultation with the SNCBs.
				Negligible	Negligible - Berwickshire and North Northumberland Coast SAC (Reefs; sea caves; intertidal mudflats and sandflats; shallow inlets and bays)	Negligible	None	N/A	
				Negligible	Negligible - Berwickshire Coast (intertidal) SSSI (Rocky shore and sea caves)	Negligible	None	N/A	
				Negligible	Negligible - St Abb's Head to Fast Castle SSSI (Coastal Geomorphology of Scotland; Maritime cliff; Old Red Sandstone Igneous)	Negligible	None	N/A	
				Negligible	Negligible - Pease Bay Coast SSSI (Lower Carboniferous; Maritime cliff; and Silurian - Devonian Chordata)	Negligible	None	N/A	
				Negligible	Negligible - Barns Ness Coast SSSI (Lower Carboniferous; Saltmarsh; Sand dunes; and Shingle)	Negligible	None	N/A	
				Negligible	Negligible - Firth of Forth SSSI (Geomorphology of Scotland; Lower Carboniferous; Maritime cliff; Mudflats; Quaternary of Scotland; Saltmarsh; and Sand dunes)	Negligible	None	N/A	
Presence of infrastructure may lead to changes to tidal currents, wave climate, littoral currents and sediment transport resulting in changes to the following: • sediment transport pathways; • bank morphology; and • beach morphology.	✓	✓	✓	Low	Low - Firth of Forth Banks Complex ncMPA – (offshore subtidal sands and gravels; shelf bank and mounds; moraines and habitat to aggregations of ocean quahog)	Negligible to Minor	None	N/A	
				Negligible	Negligible - Berwickshire and North Northumberland Coast SAC (Reefs; sea caves; intertidal mudflats and sandflats; shallow inlets and bays)	Negligible	None	N/A	
				Negligible	Negligible - Berwickshire Coast (intertidal) SSSI (Rocky shore and sea caves)	Negligible	None	N/A	
				Negligible	Negligible - St Abb's Head to Fast Castle SSSI (Coastal Geomorphology of Scotland; Maritime cliff; Old Red Sandstone Igneous)	Negligible	None	N/A	
				Negligible	Negligible - Pease Bay Coast SSSI (Lower Carboniferous; Maritime cliff; and Silurian - Devonian Chordata)	Negligible	None	N/A	
				Negligible	Negligible - Barns Ness Coast SSSI (Lower Carboniferous; Saltmarsh; Sand dunes; and Shingle)	Negligible	None	N/A	
				Negligible	Negligible - Firth of Forth SSSI (Geomorphology of Scotland; Lower Carboniferous; Maritime cliff; Mudflats; Quaternary of Scotland; Saltmarsh; and Sand dunes)	Negligible	None	N/A	

Table 7.20: Summary of Likely Significant Cumulative Environment Effects, Mitigation and Monitoring

Description of Impact	Phase			Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Residual Effect	Proposed Monitoring
	C	O	D							
Increased SSCs and associated deposition on physical features as a result of the following activities: • seabed preparation; • foundation installation; • cable installation; • maintenance activity; and • decommissioning.	✓	✓	✓	Tier 2	Low	Low - Firth of Forth Banks Complex ncMPA – (offshore subtidal sands and gravels; shelf bank and mounds; moraines and habitat to aggregations of ocean quahog)	Negligible to Minor	None	N/A	None
					Negligible	Negligible - Berwickshire and North Northumberland Coast SAC (Reefs; sea caves; intertidal mudflats and sandflats; shallow inlets and bays)	Negligible	None	N/A	None
					Negligible	Negligible - Berwickshire Coast (intertidal) SSSI (Rocky shore and sea caves)	Negligible	None	N/A	None
					Negligible	Negligible - St Abb's Head to Fast Castle SSSI (Coastal Geomorphology of Scotland; Maritime cliff; Old Red Sandstone Igneous)	Negligible	None	N/A	None
					Negligible	Negligible - Pease Bay Coast SSSI (Lower Carboniferous; Maritime cliff; and Silurian - Devonian Chordata)	Negligible	None	N/A	None
					Negligible	Negligible - Barns Ness Coast SSSI (Lower Carboniferous; Saltmarsh; Sand dunes; and Shingle)	Negligible	None	N/A	None
					Negligible	Negligible - Firth of Forth SSSI (Geomorphology of Scotland; Lower Carboniferous; Maritime cliff; Mudflats; Quaternary of Scotland; Saltmarsh; and Sand dunes)	Negligible	None	N/A	None
	✓	✓	✓	Tier 3	Low	Low - Firth of Forth Banks Complex ncMPA – (offshore subtidal sands and gravels; shelf bank and mounds; moraines and habitat to aggregations of ocean quahog)	Negligible to Minor	None	N/A	None
					Negligible	Negligible - Berwickshire and North Northumberland Coast SAC (Reefs; sea caves; intertidal mudflats and sandflats; shallow inlets and bays)	Negligible	None	N/A	None
					Negligible	Negligible - Berwickshire Coast (intertidal) SSSI (Rocky shore and sea caves)	Negligible	None	N/A	None
					Negligible	Negligible - St Abb's Head to Fast Castle SSSI (Coastal Geomorphology of Scotland; Maritime cliff; Old Red Sandstone Igneous)	Negligible	None	N/A	None
					Negligible	Negligible - Pease Bay Coast SSSI (Lower Carboniferous; Maritime cliff; and Silurian - Devonian Chordata)	Negligible	None	N/A	None
					Negligible	Negligible - Barns Ness Coast SSSI (Lower Carboniferous; Saltmarsh; Sand dunes; and Shingle)	Negligible	None	N/A	None
					Negligible	Negligible - Firth of Forth SSSI (Geomorphology of Scotland; Lower Carboniferous; Maritime cliff; Mudflats; Quaternary of Scotland; Saltmarsh; and Sand dunes)	Negligible	None	N/A	None

Description of Impact	Phase C	Phase O	Phase D	Cumulative Effects Assessment Tier	Magnitude of Impact	Sensitivity of Receptor	Significance of Effect	Additional Measures	Residual Effect	Proposed Monitoring
Presence of infrastructure may lead to changes to tidal currents, wave climate, littoral currents and sediment transport resulting in changes to the following: • sediment transport pathways; • bank morphology; and • beach morphology.	✓	✓	✓	Tier 2	Low	Low - Firth of Forth Banks Complex ncMPA – (offshore subtidal sands and gravels; shelf bank and mounds; moraines and habitat to aggregations of ocean quahog)	Negligible to Minor	None	N/A	None
					Negligible	Negligible - Berwickshire and North Northumberland Coast SAC (Reefs; sea caves; intertidal mudflats and sandflats; shallow inlets and bays)	Negligible	None	N/A	None
					Negligible	Negligible - Berwickshire Coast (intertidal) SSSI (Rocky shore and sea caves)	Negligible	None	N/A	None
					Negligible	Negligible - St Abb's Head to Fast Castle SSSI (Coastal Geomorphology of Scotland; Maritime cliff; Old Red Sandstone Igneous)	Negligible	None	N/A	None
					Negligible	Negligible - Pease Bay Coast SSSI (Lower Carboniferous; Maritime cliff; and Silurian - Devonian Chordata)	Negligible	None	N/A	None
					Negligible	Negligible - Barns Ness Coast SSSI (Lower Carboniferous; Saltmarsh; Sand dunes; and Shingle)	Negligible	None	N/A	None
					Negligible	Negligible - Firth of Forth SSSI (Geomorphology of Scotland; Lower Carboniferous; Maritime cliff; Mudflats; Quaternary of Scotland; Saltmarsh; and Sand dunes)	Negligible	None	N/A	None
	✓	✓	✓	Tier 3	Low	Low - Firth of Forth Banks Complex ncMPA – (offshore subtidal sands and gravels; shelf bank and mounds; moraines and habitat to aggregations of ocean quahog)	Negligible	None	N/A	None
					Negligible	Negligible - Berwickshire and North Northumberland Coast SAC (Reefs; sea caves; intertidal mudflats and sandflats; shallow inlets and bays)	Negligible	None	N/A	None
					Negligible	Negligible - Berwickshire Coast (intertidal) SSSI (Rocky shore and sea caves)	Negligible	None	N/A	None
					Negligible	Negligible - St Abb's Head to Fast Castle SSSI (Coastal Geomorphology of Scotland; Maritime cliff; Old Red Sandstone Igneous)	Negligible	None	N/A	None
					Negligible	Negligible - Pease Bay Coast SSSI (Lower Carboniferous; Maritime cliff; and Silurian - Devonian Chordata)	Negligible	None	N/A	None
					Negligible	Negligible - Barns Ness Coast SSSI (Lower Carboniferous; Saltmarsh; Sand dunes; and Shingle)	Negligible	None	N/A	None
					Negligible	Negligible - Firth of Forth SSSI (Geomorphology of Scotland; Lower Carboniferous; Maritime cliff; Mudflats; Quaternary of Scotland; Saltmarsh; and Sand dunes)	Negligible	None	N/A	None

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