Rampion 2 Wind Farm

Category 6: Environmental Statement

Volume 2, Chapter 6: Coastal processes (tracked)

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Executive Summary

This chapter of the Rampion 2 Environmental Statement examines the likely significant effects on coastal processes receptors resulting from the proposed construction, operation and decommissioning of the offshore infrastructure.

For the most part coastal processes (including patterns of winds, waves, water levels, currents, coastal and seabed sediments and morphology, and water turbidity) are not in themselves receptors but are instead ‘pathways’ of effect, with the potential to indirectly impact other environmental receptors.

A desk-based review of literature and existing datasets has been undertaken to establish a baseline (what exists in the area at the time of writing). Water depths across the wind farm array area vary from approximately 13m below the Lowest Astronomical Tide (LAT) (on a rocky outcrop in the north-west of the site) to 65m LAT (within a broad depression) in the south-east of the array. Sandwaves are prevalent over much of the central and eastern array area, trending north-west to south-east, with heights of up to 2m relative to the surrounding seabed. The seabed across the array and export cable corridor is dominated by the presence of coarse-grained sediments (sands and gravels) with outcropping bedrock in places. There is also a failed seawall and groynes in the vicinity of Climping, to the west of the onshore landfall corridor.

The assessment considers a range of potential effects on coastal processes, including: changes in suspended sediment concentrations and deposition of disturbed sediments to the seabed; changes to the tidal, wave, sediment transport regimes and seabed scour; changes to landfall morphology due to installation of export cables; and, changes to the tidal regime due to presence of windfarm infrastructure.

The pathway assessments demonstrate that changes to baseline patterns of winds, waves, water levels, currents, coastal and seabed sediments and morphology will be of negligible or very small magnitude (in both absolute and relative terms, in the context of natural baseline variability in these parameters, and not measurable in practice). Changes to baseline patterns of water turbidity (i.e. sediment plumes) can be of relatively high magnitude, but only in a very localised extent around the activity, and for a very limited period of time.

The impact assessments demonstrate that the magnitude of changes to designated coastal and seabed sediments and morphological features are also of negligible or very small magnitude (in both absolute and relative terms, in the context of natural baseline variability in these parameters, and not measurable in practice).

A range of environmental measures are embedded as part of the Rampion 2 design to remove or reduce any significant environmental effects on coastal processes, as far as possible.

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6. Coastal processes

6.1 Introduction

6.1.1 This chapter of the Environmental Statement (ES) presents the results of the assessment of the likely significant effects of Rampion 2 with respect to coastal processes, including waves, tides, sediments and morphology during the construction, operation and maintenance (O&M) and decommissioning phases of the Proposed Development.

6.1.2 This chapter should be read in conjunction with the project description provided in **Chapter 3: Alternatives** and **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.3 and 6.2.4 respectively) and the relevant parts of the following chapters and appendices which will consider whether the identified pathways of coastal processes effects may impact other sensitive receptors considered by other aspects):

- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 9: Benthic subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference: 6.2.10) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 11: Marine mammals, Volume 2** of the ES (Document Reference: 6.2.11) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects);
- **Chapter 12: Offshore ornithology, Volume 2** of the ES (Document Reference: 6.2.12) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects);
- **Chapter 13: Shipping and navigation, Volume 2** of the ES (Document Reference: 6.2.13) (due to potential changes in hydrodynamic and wave regime, seabed and coastal morphology); and
- **Chapter 26: Water environment, Volume 2** of the ES (Document Reference: 6.2.26) (due to potential changes to suspended sediments).

6.1.3 This chapter describes:

- the legislation, planning policy and other documentation that has informed the assessment (**Section 6.2: Relevant legislation, planning policy, and other documentation**);

- the outcome of consultation and engagement that has been undertaken to date, including how matters relating to coastal processes within the Statutory Consultation periods, have been addressed (**Section 6.3: Consultation and engagement**);
- the scope of the assessment for coastal processes (**Section 6.4: Scope of the assessment**);
- the methods used for the baseline data gathering (**Section 6.5: Methodology for baseline data gathering**);
- the overall baseline (**Section 6.6: Baseline conditions**);
- embedded environmental measures relevant to coastal processes and the relevant maximum design scenario (**Section 6.7: Basis for ES assessment**);
- the assessment methods used for the ES (**Section 6.8: Methodology for ES assessment**);
- the assessment of coastal processes effects (**Section 6.9 - 6.11: Assessment of effects** and **Section 6.12: Assessment of cumulative effects**);
- consideration of transboundary effects (**Section 6.13: Transboundary effects**);
- inter-related effects (**Section 6.14: Inter-related effects**);
- a summary of residual effects for coastal processes (**Section 6.15: Summary of residual effects**);
- a glossary of terms and abbreviations is provided in **Section 6.16: Glossary of terms and abbreviations**; and
- a references list is provided in **Section 6.17: References**.

6.1.4 The chapter is also supported by the following appendices:

- **Appendix 6.1: Coastal processes technical report: Baseline description, Volume 4** of the ES (Document Reference: 6.4.6.1);
- **Appendix 6.2: Coastal processes model design and validation, Volume 4** of the ES (Document Reference: 6.4.6.2); and
- **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** (Document Reference: 6.4.6.3).

6.2 Relevant legislation, planning policy and other documentation

Introduction

6.2.1 This section identifies the legislation, policy and other documentation that has informed the assessment of effects with respect to coastal processes. Further information on policies relevant to the Environmental Impact Assessment (EIA) and their status is provided in **Chapter 2: Policy and legislative context, Volume 2** of the ES (Document Reference: 6.2.2).

Legislation and national planning policy

6.2.2 Coastal processes are not subject to specific aspect legislation but are relevant to legislative requirements of other aspects, including the Birds and Habitats Directives and associated regulations, Water Framework Directive (WFD) and so on, due to the potential for pathways of coastal processes effects to impact other aspects. The following aspect chapters provide additional information about other aspect-specific relevant legislation:

- **Chapter 7: Other marine users, Volume 2** of the ES (Document Reference: 6.2.7);
- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8);
- **Chapter 9: Benthic subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9);
- **Chapter 12: Offshore ornithology, Volume 2** of the ES (Document Reference: 6.2.12);
- **Chapter 22: Terrestrial ecology, Volume 2** of the ES (Document Reference: 6.2.22);
- **Chapter 26: Water environment, Volume 2** of the ES (Document Reference: 6.2.26); and
- **Appendix 26.3: Water Framework Directive compliance assessment, Volume 4** of the ES (Document Reference: 6.4.26.3).

6.2.3 **Table 6-1** lists the national planning policy relevant to the assessment of the effects on coastal processes receptors.

Table 6-1 National planning policy relevant to coastal processes

Policy description	Relevance to assessment
Overarching National Policy Statement for Energy (EN1) (July 2011)	
(Paragraph 5.5.7 of NPS EN-1). "*The Environmental Statement should include an assessment of the effects on the coast. In particular, applicants should assess:* • *The impact of the proposed project on coastal processes and geomorphology, including by taking account of potential impacts from climate change. If the development will have an impact on coastal processes the applicant must demonstrate how*	Changes to coastal processes receptors and 'pathways' (for example, elevations in Suspended Sediment Concentration (SSC), scour around foundations etc.) are the basis for this chapter and are assessed for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and **Section 6.11** for the decommissioning phase. **Section 6.12** assesses the potential cumulative effects. More detailed supporting assessments are provided in

Policy description	Relevance to assessment
the impacts will be managed to minimise adverse impacts on other parts of the coast; • *The implications of the proposed project on strategies for managing the coast as set out in Shoreline Management Plans (SMPs)…any relevant Marine Plans…and capital programmes for maintaining flood and coastal defences;* • *The effects of the proposed project on marine ecology, biodiversity and protected sites;* • *The effects of the proposed project on maintaining coastal recreation sites and features; and* • *The vulnerability of the proposed development to coastal change, taking account of climate change, during the project's operational life and any decommissioning period."*	**Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3). The vulnerability of Rampion 2 to coastal change (taking account of climate change) is also considered in these sections. The implications of the Proposed Development on strategies for managing the coast is considered within the nearshore area assessment, presented in **Section 6.9 paragraphs 6.9.46** to **6.9.70** (for the construction phase), **Section 6.10 paragraphs 6.10.34** to **6.10.37** (for the O&M phase) and **Section 6.11 paragraphs 6.11.9** to **6.11.16** for the decommissioning phase). The effects of Rampion 2 on marine ecology, biodiversity and protected sites is set out in **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9). The effects of the Proposed Development on maintaining coastal recreation sites and features is set out in **Chapter 7: Other marine users, Volume 2** (Document Reference: 6.2.7)
(Paragraph 5.5.9 of NPS EN-1). "*The applicant should be particularly careful to identify any effects of physical changes on the integrity and special features of Marine Conservation Zones (MCZs), candidate marine Special Areas of Conservation (SACs), coastal SACs and candidate coastal SACs, coastal Special Protection Areas (SPAs) and potential Sites of Community Importance (SCIs) and Sites of Special Scientific Interest (SSSI)*"	Designated nature conservation sites within the Rampion 2 coastal processes study area are listed as receptors in **Table 6-6** and illustrated in **Figure 6.2, Volume 3** of the ES (Document Reference: 6.3.6) and are assessed for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and **Section 6.11** for the decommissioning phase. The predicted changes to coastal processes have been considered in relation to indirect effects on other receptors elsewhere in the ES, in particular **Chapter 8: Fish and shellfish ecology, Chapter 9: Benthic, subtidal and intertidal ecology,** and **Chapter 11:**

Policy description	Relevance to assessment
	Marine mammals, Volume 2 of the ES (Document Reference: 6.2.8, 6.2.9 and 6.2.11 respectively).
(Paragraph 5.5.11 of NPS EN-1). "*The IPC (now the Secretary of State) should not normally consent new development in areas of dynamic shorelines where the proposal could inhibit sediment flow or have an adverse impact on coastal processes at other locations. Impacts on coastal processes must be managed to minimise adverse impacts on other parts of the coast. Where such proposals are brought forward consent should only be granted where the IPC is satisfied that the benefits (including need) of the development outweigh the adverse impacts.*"	Local and regional coastal morphology is defined as a coastal process receptor (**Table 6-6**). This assessment considers the nature of ongoing shoreline change at the nearshore area and the potential for cables and other project infrastructure to impact coastal processes for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and **Section 6.11** for the decommissioning phase.
(Section 4.8 of NPS EN-1). *"The resilience of the project to climate change (such as increased storminess) should be assessed in the Environmental Statement accompanying an application."*	Potential changes in climate are described in **Section 6.6 paragraph 6.6.9** and are taken into consideration within the assessments for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and **Section 6.11** for the decommissioning phase.
National Policy Statement for Renewable Energy Infrastructure (EN-3) (July 2011)	
(Paragraph 2.6.81 of NPS EN-3). "*An assessment of the effects of installing cable across the intertidal zone should include information, where relevant, about:* • *Any alternative landfall sites that have been considered by the applicant during the design phase and an explanation for the final choice;* • *Any alternative cable installation methods that have been considered by the applicant during the design phase and an explanation for the final choice;* • *Potential loss of habitat;*	Effects of the cable installation in the nearshore area (including seabed disturbance, increased SSC and coastal morphology) are presented in **Section 6.9 paragraphs 6.9.21** to **6.9.75**, whilst effects associated with decommissioning activities are presented in **Section 6.11 paragraphs 6.11.1** to **6.11.16**. Where possible, the assessment includes estimates of the rates which the intertidal area might recover from temporary effects. A cable nearshore assessment is also presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES **Section 5.4** (Document Reference: 6.4.6.3). This assessment considers the nature of

Policy description	Relevance to assessment
• *Disturbance during cable installation and removal (decommissioning);* • *Increased suspended sediment loads in the intertidal zone during installation; and* • *Predicted rates at which the intertidal zone might recover from temporary effects."*	ongoing shoreline change at the nearshore area and the potential for cables and other project infrastructure to impact coastal processes. Details regarding the Proposed Development design at the nearshore area, including alternative designs considered, are set out in **Chapter 3: Alternatives, Volume 2** of the ES (Document Reference: 6.2.3). Details regarding alternative nearshore areas that have been considered during the design phase and an explanation for the final choice is provided in **Chapter 3: Alternatives, Volume 2** of the ES (Document Reference: 6.2.3). The potential for habitat loss is discussed within **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9).
(Paragraph 2.6.113 of NPS EN-3). "*Where necessary, assessment of the effects on the subtidal environment should include:* • *Loss of habitat due to foundation type including associated seabed preparation, predicted scour, scour protection and altered sedimentary processes;* • *Environmental appraisal of array and cable routes and installation methods;* • *Habitat disturbance from construction vessels' extendible legs and anchors;* • *Increased suspended sediment loads during construction; and* • *Predicted rates at which the subtidal zone might recover from temporary effects."*	Changes to the subtidal environment (including elevations in SSC) are described in **Section 6.9 paragraphs 6.9.1** to **6.9.33**. Where possible, the assessment includes estimates of the rates which the subtidal zone might recover from temporary effects. The impact of Rampion 2 on identified coastal processes receptors is considered for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and **Section 6.11** for the decommissioning phase. **Section 6.12** assesses the potential cumulative effects. The potential for habitat loss/change is discussed within **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9).
(Paragraph 2.6.190 of NPS EN-3). "*Assessment should be undertaken for all*	The impact of Rampion 2 on identified coastal processes receptors is considered

Policy description	Relevance to assessment
stages of the lifespan of the proposed wind farm in accordance with the appropriate policy for offshore wind farm EIAs"	for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and **Section 6.11** for the decommissioning phase. **Section 6.12** assesses the potential cumulative effects.
(Paragraph 2.6.191 and 2.6.192 of NPS EN-3). "*The Applicant should consult the Environment Agency, Marine Management Organisation (MMO) and Centre for Environment, Fisheries and Aquaculture Science (Cefas) on methods for assessment of impacts on physical processes*"	Consultation on approach to assessment for coastal processes has been carried out with the Environment Agency, MMO, Natural England and Cefas. Details of the issues raised and responses to consultation are provided in **Table 6-5.**
(Paragraph 2.6.193 of NPS EN-3). "*Geotechnical investigations should form part of the assessment as this will enable the design of appropriate construction techniques to minimise any adverse effects*"	Geotechnical data has informed the assessment and Proposed Development design of Rampion 2. Details are provided in **Table 6-10**.
(Paragraph 2.6.194 of NPS EN-3). "*The assessment should include predictions of the physical effect that will result from the construction and operation of the required infrastructure and include effects such as the scouring that may result from the proposed development.*"	The assessment of the effects that will result from the construction and operation are assessed in **Section 6.9** and **Section 6.10**. More detailed supporting assessments are provided in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3). A scour assessment is presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3), Section 6. Results are summarised in **Section 6.10 paragraphs 6.10.38** to **6.10.44.**
(Paragraph 2.6.197 of NPS EN-3). "*Mitigation measures which the Secretary of State should expect the applicants to have considered include the burying of cables to a necessary depth and using scour protection techniques around offshore structures to prevent scour effects around them. Applicants should consult the*	The embedded environmental measures relating to cable burial and scour are set out in **Chapter 3: Alternatives, Volume 2** (Document Reference: 6.2.3) and in **Table 6-12** of this chapter. Details of consultation with statutory consultees is provided in **Section 6.3** of this chapter, and embedded environmental measures were provided

Policy description	Relevance to assessment
statutory consultees on appropriate mitigation."	previously in the Rampion 2 formal consultation period.

6.2.4 **Table 6-2** lists the emerging national planning policy considerations relevant to the assessment of the effects on coastal processes receptors.

Table 6-2 Emerging national planning policy relevant to coastal processes

Policy description	Relevance to assessment
Draft Overarching National Policy Statement for Energy (EN-1), March 2023.	
Section 4.9 of NPS EN-1 refers to adaptation to climate change. (Paragraph 4.9.13 of NPS EN-1). "*The Secretary of State should be satisfied that applicants for new energy infrastructure have taken into account the potential impacts of climate change using the latest UK Climate Projections and associated research and expert guidance (such as the EA's Climate Change Allowances for Flood Risk Assessments or the Welsh Government's Climate change allowances and flood consequence assessments) available at the time the ES was prepared to ensure they have identified appropriate mitigation or adaptation measures. This should cover the estimated lifetime of the new infrastructure, including any decommissioning period.*"	The future baseline has taken climate change into account using UKCP18 scenarios. Likely future baseline environment changes are described in **Section 6.6 paragraph 6.6.9.**
(Paragraph 4.9.10 of NPS EN-1). "*Applicants should assess the impacts on and from their proposed energy project across a range of climate change scenarios, in line with appropriate expert advice and guidance available at the time. Applicants should be able to demonstrate that proposals have a high level of climate resilience built-in from the outset.*"	The future baseline has taken climate change into account using UKCP18 scenarios. Likely future baseline environment changes are described in **Section 6.6 paragraph 6.6.9.**
Section 5.6 of NPS EN-1 refers to coastal change. (Paragraph 5.6.8 of NPS EN-1*)* "*This section only applies to onshore energy infrastructure projects situated on*	(See below for EN3).

Policy description	Relevance to assessment
the coast. The impacts of offshore renewable energy projects on marine life and coastal geomorphology are considered in EN-3.”	
Draft National Policy Statement for Renewable Energy Infrastructure (EN-3), September 2023. Section 2.25 outlines the considerations and requirements for the physical environment.	
(Paragraph 2.3.5 of NPS EN-3). “*Offshore wind farms will not be affected by flooding, but applicants should set out how the proposal would be resilient to storms.*”	The engineering design of the project will take account of climate change with respect to physical resilience to climate change. Likely future baseline environment changes are described in **Section 6.6 paragraph 6.6.9**.
(Paragraph 2.3.6 of NPS EN-3). “*Reiterates Section 4.9 of EN-1 advises that the resilience of the project to climate change should be assessed in the Environmental Statement (ES) accompanying an application*”	The engineering design of the project will take account of climate change with respect to physical resilience to climate change. Likely future baseline environment changes are described in **Section 6.6 paragraph 6.6.9.**
(Paragraph 2.25.1 of NPS EN-3). “*Lists the following elements of the physical offshore environment which can be affected, and which can have knock-on impacts on biodiversity receptors: water quality; waves and tides; scour effect; sediment transport; suspended solids.*” (Paragraph 2.25.2 of NPS EN-3). “*The assessment should include predictions of the physical effect that will result from the construction and operation of the required infrastructure and include effects such as the scouring that may result from the proposed development and how that might impact sensitive species and habitats.*”	All physical elements listed have been included in this ES along with the assessment of the effect resulting from the construction and operation of the Proposed Development in **Sections 6.9** to **6.10**, including potential impacts on: • water quality; • waves • tides • scour effect • sediment transport • suspended solids
(Paragraph 2.25.3 of NPS EN-3). “*Geotechnical investigations should form part of the assessment as this will enable design of appropriate construction techniques to minimise any adverse effects.*”	The design of the Proposed Development has been an iterative process that has sought to minimise significant adverse effects wherever possible. Investigation of the effects on the mobile bed including sediment transport is

Policy description	Relevance to assessment
	provided in **Section 6.10. Section 6.9** assesses the effects of the release of seabed material into the water column. Further assessment is provided in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3). These assessments are supported by sediment sampling, geophysical and geotechnical site surveys. Assessment of the effects on substrata is assessed in **Chapter 24: Ground conditions, Volume 2** of the ES (Document Reference: 6.2.24).
(Paragraph 2.25.4 of NPS EN-3). *“Applicants should have considered the best ecological outcomes in terms of potential mitigation. These might include the burying of cables to a necessary depth, using scour protection techniques around offshore structures to prevent scour effects or designing turbines to withstand scour, so scour protection is not required or is minimised.”*	The embedded environmental measures relating to cable burial and scour are set out in **Chapter 3: Alternatives, Volume 2** of the ES (Document Reference: 6.2.3) and in **Table 6-12** of this chapter.
(Paragraph 2.25.4 of NPS EN-3). “*Applicants should consult the statutory consultees on appropriate mitigation and monitoring.*”	Statutory consultees have been consulted at EIA Scoping and PIER stage. Further engagement has been undertaken via the Evidence Plan Process (EPP) Coastal Processes, Water Quality, Benthic Ecology and Fish Ecology Expert Topic Group (ETG) as detailed in **Paragraph 6.3.4**.

Local planning policy

6.2.5 **Table 6-3** lists the local planning policy relevant to the assessment of the potential effects on coastal processes receptors.

Table 6-3 Local planning policy relevant to coastal processes

Policy description	Relevance to assessment
South Inshore and South Offshore Marine Plan (July 2018)	

Policy description	Relevance to assessment
(Policy S-CAB-1) "*Preference should be given to proposals for cable installation where the method of installation is burial. Where burial is not achievable, decisions should take account of protection measures for the cable that may be proposed by the applicant. Where burial or protection measures are not appropriate, proposals should state the case for proceeding without those measures.* "	Cables will be buried where possible and cable protection will be applied as and where appropriate according to the Cable Specification and Installation Plan (C-45). Indicative design options for cable burial and protection are set out in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.4)
(Policy S-CAB-2) "*Proposals that have a significant adverse impact on new and existing landfall sites for subsea cables (telecoms, power and interconnectors) should demonstrate that they will, in order of preference: a) avoid, b) minimise, c) mitigate significant adverse impacts, d) if it is not possible to mitigate significant adverse impacts, proposals should state the case for proceeding.*"	Indicative design options for the various elements of the Proposed Development are covered in **Chapter 3: Alternatives** and **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.3 and 6.2.4 respectively). Embedded mitigation measures for the project are listed in **Table 6-12.**
(Policy S-CC-2) "*Proposals should demonstrate for the lifetime of the proposal that: 1) they are resilient to the effects of climate change 2) they will not have a significant adverse impact upon climate change adaptation measures elsewhere. In respect of 2) proposals should demonstrate that they will, in order of preference:* *a) avoid, b) minimise, c) mitigate the significant adverse impacts upon these climate change adaptation measures.*"	Indicative design options for cable landfall are set out in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.4). Baseline conditions are described in detail within **Appendix 6.1: Coastal processes technical report: Baseline description, Volume 4** of the ES (Document Reference: 6.4.6.1) and include for the potential effects of climate change. The future baseline has taken climate change into account using UKCP18 scenarios. Likely future baseline environment changes are described in **Section 6.6 paragraph 6.6.9**. Embedded mitigation measures for the project are listed in **Table 6-12**.
(Policy S-CC-3) "*Proposals in the south marine plan area and adjacent marine plan areas that are likely to have a significant adverse impact*	Potential impacts on the coastline in the south marine plan area are described for the construction phase in **Section 6.9**, **Section 6.10** for the O&M phase and

Policy description	Relevance to assessment
on coastal change should not be supported."	**Section 6.11** for the decommissioning phase. **Section 6.12** assesses the potential cumulative effects.
Policy (S-WQ-1) "*Proposals that may have significant adverse impacts upon water environment, including upon habitats and species that can be of benefit to water quality must demonstrate that they will, in order of preference: a) avoid, b) minimise, c) mitigate significant adverse impacts.*"	Changes in SSC are assessed in **Section 6.9 paragraphs 6.9.1** to **6.9.33** for the construction phase and **Section 6.11 paragraphs 6.11.1** to **6.11.8** for the decommissioning phase. Embedded mitigation measures for the project are listed in **Table 6-12.** Potential impacts on the water environment are discussed in **Chapter 26: Water environment, Volume 2** of the ES (Document Reference: 6.2.26).
Arun Local Plan 2011-2031 (Adopted July 2018)	
Section 18.5.8 highlights the importance of vegetated shingle habitat and that "*new development should take into consideration impacts on vegetated shingle to ensure that it does not exacerbate the situation [of 'coastal squeeze' caused by urban development on the landward side and rising sea levels on the seaward side].*" (Policy W DM4). In particular "*proposals for development in coastal locations, including for example, sea defence works, will be permitted providing they protect and enhance coastal habitats such as vegetated shingle. Where habitats are lost through the provision of sea defence works, replacement habitats must be provided in a suitable location*".	Potential pathways of impact on vegetated shingle habitats are described in **Section 6.9 paragraphs 6.9.46** to **6.9.75** (for the construction phase), **Section 6.10 paragraphs 6.10.21** to **6.10.37** (for the operation phase), and **Section 6.11 paragraphs 6.11.9** to **6.11.16** (for the decommissioning phase). Potential impacts on vegetated shingle habitats are discussed in **Chapter 22: Terrestrial ecology and nature conservation, Volume 2** of the ES (Document Reference: 6.2.22).

Other relevant information and guidance

6.2.6 A summary of other relevant information and guidance relevant to the assessment undertaken for coastal processes is provided here along with knowledge gained from Rampion 1:

- National flood and coastal erosion risk management strategy for England (Environment Agency, 2021);
- Environmental impact assessment for offshore renewable energy projects. (BSI, 2015);

- Review of environmental data associated with post-consent monitoring of licence conditions of offshore wind farms.' MMO Project No: 1031. (Fugro-Emu, 2014);
- General advice on assessing potential impacts of and mitigation for human activities on Marine Conservation Zone (MCZ) features, using existing regulation and legislation (JNCC and Natural England, 2011);
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects. (Cefas, 2011);
- Coastal Process Modelling for Offshore Wind farm Environmental Impact Assessment: Best Practice Guide. ABPmer and HR Wallingford for COWRIE, 2009, [http://www.offshorewindfarms.co.uk];
- Advice Note Nine: Using the Rochdale Envelope' (The Planning Inspectorate, 2012);
- Guidelines in the use of metocean data through the lifecycle of a marine renewables development' (ABPmer et al., 2008);
- Review of Cabling Techniques and Environmental Effects applicable to the Offshore Wind farm Industry. Department for Business Enterprise and Regulatory Reform in association with Defra. (BERR, 2008); and
- Potential effects of offshore wind developments on coastal processes. (ABPmer and METOC, 2002).

6.3 Consultation and engagement

Overview

6.3.1 This section describes the stakeholder engagement undertaken for Rampion 2. This consists of early engagement, the outcome of, and response to, the Scoping Opinion in relation to the coastal processes assessment, the Evidence Plan Process (EPP), informal consultation and Rampion 2's statutory consultation (hereafter referred to as the 'formal consultation'). An overview of engagement undertaken for Rampion 2 as a whole can be found in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference: 6.2.5) and the **Consultation Report** (Document Reference: 5.1).

6.3.2 Given the social distancing restrictions which have been in place due to the COVID-19 pandemic, all technical consultation relating to coastal processes has taken place online, primarily in the form of conference calls using Microsoft Teams.

Scoping Opinion

6.3.3 Rampion Extension Development Limited (RED) submitted a Scoping Report (RED, 2020) and request for a Scoping Opinion to the Secretary of State (administered by the Planning Inspectorate (PINS)) on 2 July 2020. A Scoping Opinion was received on 11 August 2020. The Scoping Report sets out the proposed coastal processes assessment methodologies, outline of the baseline data collected to date and proposed, and the scope of the assessment. **Table 6-4** sets out the comments received in Section 4 of the PINS Scoping Opinion 'Aspect based scoping tables – Offshore' and how these have been addressed in this ES. A full list of the PINS Scoping Opinion comments and responses is provided in **Appendix 5.2: Response to the Scoping Opinion, Volume 4** of the ES (Document Reference: 6.4.5.2). Regard has also been given to other stakeholder comments that were received in relation to the Scoping Report.

Table 6-4 PINS Scoping Opinion responses – coastal processes

PINS ID number	Scoping Opinion comment	How this is addressed in this ES
4.1.2	The Scoping Report states that the potential impact of the design of the Proposed Development will be assessed "*both alone and in conjunction with the built design of the existing Rampion project".* It is unclear why the Proposed Development would be assessed alone given that Rampion 1 is now entirely completed. The ES should assess the impacts of the Proposed Development in the context of the relevant baseline environment.	Potential changes to waves and currents caused by maximum design scenario (MDS) foundations in Rampion 2 are assessed in **Section 6.10 paragraphs 6.10.11 to 6.10.17** against a baseline environmental condition that includes the number, type, dimensions and locations of foundations built in Rampion 1.
4.1.3	The Scoping Report states that the assessment for Rampion 1 was overly conservative and overestimated the number of structures built, yet it asserts that the results of the previous modelling remain valid and can reliably support the ES for the Proposed Development. The ES should ensure that potential changes to the wave and hydrodynamic regime are assessed against an accurately described baseline so as not to underestimate the scale and significance of effects.	Potential changes to waves caused by MDS foundations in Rampion 2 are assessed in **Section 6.10 paragraphs 6.10.11 to 6.10.19** using a new numerical model which includes Rampion 1 in the baseline. Potential changes to currents caused by MDS foundations in Rampion 2 are assessed in **Section 6.10 paragraphs 6.10.1** to **6.10.9** using a desktop assessment that uses previous conservative modelling results (based on a greater total number of larger foundations) to realistically account for the maximum likely effect of the smaller number, type, dimensions and locations of foundations subsequently built in Rampion 1.
4.1.4	The Scoping Report does not address impacts on tidal, wave and	Potential changes to waves, currents and sediment transport,

PINS ID number	Scoping Opinion comment	How this is addressed in this ES
	sediment transport regime to seabed scour during construction and decommissioning of the Proposed Development. The ES should include as assessment of the impacts associated with changes to tidal, wave and sediment transport regime and seabed scour where significant effects are likely to occur. The Applicant should make effort to agree the approach with relevant consultation bodies including Natural England and the MMO.	and scour caused by all MDS infrastructure (foundations and cable protection) in Rampion 2 during the O&M phase are assessed in **Section 6.10 paragraphs 6.10.38** to **6.10.44**. Potential changes of similar or lesser magnitude and extent caused by any less than all MDS infrastructure during the construction and decommissioning phases are separately assessed in **Section 6.9 paragraphs 6.9.76** to **6.9.80**, and in **Section 6.11 paragraphs 6.11.17** to **6.11.22**, respectively (using the same MDS as for all infrastructure present). A number of ETG meetings, described in **Section 6.3 paragraph 6.3.4 onwards,** were held to discuss and agree the approach with relevant consultation bodies including Natural England, Cefas and the MMO.
4.1.5	SSSIs along the coastline have not been listed as sensitive receptors in this regard. The ES should present a full list of designated sites that have the potential to be impacted in terms of coastal processes, including any effects on Climping Beach SSSI (in relation to changes to landfall morphology) and Beachy Head East MCZ and the Bembridge MCZ.	A full list of designated sites that have the potential to be impacted in terms of coastal processes is provided in **Table 6-6**.
4.1.6	The Scoping Report does not address the likelihood of the potential impacts to the sediment transport regime to act cumulatively with other developments and/or infrastructure (including the AQUIND interconnector). The ES should include an assessment of the cumulative impacts on the sediment	Potential cumulative changes and impacts on the sediment transport regime are assessed in **Section 6.12** including the potential AQUIND interconnector.

PINS ID number	Scoping Opinion comment	How this is addressed in this ES
	transport regime where significant effects are likely to occur.	

Evidence Plan Process (EPP)

6.3.4 The Evidence Plan Process (EPP) has been set up to provide a formal, non-legally binding, independently chaired forum to agree the scope of the EIA and Habitats regulations Assessment (HRA), and the evidence required to support the Development Consent Order (DCO) Application. The EPP commenced in January 2020 and has continued throughout the EIA helping to inform the ES.

6.3.5 For coastal processes, engagement has been undertaken via the EPP Coastal Processes, Water Quality, Benthic Ecology and Fish Ecology ETG.

6.3.6 Further information is provided in the **Evidence Plan** (Document Reference: 7.21).

Non-statutory consultation

Overview

6.3.7 Non-statutory consultation captures all consultation and engagement outside of statutory consultation (formal consultation), and has been ongoing with a number of prescribed and non-prescribed consultation bodies and local authorities in relation to coastal processes. A summary of the informal consultation undertaken since completion of the Scoping Report is outlined in this section.

Informal Consultation Exercise – January / February 2021

6.3.8 RED carried out an Informal Consultation Exercise for a period of four weeks from 14 January 2021 to 11 February 2021. This Informal Consultation Exercise aimed to engage with a range of stakeholders including the prescribed and non-prescribed consultation bodies, local authorities, Parish Councils and general public with a view to introducing the Proposed Development and seeking early feedback on the emerging designs.

6.3.9 The key themes emerging from the Informal Consultation Exercise in January 2021 relating to coastal processes are:

- Coastal morphology stability and flood risk at and around the landfall at Climping. Concerns relating to any new engineering works, in the context of the present poor state of the defences and presently undecided future management plans for this area.

6.3.10 Further detail about the results of the Informal Consultation Exercise can be found in the **Consultation Report** (Document Reference: 5.1).

Formal consultation

6.3.11 Rampion 2's first statutory consultation exercise ran from 14 July to 16 September 2021, a period of nine weeks. The PEIR (RED, 2021) was published as part of Rampion 2's first statutory consultation exercise which provided preliminary information on shipping and navigation within Chapter 13: Shipping and navigation (RED, 2021).

6.3.12 Following feedback to the Statutory Consultation exercise in 2021 it was identified that some coastal residents did not receive consultation leaflets as intended. Therefore, the first Statutory Consultation exercise was reopened between 7 February 2022 to 11 April 2022 for a further nine weeks. The original PEIR published as part of the first Statutory Consultation exercise in 2021 was unchanged and re-provided alongside the reopened Statutory Consultation exercise in early 2022.

6.3.13 The following statutory consultation exercises focussed on changes made to the onshore cable route, onshore substation, and National Grid interface point and did not consider offshore aspects of the Proposed Development.

6.3.14 The second Statutory Consultation exercise was undertaken from 18 October 2022 to 29 November 2022. This was a targeted consultation which focused on updates to the onshore cable route proposals which were being considered following feedback from consultation and further engineering and environmental works. As part of this second Statutory Consultation exercise, RED sought feedback on the potential changes to the onshore cable route proposals to inform the onshore design taken forward to DCO application.

6.3.15 The third Statutory Consultation exercise was undertaken from 24 February 2023 to 27 March 2023. This was a targeted consultation which focused on a further single onshore cable route alternative being considered following feedback from consultation and further engineering and environmental works. As part of this third Statutory Consultation exercise, RED sought feedback on the potential changes to the onshore cable route proposals to inform the onshore design taken forward to DCO Application.

6.3.16 The fourth Statutory Consultation exercise was undertaken from 28 April 2023 to 30 May 2023. This was a targeted consultation which focused on the proposed extension works to the existing National Grid Bolney substation to facilitate the connection of the Rampion 2 onshore cable route into the national grid electricity infrastructure. As part of this fourth Statutory Consultation exercise, RED sought feedback on the proposed substation extension works to inform the onshore design taken forward to the DCO Application.

6.3.17 **Table 6-5** provides a summary of the key themes of the feedback received in relation to coastal processes and outlines how the feedback has been considered in this ES chapter. A full list of all comments received during the formal consultation period and the responses to those comments is provided in the **Consultation Report** (Document Reference: 5.1).

Table 6-5 Formal Consultation feedback

Stakeholder	Theme	How this is addressed in this ES
Natural England	"*We are concerned that insufficient baseline data has been gathered to allow adequate baseline characterisation of the marine and coastal environment and processes*"	Detailed baseline information is provided as **Appendix 6.1: Coastal processes technical report: Baseline description, Volume 4** of the ES (Document Reference: 6.4.6.1).
Natural England	"*We are concerned with the applicability and relevance of the use of large sections of the Hornsea Three PEIR Volume 5 Annex 11 Marine Processes Technical Report in the Rampion 2 Physical Processes Chapter.*"	Concerns were discussed as part of the ETG meetings. It was noted that the assessment for Rampion 2 is undertaken on a site specific basis and any evidence or assessments from other developments are only used where suitably applicable.
Natural England	"*We have specific concerns regarding WCS [worst case scenario] including calculations of sandwave clearance, potential impacts of TFPs [Temporary flotation pits] in the nearshore, cable protection in the nearshore, scour impacts due to foundation installation.*"	Concerns were discussed as part of the ETG meetings. The project design envelope has been reviewed and the relevant named assessment sections of the ES were reviewed in terms of the WCS used. TFPs in the nearshore have since been removed from the design envelope.
Natural England	"*Plume modelling results are not shown schematically across the array area.*"	The assessment of plume dispersion has been completed using spreadsheet-based modelling. The assessment is detailed in **Section 2 of Appendix 6.3: Technical report: impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3) with results provided in tables showing distance from release.
Natural England	"*Evidence should be provided to show both near- and far-field effects on the tidal regime due to the development (and in-combination with Rampion 1).*"	The assessment (including potential in-combination effects with Rampion 1) has been based on fluid dynamics theory which concludes that the wake length distance is significantly less than the corresponding tidal excursion distance with effects limited both in space and magnitude. This is in line with numerical modelling for

Stakeholder	Theme	How this is addressed in this ES
		numerous other windfarms. Detail is provided in **Section 4 of Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3)
Natural England	"*The potential impact of the following aspects of the project have not been adequately assessed: Temporary Floatation Pits (TFPs) in the nearshore zone (potentially for up to 5 years)*"	Following a review of the planned installation options, TFPs in the nearshore have since been removed from the design envelope.
Natural England	"*We advise the Applicant to consider avoiding the use of Temporary Floatation Pits. For example, by extending the length of each duct from the HDD drill compound location to a pop-out location at a subtidal water depth which is sufficient to facilitate the safe operating depth of the Cable Lay Vessel.*"	Following a review of the planned installation options, TFPs in the nearshore have since been removed from the design envelope.
Natural England	"*The Applicant should also consider historical morphological change of the sandbanks in order to understood how the sandbanks might be affected by the project.*"	The primary process mechanisms driving sediment transport (affecting sandbank morphology) are waves and tides. The EIA has assessed that these pathways of effect and so the potential impacts on the (sandbank) receptor are limited (no measurable effect). As such, even more detailed baseline assessments of historic patterns of morphological change through natural processes would not influence the outcome of the assessment.
Natural England	"*Given the proximity to the Offshore Overfalls MCZ, we would wish to see the predictions and a plot of suspended sediment concentrations and the spatial extent of potential cumulative sediment plumes generated by the AQUIND interconnector cable*	The assessment of plume dispersion (including potential cumulative effects with the AQUIND interconnector cable) has been completed using spreadsheet-based modelling. The assessment is detailed in **Section 2.8** of **Appendix 6.3: Coastal**

Stakeholder	Theme	How this is addressed in this ES
	installation/maintenance activities and the Rampion 2 cable/foundation installation activities“	**processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3) with results provided in tables showing distance from release**.**
Natural England	“*Given the potential for local and short-term increases in SSCs that is predicted during the foundation preparation and cable burial operations, it is recommended that sampling of in-water suspended sediment concentrations should be undertaken during these operations.*“	The increase in SSC does not affect coastal process receptors and therefore no monitoring is required. Refer to the following chapters for potential monitoring requirements for other receptors: **Chapter 8: Fish and shellfish ecology; Chapter 9: Benthic, subtidal and intertidal ecology; Chapter 10: Commercial fisheries; Chapter 11: Marine mammals; Chapter 12: Offshore and intertidal ornithology;** and **Chapter 26: Water environment, Volume 2** of the ES (Document Reference: 6.2.8, 6.2.9, 6.2.10, 6.2.11, 6.2.12 and 6.2.26 respectively).
Natural England	“*Please can the Applicant provide a separate assessment that considers whether sandwave clearance (as well as any material disposal), could influence patterns of sediment transport, resulting in morphological change? We would also like to see an assessment of the potential adverse impact on adjacent sandbank systems due to the removal of sandwaves (or other significant bedforms).*“	Concerns were discussed as part of the ETG meetings. It was agreed that no measurable change is assessed as likely to occur to the wave climate or tidal regimes affecting the banks, and therefore, there would logically be no change to regional sediment transport patterns interacting with the banks. Sandwave levelling will only redistribute sediment locally and so is also unlikely to cause changes to relatively distant features.
Natural England	“*The potential environmental impacts on nearshore hydrodynamics and the sediment transport regime should be assessed for a WCS whereby the 16 TFPs remain in situ for up to 5 years.*“	Following a review of the planned installation options, TFPs in the nearshore have since been removed from the design envelope.

Stakeholder	Theme	How this is addressed in this ES
Natural England	"*It will be important for a full assessment of coastal variability to be undertaken under a range of coastal management and climate change scenarios…this will enable appropriate setback distances for the Transition Jointing Bays (TJBs)*"	Concerns were discussed as part of the ETG meetings. It was discussed that future management decisions by other third-parties (e.g. the Environment Agency) will control the future evolution of the coastline, incorporating but otherwise irrespective of the landfall design chosen in the present by Rampion 2. A commitment has been made (C-247 in **Table 6-12**) to undertake ground investigation at the landfall site at the post-DCO application stage. This would be carried out to inform the exact siting and detailed design of the TJB and associated apparatus. In addition, this would inform a 'coastal erosion and future beach profile estimation assessment', which in turn would inform the need for and design of any further mitigation and adaptive measures to help minimise the vulnerability of these assets from future coastal erosion and tidal flooding.
MMO	"*The PEIR should address the spatial scale and consequences of UXO and boulder clearance, as well as the potential for any sandwave clearance requirement*"	Assessment of impacts of UXO clearance will be undertaken in line with industry standard approaches as part of post consent licencing requirements when further details are known.
MMO	"*It would be valuable to provide graphic spatial representation of the data [spreadsheet model outputs] as calculated versus (perhaps) measured or other (process) modelled data to illustrate the efficacy of the method and to understand the difference in spatial representation of impact that is implied.*"	The maximum spatial extent of varying levels of impact on suspended sediment concentrations and corresponding sediment deposition for all activities is illustrated in a new **Figure 6.3.4** in **Section 2.9** of **Appendix 6.3: Coastal processes technical report: Impact assessment,**

Stakeholder	Theme	How this is addressed in this ES
MMO	"*Due to the desktop methods adopted, there is no clear spatial representation of impacts in either Section 6 or Chapter 6 appendices (other than the wave impact extents on Graphics A-6 to A-20) – impacts are resented solely as tabulated data. Where data has not been modelled in the same way (e.g., suspended sediment plume and deposition extents), a representative graphic would be of value, in order to illustrate how the spreadsheet method translates to a map view for impact assessment.*"	**Volume 4** of the ES (Document Reference: 6.4.6.3)**.**
MMO	"*Chapter 5, Section 5.7.2 identifies a need to define both a present and future baseline. The MMO notes that the latter is not clearly defined and requests that this is updated within the ES.*"	The future baseline is more clearly defined, in **Section 6.6 paragraph 6.6.9**.
MMO	"*References are made to situations which will not be permitted to arise e.g., Chapter 6 Appendix Table 2-6 and associated text suggest that sediment deposition (such as associated with drilling and dredging for WTG locations) will not be permitted to thicknesses over 4-5m thick, limited by 'drilling protocols'. However, this is not explained and questions arise such as how will this be limited and where will any other sediment go? This mitigation should be explained in more detail in the ES.*"	The distribution of deposited sediment volume can be managed during the construction period. Either through selective placement of the material in the first place, or through redistribution of sediment afterwards. These limits are presented as a realistic limitation on the maximum design scenario. As part of the construction method statement, RED will produce a foundation installation methodology, including a dredging protocol, drilling methods and disposal of drill arisings and material extracted (C-279) in **Table 6-12**.
MMO	"*The assessment of plumes and sediment suspension and deposition has largely assumed a sediment type based on sand (quartz density etc). However, the underlying bed contains both sand and area of chalk. The assessment*	Additional comment and assessment are included in the relevant sections of **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3) for the

Stakeholder	Theme	How this is addressed in this ES
	has not addressed the differences that may arise as a result of this difference in sediment type this should be updated in the ES."	possibility of some or all of sediment arisings being chalk.
Clymping Parish Council	"*Will this increase or decrease the risk of flooding from the sea at Clymping?* "	A separate Flood Risk Assessment is provided in **Appendix 26.2: Flood Risk Assessment, Volume 4** of the ES (Document Reference: 6.4.26.2)**.**
Clymping Parish Council	" *[Provide detail of] The detail of the proposed horizontal drilling works and the potential risks of this to the fragile coastline and sea defences at Clymping.*"	Horizontal drilling techniques avoid direct disturbance of the upper soil layers by design. As such, there is minimal disturbance to the fabric of the coastline and so minimal risk of affecting the naturally occurring patterns of coastline evolution.

6.4 Scope of the assessment

Overview

6.4.1 This section sets out the scope of the ES assessment for coastal processes. This scope has been developed as Rampion 2 design has evolved and responds to feedback received to-date as set out in **Section 6.3**.

Spatial scope and study area

6.4.2 The spatial scope of the coastal processes assessment is defined as the Proposed DCO Order Limits together with the Zone Of Influence (ZOI). The study area extent includes the spatial extent of the potential impact on waves at the adjacent coastline between Beachy Head and Selsey Bill. It also includes the likely extent of potential sediment plume impacts described by the tidal excursion buffer. (describing the greatest distance and direction that water carrying an impact may travel during one mean spring tide, from any part of the Proposed DCO Order Limits).

6.4.3 The resulting study area is illustrated in **Figure 6.1, Volume 3** of the ES (Document Reference: 6.3.6).

Temporal scope

6.4.4 The temporal scope of the assessment of coastal processes is the entire lifetime of Rampion 2, which therefore covers the construction, O&M (of around 30 years), and decommissioning phases as described in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.4).

Potential receptors

6.4.5 The spatial and temporal scope of the assessment enables the identification of receptors which may experience a change as a result of Rampion 2.

6.4.6 Whilst coastal processes can largely be considered as pathways, a number of features have been identified as potentially sensitive coastal processes receptors. The receptors identified that may experience likely significant effects for coastal processes are outlined in **Table 6-6** with locations shown in **Figure 6.2, Volume 3** of the ES (Document Reference: 6.3.6).

Table 6-6 Receptors requiring assessment for coastal processes

Receptor group	Receptors included within group
Nationally or internationally designated sites	The following nature conservation designations include geological and geomorphological features within the spatial scope of the EIA: • Solent and Dorset Coast SPA; • Selsey Bill and the Hounds MCZ; • Offshore Overfalls MCZ; • Kingmere MCZ; • Selsey East Beach SSSI; • Bognor Reef SSSI; • Felpham SSSI; • Climping Beach SSSI; • Brighton to Newhaven Cliffs SSSI; and • Seaford to Beachy Head SSSI.
Local coastline morphology	Coastal morphology in the landfall area at Climping
Regional coastline morphology	Coastlines between Selsey Bill and Beachy Head
Nearby offshore sandbanks	Important geomorphological features including East Bank and Outer Owers Bank
Recreational surfing wave resource	Surfing venues on coastlines between Selsey Bill and Beachy Head[1]

[1] Identified using Magicseaweed surf beach spot guide (https://magicseaweed.com/)

Potential effects

6.4.7 For the most part coastal processes are not in themselves receptors but are instead 'pathways'. However, changes to coastal processes have the potential to indirectly impact other environmental receptors (Lambkin *et al*., 2009). For instance, the creation of sediment plumes (which is considered in the coastal processes assessment) may lead to settling of material onto benthic habitats. The potential significance of this change is assessed in **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9).

6.4.8 Potential effects on coastal processes receptors that have been scoped in for assessment are summarised in **Table 6-7**.

6.4.9 All of the windfarm infrastructure' (i.e. the final total number of foundations, amount of foundation scour protection, length of cables buried and cable protection applied) will only be present at the end of the construction phase/beginning of the operational phase. The phrase 'less than all windfarm infrastructure' used in **Table 6-7, Table 6-11** and **Table 6-15** refers to the potential impacts/effects at any intermediate stage of construction, from the earliest installation of the first single item, to the penultimate installations prior to completion.

Table 6-7 Potential effects on coastal processes receptors scoped in for further assessment

Receptor	Activity or impact	Potential effect
Construction		
Water column and seabed environment.	Changes in SSC and deposition of disturbed sediments to the seabed due to drilling for foundation installation.	Potential pathway of effect for other aspects.
Water column and seabed environment.	Changes in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to installing jacket foundations.	Potential pathway of effect for other aspects.
Water column and seabed environment.	Increases in SSC and deposition of disturbed sediments to the seabed due to cable installation.	Potential pathway of effect for other aspects.

Receptor	Activity or impact	Potential effect
Water column and seabed environment.	Increases in SSC and deposition of sediment to the seabed due to HDD drilling fluid release.	Potential pathway of effect for other aspects.
Nationally or internationally designated sites Local coastal morphology at the Climping landfall.	Changes to landfall morphology due to installation of export cable at the landfall.	Morphological change.
Nationally or internationally designated sites Regional coastline morphology Nearby offshore sandbanks Recreational surfing venues	Changes to the tidal, wave, sediment transport regimes and seabed scour as a result of the presence of less than all windfarm infrastructure (see **paragraph 6.4.9**).	Morphological change. Change in the wave regime at surfing venues. Potential pathway of effect for other aspects.
Operation and maintenance		
Water column and seabed environment.	Changes to the tidal regime due to presence of windfarm infrastructure.	Potential pathway of effect for other aspects.
Recreational surfing venues	Changes to the wave regime (presence of wind farm infrastructure).	Change in the wave regime at surfing venues. Potential pathway of effect for other aspects.
Nationally or internationally designated sites Regional coastline morphology Nearby offshore sandbanks	Changes to the sediment transport regime due to presence of wind farm infrastructure.	Morphological change. Potential pathway of effect for other aspects.
Water column and seabed environment.	Seabed scour due to the presence of windfarm infrastructure.	Potential pathway of effect for other aspects.
Decommissioning		

Receptor	Activity or impact	Potential effect
Water column and seabed environment.	Changes to SSC, bed levels and sediment type due to removal of foundations.	Potential pathway of effect for other aspects.
Nationally or internationally designated sites Local coastal morphology at the Climping landfall.	Changes to landfall morphology due to removal of export cable at the landfall.	Potential pathway of effect for other aspects.
Nationally or internationally designated sites Regional coastline morphology Nearby offshore sandbanks Recreational surfing venues	Changes to the tidal, wave, sediment transport regimes and seabed scour due to removal/presence of less than all windfarm infrastructure.	Morphological change. Change in the wave regime at surfing venues. Potential pathway of effect for other aspects.

Activities or impacts scoped out of assessment

6.4.10 No matters have been scoped out of the assessment. This is due to the potential for pathway changes to coastal processes to impact on other aspect receptors and the requirement for informing those assessments as identified in **Table 6-8**.

Table 6-8 Activities or impacts scoped out of assessment

Activity or impact	Rationale for scoping out
No activities have been scoped out of the assessment.	Potential for pathway changes to impact other aspect receptors and the requirement for informing those assessments.

6.5 Methodology for baseline data gathering

Overview

6.5.1 Baseline data collection has been undertaken to obtain information over the study areas described in **Section 6.4: Scope of the assessment**. The current baseline conditions presented in **Section 6.6: Baseline conditions** sets out data currently available information from the study area/s.

Desk study

6.5.2 The data sources that have been collected and used to inform this coastal processes assessment are summarised in **Table 6-9**.

Table 6-9 Data sources used to inform the coastal processes ES assessment

Source	Date	Summary	Coverage of study area
Navigation Charts (UKHO)	Accessed March 2021	Description of bathymetry and general seabed type at a regional scale.	Full coverage of the study area.
UK Atlas of Marine Renewable Energy	Accessed March 2021	Mapped summary statistics for wind and wave climate and tidal regime (available online www.renewables-atlas.info/).	Full coverage of the study area.
ABPmer SEASTATES Wave Hindcast Database	Accessed March 2021	Hindcast database of wave height, period and direction (approximately 40 years, 1979 to near present) approximately 5km resolution (for more information see www.seastates.net/downloads/).	Full coverage of the study area.
ABPmer SEASTATES Tide and Surge Hindcast Database	Accessed March 2021	Hindcast database of water levels, current speed and direction (approximately 40 years, 1979 to near present) approximately 2km resolution (for more information see www.seastates.net/downloads/).	Full coverage of the study area.
NOAA Climate Forecast System Reanalysis (CFSR)	Accessed March 2021	Hindcast database of wind speed and direction (approximately 40 years, 1979 to near present) approximately 2km resolution (available online rda.ucar.edu/datasets/ds093.1/).	Full coverage of the study area.
Rustington Wave Buoy (Channel Coastal Observatory)	Accessed March 2021	Observations of wave height, period and direction (approximately 10 years used, January 2010 to near present) (available online www.channelcoast.org/).	Point location 4nm SSE of Littlehampton Harbour, inside the study area.
Geophysical survey of	2010 to 2011	High resolution geophysical survey of the Round 3 Zone 6	Partial coverage of

Source	Date	Summary	Coverage of study area
Zone 6 (Osiris Projects Ltd)		area, including the present extent of Rampion 1 and parts of the Rampion 2 Scoping Boundary.	the study area.
Geotechnical survey of Zone 6 (Fugro Geoconsulting Ltd)	2011	Geotechnical survey of the Round 3 Zone 6 area, including the present extent of Rampion 1 and parts of the Rampion 2 Scoping Boundary.	Partial coverage of the study area.
Metocean survey (EMU Ltd)	2011	Measurements of water levels, currents and waves at three locations (2 over a period of 3 months and 1 for 6 months) in the Round 3 Zone 6 area, including the present extent of Rampion 1 and parts of the Rampion 2 Scoping Boundary.	Partial coverage of the study area.
Benthic Survey (EMU Ltd)	2011	Benthic survey including sediment grab samples at 59 locations in the Round 3 Zone 6 area, including the present extent of Rampion 1 and parts of the Rampion 2 Scoping Boundary.	Partial coverage of the study area.
Environment Agency	2017	Regional Beach Management Plan 2017: Selsey Bill to Climping	Partial coverage of the study area.

Site surveys

6.5.3 Additional site-specific survey data sources that have been collected and used to inform the coastal processes assessment are summarised in **Table 6-10.**

Table 6-10 Site surveys undertaken

Survey type	Scope of survey	Coverage of study area
Geophysical and geotechnical survey of Rampion 2	High resolution bathymetry, side scan sonar and sub-bottom geophysical data collection.	Full coverage of the Rampion 2 Offshore Array Areas and Offshore Export Cable Corridor
Benthic survey of Rampion 2	Including collection of seabed sediment samples and	Full (discrete) coverage of the Rampion 2 Offshore

Survey type	Scope of survey	Coverage of study area
	characterisation of sediment grain size distribution	Array Areas and Offshore Export Cable Corridor

Data limitations

6.5.4 There are no data limitations relating to coastal processes that affect the robustness of the assessment of this ES.

6.6 Baseline conditions

Overview

6.6.1 The baseline physical environment within the ZOI is described in detail in **Appendix 6.1: Coastal processes technical report: Baseline description, Volume 4** of the ES (Document Reference: 6.4.6.1). This section provides a summary of that information for the current (recent historical and present day) timeframe, and for a future period including the operational lifetime of Rampion 2 (of around 30 years). The baseline conditions describe the relevant conditions and ranges of variability for aspects of the physical environment that are relevant to the assessment of potential effects in the array, export cable corridor, landfall and surrounding areas, within the wider ZOI. This characterisation of the receiving environment is presented as the baseline against which potential changes or impacts arising from the Proposed Development can be assessed.

6.6.2 The baseline description has been achieved through the combined analysis of the project specific survey data, information previously collected to inform the construction and operation of the adjacent Rampion 1, as well as data collected as part of regional coastal monitoring programmes, listed in **Section 6.5.**

6.6.3 It is noted that many of the datasets used to inform the baseline were collected all or in part during and after the construction of Rampion 1 'as built' and therefore any localised changes associated with the operation of Rampion 1 are also captured within the baseline for Rampion 2. Longer term statistics will include periods of data from before, during and after the construction of Rampion 1.

6.6.4 The conclusions of the assessment of changes to currents and waves (**Section 6.10 paragraphs 6.10.1 to 6.10.8** and **paragraphs 6.10.11 to 6.10.17**, respectively) show that Rampion 1 causes only very small absolute or relative changes to these parameters, in a limited spatial extent mainly downstream or downwind of the individual foundations. The regional baseline description in this section is therefore equally valid in the presence or absence of Rampion 1 (i.e. the periods of time pre-, during- and post-construction). A summary of key findings is set out below.

6.6.5 A technical report and ES chapter were produced for the area of the Rampion 1 array (E.ON Climate & Renewables, 2012). A review of the key data and findings from that study has been incorporated into the description of the existing baseline environment.

Current baseline

Hydrodynamic regime

6.6.6 A summary of key findings of the baseline hydrodynamic regime is as follows.

- The array and export cable corridor are situated within a macro-tidal setting, with the mean spring tidal range increasing gradually from 4m at the western boundary of the study area (around Selsey Bill), to 6.5m at the eastern boundary (around Beachy Head).
- Storm surges may cause short term modification to predicted water levels and under an extreme (1:50 year return period) storm surge, water levels at the landfall are expected to reach 3.76m below Ordnance Datum Newlyn (ODN), approximately 1m above mean high water springs.
- The tidal currents within the study area are generally energetic with peak spring current speeds between 0.75 and 1.1m/s in the offshore array areas, reducing gradually from 0.9m/s at the offshore end of the export cable corridor to 0.5m/s at the landfall. There is a general south-west to north-east reduction in current speeds and from offshore to onshore generally.
- The flood tide (to the east-northeast) is marginally stronger than the ebb tide (to the west-southwest) and this leads to a general net residual flow to the north-east, especially on spring tides.
- The wave regime in the English Channel is the outcome of locally generated wind waves and swell waves. Analysis of long-term wave records from the study area show that the most frequent wave direction is from the south-west to south-southwest, with waves occurring from this direction approximately 60 percent of the time.
- Extremes analysis of available long-term wave hindcast data shows a clear increase in wave height with distance offshore. Within the array, significant wave heights associated with a 1:2 year return period event are expected to be approximately 4.8m, whereas for the 1:10 year event this value increases to approximately 5.3m.

Morphological regime

6.6.7 A summary of key findings of the baseline morphological regime is as follows.

- Water depths across the array area vary from approximately 13m LAT (on a rocky outcrop in the north-west of the site) to 65m LAT (within a broad depression) in the south-east on the array. Sandwaves are prevalent over much of the central and eastern array area, trending north-west to south-east, with wave heights of up to 2m relative to the surrounding seabed.
- The seabed undulates across much of the export cable corridor, influenced by the underlying geology. Water depths within the export cable corridor are greatest at the southern end where they reach 28m LAT within a significant seabed depression. Megaripples are present towards the southern end of the export cable corridor with heights of 0.2m and wavelengths reaching 7m.

- The sandwaves and megaripples mapped within the array and export cable corridor have axes broadly aligned perpendicular to the direction of flow. Given known relationships between sediment availability, flow speeds and bedform development, it is expected that these bedforms are active. This has been confirmed to be the case through a comparison in the area of partial overlap between the 2020 survey of the Rampion 2 Offshore Array Areas and the earlier Rampion Zone survey (undertaken in 2010).
- The asymmetry of the sandwaves along with the easterly displacement of the features between the 2010 and 2020 bathymetric surveys points to a general easterly direction for sediment transport. This is entirely consistent with known sediment transport pathways across the wider study area.
- The Rampion 2 landfall is located at Climping. The beach frontage here consists of mixed sand and shingle sediment with a 1:7.5 slope to the sand foreshore and sediment transport in an easterly direction. A failed seawall and groynes are also present.
- The landfall at Climping is located within Shoreline Management Plan (SMP) Policy Unit 4D20 (Littlehampton to Poole Place) with the Environment Agency being responsible for coastal management along this section of coastline. The original SMP policy was for ‘Managed Realignment’ but this has now evolved to ‘Withdraw Management’ and more recently, ‘Do Minimum’. There is currently ongoing discussion regarding the most appropriate management policy for this stretch of coast.

Sedimentary regime

6.6.8 A summary of key findings of the baseline sedimentary regime is as follows:

- The seabed across the array and export cable corridor is dominated by the presence of coarse-grained sediments (sands and gravels) with outcropping bedrock in places. Holocene deposits are widespread across central and eastern areas of the Rampion 2 array area whereas in western areas hard substrate is at or close to the surface in most areas. Bedrock is found throughout the seafloor within the export cable corridor, except when cut through by palaeo-channel systems.
- Sediments across the Rampion 2 array and export cable corridor are characteristics of two very different depositional environments. The Holocene seabed sediments generally consist of sand, gravelly sand and sandy gravel and have been reworked and deposited by marine processes. The sediments associated with the palaeo-channels are also sands and gravels but have a fluvial origin, deposited in a terrestrial setting.
- The available evidence suggests that net sediment transport as bedload is directed east-northeast towards the eastern English Channel. In the offshore environment, tidal currents are the primary agent for mobilising sediment through bedload and suspended load transport. Wave action during larger storms will occasionally increase the rate of transport, but is not a primary factor in the patterns of transport in offshore areas.

- Within the array area, suspended sediment concentrations (SSC) are typically between 5 to 10mg/l. However, during stormier conditions, near bed SSC can be temporarily much higher (order of hundreds of mg/l) due to the influence of waves stirring of the seabed. Coarser sediments disturbed by waves may be transported a short distance in the direction of ambient currents or down-slope under gravity before being deposited. Finer material that persists in suspension will eventually be transported in the direction of net tidal residual flow, that is, to the east-northeast.

Future baseline

6.6.9 The baseline is expected to evolve in response to natural variation (for example, lunar nodal cycle, North Atlantic Oscillation etc), wider changes in climate expected over the lifetime of the development, and anthropogenic management of the coast. These are discussed below:

- Mean sea level in the ES Assessment Boundary is likely to rise slightly over the lifetime of the wind farm (expected around 30-year minimum operational period). This change is generally accepted to include contributions from global eustatic changes in mean sea level and as a result of regionally varying vertical (isostatic) adjustments of the land.
- Information on the rate and magnitude of anticipated relative sea level change in the English Channel during the 21st Century is available from UKCP18 (Palmer *et al*. 2018). It is predicted that by 2060, relative sea level could have risen by approximately 0.35 to 0.4m above present day (2021) levels (Representative Concentration Pathway (RCP) 8.5; 95th percentile) at the landfall with rates of change increasing over time.
- A rise in sea level would potentially allow larger waves, and therefore more wave energy, to reach the coast in certain conditions and consequently result in an increase in local rates or patterns of erosion and the equilibrium position of coastal features. Sea level rise may also result in a loss of intertidal habitat through the process of ‘coastal squeeze’ caused by the presence of coastal defences preventing natural roll back of the coast.
- UKCP18 also includes projections of changes to storm surge magnitude in the future as a result of climate change. However, it is found that UKCP18 projections of change in extreme coastal water levels are dominated by the increases in mean sea level with only a minor (less than ten percent) additional contribution due to atmospheric storminess changes over the 21st century (Palmer *et al*. 2018).
- Modification of the wave regime may also occur in response to changing patterns of atmospheric circulation, although this is associated with much uncertainty (Palmer *et al*., 2018).
- There is currently ongoing discussion regarding the most appropriate management policy for the stretch of coast at the landfall. Should the coastline no longer be defended going forward, it is reasonable to assume the morphology of the coast could change quite substantially here over the lifetime of the Proposed Development.

6.7 Basis for ES assessment

Maximum design scenario

6.7.1 Assessing using a parameter-based design envelope approach means that the assessment considers a maximum design scenario whilst allowing the flexibility to make improvements in the future in ways that cannot be predicted at the time of submission of the DCO Application. The assessment of the maximum adverse scenario for each receptor establishes the maximum potential adverse impact and as a result impacts of greater adverse significance would not arise should any other development scenario (as described in **Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.4) to that assessed within this Chapter be taken forward in the final scheme design.

6.7.2 The maximum parameters and assessment assumptions that have been identified to be relevant to coastal processes are outlined in **Table 6-11** and are in line with the Project Design Envelope (**Chapter 4: The Proposed Development, Volume 2** of the ES (Document Reference: 6.2.4)).

Table 6-11 Maximum parameters and assessment assumptions for impacts on coastal processes

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
Construction: Changes in suspended sediment concentrations (SSC) and deposition of disturbed sediments to the seabed due to drilling for foundation installation	Larger wind turbine generator (WTG) monopile maximum diameter: 13.5m Maximum number of larger WTG: 65 Maximum number of Offshore Substations (OSS): 3	Maximum % of WTG locations using drilling: 50% Maximum number of larger WTG foundations requiring drilling: 50% of 65 = 33. Assumed representative drilling rate: 5m/hr Maximum volume of sediment released per WTG foundation: 8,588m^3 (based on larger WTGs; drilling to 60m with drill diameter of 13.5m) Maximum volume of sediment released in the array from WTG foundations: 283,415m^3 (based on array comprising 33 x larger WTGs; drilling to 60m with drill diameter of 13.5m) Maximum volume of sediment released per OSS foundation: 11,451m^3 (based on 12 pin piles; drilling to 60m with drill diameter of 4.5m) Maximum volume of sediment released from all OSS foundations: 34,353m^3 (based on total 36 pin piles; drilling to 60m with drill diameter of 4.5m)	MDS represents the greatest likely local and total volume, and local rate of sediment disturbed by drilling and released into suspension in the water column. Other details and justification for the MDS is set out in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

[1] Derivative values (e.g. area, volume, mass, etc) are calculated with full precision from the basic design dimensions, but are presented as rounded values in this table for both Maximum parameters, and Maximum assessment assumptions.

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
Construction: Changes in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to installing multileg foundations	**Seabed preparation** Maximum number of smaller WTG foundations: 90 Maximum number of Offshore Substation (OSS): 3	**Seabed preparation** Maximum number of smaller WTG foundations requiring seabed preparation: 90 Maximum smaller WTG jacket dimensions at the seabed 30 x 30m. Dredging to 15m beyond the footprint of the jacket, i.e. 60 x 60m = 3,600m^2 Total dredge/ disposal volume of 324,000m^3 (for all smaller WTG foundation bed preparation; 1m seabed preparation; seabed preparation area of 60 x 60m; 90 WTGs) Maximum number of OSS foundations requiring seabed preparation: 3 Total dredge/ disposal volume of 19,500m^3 (for OSS foundation bed preparation; 1m seabed preparation; seabed preparation area of 100 x 60m). **Dredge spoil disposal** Disposal technique: carried out using a representative Trailing Suction Hopper Dredger (THSD) (11,000m^3 hopper capacity with split bottom for spoil disposal). Multiple dredgers to be working simultaneously. Disposal location: ‘close’ to the installation works. Maximum volume of sediment released in the array from WTG and OSS foundations:	MDS represents the greatest likely local and total volume, and local rate of sediment disturbed by dredging (and associated spoil disposal) and released into suspension in the water column. Other details and justification for the MDS is set out in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
		343,500m^3 (foundation details as above for seabed preparation).	
Construction: Increases in SSC and deposition of disturbed sediments to the seabed due to cable installation	**Pre-lay trenching** Total length of all export cables: 170km in the offshore array areas and offshore cable corridor; including: Total length of all interconnector cables : 40km in the offshore array areas Total length of all inter-array cables : 250km in offshore array area	**Pre-lay trenching** 4 export cables x 19km in offshore cable corridor, plus interconnectors in the offshore array area, plus contingency. 2 interconnector cables in offshore array area Trench with a 'U' shaped profile. Trench up to 2m wide. 1.5 m deep in the export cable corridor. 1.0m deep in the offshore array area. Maximum rate of cable burial: 300m /hr Burial technique: Jetting or Mass Flow Excavator (MFE)	MDS represents the greatest likely local and total volume, and local rate of sediment disturbed by cable installation and released into suspension in the water column. Jetting and mass flow excavators are considered to have the greatest (similar) potential to cause energetic resuspension of sediment at the seabed, at a rate described by the trench dimensions and rate of cable burial. Other details and justification for the MDS is set out in **Appendix 6.3: Coastal processes technical report: Impact**

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
			assessment, Volume 4 of the ES (Document Reference: 6.4.6.3).
Construction: Increases in SSC and deposition of sediment to the seabed due to HDD drilling fluid release	**HDD drilling fluid release** Maximum number of cables and bores: 4	**HDD drilling fluid release** Punch-out location for HDD: below MHWS Maximum conduit dimensions: 0.63m diameter; 1000m length, 312m^3 volume Drilling fluid concentration: 80kg/m^3 bentonite in water, approximate SSC 80,000mg/L Maximum volume and mass of drilling fluid released per HDD conduit: 312m^3 fluid (24,960kg bentonite) Maximum volume and mass of drilling fluid released for all four HDD conduits: 1,248m^3 fluid (99,840kg bentonite)	MDS represents the maximum volume of drilling fluid released that has been conservatively estimated as the total volume of the installed conduit. In practice, only a smaller proportion of the total volume might be expelled or lost from the conduit following breakout.
Construction: Changes to landfall morphology due to installation of export cable at the landfall	Maximum number of cables: 4	**Trenching in mainly nearshore subtidal areas, possibly into the lower intertidal area** Burial technique: plough and or manual excavation Trench with a 'U' shaped profile. Trench depth: 1.5m Trench width at base: 2m **Drilling and associated works** Horizontal Directional Drilling (HDD) or alternative trenching techniques	MDS represents the construction activities that give rise to the greatest (direct) disturbance to the beach and provide the greatest potential to interact with coastal processes responsible for maintaining the

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
		Punch-out location for HDD: below MHWS Four HDD exit pits; 30 m long x 4 m wide x (up to) 1.5 m deep Duration trenches and exit pits may remain open: up to four months	baseline form and function of the beach.
Construction: Changes to the tidal, wave, sediment transport regimes and seabed scour as a result of the presence of less than all windfarm infrastructure	MDS for Rampion 2 operation phase (as defined below)	MDS for Rampion 2 operation phase (as defined below)	The MDS for any partial proportion of the total amount of infrastructure, is the same as the total amount present in the operation phase.
Operation and Maintenance: Changes to the tidal regime due to presence of windfarm infrastructure **Operation and Maintenance: Changes to the wave regime**	**Foundations** Up to four legs with suction buckets per larger WTG jacket foundation. Suction bucket up to 15m diameter. **Cable protection** Total length of cables which may potentially require seabed protection: 20% of route.	**Foundations** Array comprising the smaller number (65) of larger type WTGs (jacket foundations, four legs, up to 5m diameter; with suction buckets, 15m diameter, up to 10m high) and three OSSs (jacket foundations, six legs, up to 5m diameter; with pin piles). Scour protection up to 3m high at the foundation, extending to 15m beyond the footprint of the foundation. Minimum foundation spacing of 1,130m (centre to centre for larger type WTGs).	Combination of foundation type, dimensions and number that present the greatest total blockage width to currents and waves. Cable protection type, dimensions and length presenting the greatest total blockage to currents, waves and

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
(presence of wind farm infrastructure) **Operation and Maintenance: Seabed scour due to the presence of windfarm infrastructure**		Project operational lifespan: around 30 years (but noting some blockage (of waves, tides and sediment transport) will also occur during the construction and decommissioning period, each lasting up to three years) **Cable protection** Options include rock placement, concrete mattresses, flow energy dissipation devices, protective aprons and bagged solutions. Sloped profile above seabed level: 5m overall width and 1m height Up to four array cable crossings (four individual cables crossing the AQUIND Interconnector in the western array area of the Proposed DCO Order Limits). Each crossing 50x50m overall width/length and 1m height.	sediment transport. The worst case effect for the different types of protection is mainly considered in relation to the overall dimensions of the structure; a worst case surface shape and texture, resulting in maximum blockage to flow and sediments within the dimensions of the structure, is also considered. Longest duration of presence in operational service.
Decommissioning: Changes to SSC, bed levels and sediment type due to removal of foundations	MDS for Rampion 2 construction phase (as previously defined)	MDS for Rampion 2 construction phase (as previously defined)	Activities associated with the removal of infrastructure during decommissioning will be similar to, or cause less disturbance than, those used during construction.
Decommissioning: Changes to	MDS for Rampion 2 construction phase (as previously defined)	MDS for Rampion 2 construction phase (as previously defined)	Activities associated with the removal of

Project phase and activity/impact	Maximum parameters[1]	Maximum assessment assumptions	Justification
landfall morphology due to removal of export cable at the landfall			infrastructure during decommissioning will be similar to, or cause less disturbance than, those used during construction.
Decommissioning: Changes to the tidal, wave, sediment transport regimes and seabed scour due to removal/presence of less than all windfarm infrastructure	MDS for Rampion 2 operation phase (as previously defined)	MDS for Rampion 2 construction phase (as previously defined)	The changes or effects associated with the removal, or the ongoing presence of some or all infrastructure during and after decommissioning will be no more than the changes caused by all infrastructure during the operation phase, relative to the baseline condition.

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Embedded environmental measures

6.7.3 As part of the Rampion 2 design process, a number of embedded environmental measures have been adopted to reduce the potential for impacts on coastal processes. These embedded environmental measures have evolved over the development process as the EIA has progressed and in response to consultation.

6.7.4 These measures also include those that have been identified as good or standard practice and include actions that would be undertaken to meet existing legislation requirements. As there is a commitment to implementing these embedded environmental measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of Rampion 2 and are set out in this ES.

6.7.5 **Table 6-12** sets out the relevant embedded environmental measures within the design and how these affect the coastal processes assessment.

Table 6-12 Relevant coastal processes embedded environmental measures

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
C-38	The selection of the foundation type will primarily be based upon the site conditions combined with the wind turbine generator (WTG) that is selected. The following foundation types are being considered: Monopile and Multi-leg.	Scoping	DCO requirements or DML conditions	Limits or affects the MDS blockage to waves and currents.
C-39	To maintain suitable operational conditions for the combined foundation and wind turbine generator (WTG) structure, scour protection	Scoping	DCO requirements or DML conditions.	Limits or affects the MDS blockage to nearbed currents and sediment transport.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
	(typically consisting of rock aggregate or stone/concrete mattresses) may need to be installed. The method of scour protection will generally be to use rock armour or other large size aggregate placed around the periphery of the foundation at the seabed. However, other methods of scour protection may also be used.			
C-40	There will be up to three offshore substations installed to serve the Proposed Development. The exact locations, design and visual appearance will be subject to a structural study and electrical design, which is expected to be completed post consent. The offshore substations will be installed on multi-leg or monopile foundations, similar to those described for the wind turbine	Scoping	DCO requirements or DML conditions.	Limits or affects the MDS blockage to waves and currents.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
	generators (WTGs) themselves.			
C-41	The subsea interarray cables will typically be buried at a target burial depth of 1m below the seabed surface. The final depth of the cables will be dependent on the seabed geological conditions and the risks to the cable (e.g. from anchor drag damage).	Scoping	DCO requirements or DML conditions.	Informs the MDS trench dimensions (depth) in relation to assessments of sediment disturbance.
C-42	The subsea inter-array cables and the subsea export cables will be installed using one or a combination of the three methods: ploughing, trenching or jetting. It is likely that a combination of these methods will be adopted for localised areas depending on seabed conditions. The installation methods will be selected during detailed design and tendering phases and consideration will be given to the method that	Scoping, updated for Examination.	DCO requirements or DML conditions.	Informs the nature and rate of MDS sediment disturbance.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
	minimises the environmental impacts as far as practicable.			
C-43	The subsea export cable ducts will be drilled underneath the beach using horizontal directional drilling (HDD) techniques.	Scoping	DCO requirements or DML conditions.	Informs the nature and rate of MDS sediment disturbance.
C-44	An **Outline Scour Protection and Cable Protection Plan** (Document Reference: 7.12) has been submitted with this application, and includes details of the need, type, quantity and installation methods for scour protection. A Final Scour Protection and Cable Protection Plan will be completed prior to construction commencing and submitted to the Marine Management Organisation (MMO) for approval.	Scoping	DCO requirements or DML conditions.	Limits or affects the MDS blockage to nearbed currents and sediment transport.
C-45	Where possible, subsea cable burial will be the preferred option for cable protection.	Scoping	DCO requirements or DML conditions.	Limits or affects the MDS blockage to nearbed currents and sediment transport.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
	Cable burial will be informed by the cable burial risk assessment and detailed within the Cable Specification and Installation Plan.			
C-247	RED will undertake ground investigation at the landfall site at the post-DCO application stage. This would be carried out to inform the exact siting and detailed design of the Transition Joint Bay and associated apparatus. In addition, this would inform a 'coastal erosion and future beach profile estimation assessment', which in turn would inform the need for and design of any further mitigation and adaptive measures to help minimise the vulnerability of these assets from future coastal erosion and tidal flooding.	ES	DCO requirements or DML conditions.	Addresses some present uncertainty around the future baseline of the landfall area, informing assessments of potential impacts at the landfall.

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
C278	Trenchless crossings of Climping Beach SSSI, Sullington Hill LWS, Atherington Beach and Littlehampton Golf Course LWS would be designed to ensure a minimum depth of 5m is maintained when passing beneath them to reduce the risk of drilling fluid breaking out to the surface and avoid archaeological remains of high heritage significance at Climping Beach (identified currently or during pre-commencement investigations).	ES updated for Examination	DCO requirements or DML conditions.	Provides an initial minimum burial depth under the coast at the landfall, prior to a final design informed by further geotechnical investigation. Addresses some present concerns of Natural England around the potential for impacts in the landfall area.
C-279	As part of the construction method statement, RED will produce a foundation installation methodology, including a dredging protocol, drilling methods and disposal of drill arisings and material extracted.	ES	DCO requirements or DML conditions.	Will provide information on the dredging and drilling methodologies and methods of disposal of drill arisings and material extracted.
C-283	Gravel bags laid on the seabed to protect the cable	Examination	DCO requirements or DML conditions.	Limits or affects the MDS blockage to

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
	barge during construction of Rampion 2, will be removed prior to the completion of construction, where practicable.			nearbed currents and sediment transport.
C-288	The Applicant is committed to minimising the release of plastics into the marine environment, and commits to using suitable alternatives, where this is practicable.	Examination	DCO requirements or DML conditions.	Affects the materials used for scour protection (but not the MDS dimensions).
C-289	The Applicant will use secondary protection material, where practicable, that has the greatest potential for removal on decommissioning of the Proposed Development.	Examination	DCO requirements or DML conditions.	Consistent with the MDS for decommissioning
C-298	Where appropriate, the results of post-consent monitoring, data and reports will be made publicly available and provided to the relevant data repositories.	Examination	DCO requirements or DML conditions.	Provides a future basis to validate the results of the MDS impact assessments in this ES. Also provides additional evidence for use in future EIAs for other OWFs.
C-300	Cable protection will be used that minimises the	Examination	DCO requirements or DML conditions.	Affects the materials used for cable protection (but not

ID	Environmental measure proposed	Project phase measure introduced	How the environmental measures will be secured	Relevance to coastal processes assessment
	environmental impacts as far as practicable. At the point of selecting a cable protection supplier, consideration will be given to using the method of cable protection which is likely to be removable at decommissioning.			the MDS dimensions).
C-305	Excavated chalk will be used to infill cable trenches produced by mechanical cutters, where practicable.	Examination	DCO requirements or DML conditions.	Would locally reduce the potential for smothering and leave a smaller change to seabed level (the MDS trench dimensions and assumptions around dispersion of spoil are maintained to cover all locations where not practicable).

6.7.6 Further detail on the environmental measures in **Table 6-12** is provided in the **Commitments Register** (Document Reference: 7.22) which sets out how and where particular environmental measures will be implemented and secured.

6.8 Methodology for ES assessment

Introduction

6.8.1 The project-wide generic approach to assessment is set out in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference: 6.2.5). Aspect specific definitions are set out below.

6.8.2 The impact magnitudes are defined as follows:

- High: Permanent changes across the near- and large parts of the far-field to key characteristics or features of the particular environmental aspect's character or distinctiveness.
- Medium: Permanent changes, over the near- and parts of the far-field, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
- Low: Noticeable, temporary (for part of the Proposed Development duration) change, or barely discernible change for any length of time, restricted to the near-field and immediately adjacent far-field areas, to key characteristics or features of the particular environmental aspect's character or distinctiveness.
- Very Low: Changes which are not discernible from background conditions.

6.8.3 The sensitivity of coastal processes receptors is defined as follows.

- High: Very low or no capacity to accommodate the proposed form of change; and/or receptor designated and/ or of international level importance. Likely to be rare with minimal potential for substitution. May also be of very high socioeconomic importance.
- Medium: Moderate to low capacity to accommodate the proposed form of change; and/or receptor designated and/ or of regional level importance. Likely to be relatively rare. May also be of moderate socioeconomic importance.
- Low: Moderate to high capacity to accommodate the proposed form of change; and/or receptor not designated but of district level importance.
- Very low: High capacity to accommodate the proposed form of change; and/ or receptor not designated and only of local level importance.

6.8.4 A distinction is made throughout the assessment between the magnitude, extent and duration of 'impacts' and the resulting significance of the 'effects' upon coastal processes receptors.

6.8.5 It is important to note that where the impact is considered to be a coastal process pathway without any associated receptors, this chapter of the ES does not consider the resulting significance of effects. These are considered in other aspect chapters.

Assessment of change

6.8.6 In order to assess the potential change on coastal processes relative to the existing (baseline) coastal environment, a combination of analytical methods have been used. The assessment methodology has been updated since the Scoping Report (RED, 2020) to address the comments received in the Scoping Opinion (PINS, 2020) and as part of the Evidence Plan process.

6.8.7 These methods can be summarised as follows and subsequently described in relation to the impact pathways:

- the methods used (e.g. numerical modelling) and results created as part of the Rampion 1 EIA and consenting requirements;

- the 'evidence base' containing monitoring data collected during the construction and operation and maintenance of other offshore wind farm developments, especially Rampion 1;
- standard empirical equations describing (for example) the potential for scour development around structures (for example, Whitehouse, 1998);
- analytical assessments of Project-specific data; and
- project specific numerical wave modelling.

6.8.8 The assessment has been undertaken in accordance with industry best practice and guidance, as previously described (**Section 6.2 paragraph 6.2.6**). Full details of the methodological approach to the assessment of sediment disturbance related effects and scour are set out in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

6.8.9 The assessment also considers likely naturally occurring variability in, or long-term changes to, physical processes within the Proposed Development lifetime due to natural cycles and/or climate change (for example, sea level rise). This is important as it enables a reference baseline level to be established against which the potentially modified physical processes can be compared, throughout the Proposed Development lifecycle. Baseline conditions are described in detail within **Appendix 6.1: Coastal processes technical report: Baseline description, Volume 4** of the ES (Document Reference: 6.4.6.1) and include for the potential effects of climate change.

6.8.10 The assessment of impacts has been considered over two spatial scales. These are:

- Far-field. Defined as the area surrounding the Rampion 2 array and offshore export cable corridor over which indirect changes may occur (namely the study area).
- Near-field. Defined as the footprint of the Rampion 2 array and export cable corridor.

6.8.11 The full assessment of the magnitude of impact, taking account embedded environmental measures outlined in **Table 6-12** is documented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3). A summary of the results of the assessments are provided in this Chapter of the ES. Sensitivity and significance of residual effect assessment is completed for coastal processes receptors only.

Assessment of potential changes to suspended sediment concentration and seabed deposition

6.8.12 Potential increases in SSC are associated with construction activities such as the installation of foundations and cable burial and associated seabed preparation. For these relatively common marine activities, the potential extent, duration and concentration of suspended sediment plumes is assessed using a combination of the available evidence base, and project specific spreadsheet based numerical models. The change is assessed in terms of the difference caused, relative the normal range of natural occurrence and variability.

6.8.13 Potential sediment deposition is associated with the settlement of sediment disturbed by installation activities. The potential extent and thickness of sediment deposition is assessed using a combination of the available evidence base, and project specific spreadsheet based numerical models. The change is assessed in terms of the difference caused, relative to the normal range of natural occurrence and variability.

Assessment of potential changes to coastal morphology at the landfall

6.8.14 Potential changes to coastal morphology at the landfall are associated with the process used to transition the export cables from the offshore to the onshore environment. The proposed method for cable landfall is to bury the cables beneath the beach using HDD techniques. By avoiding any direct disturbance to the coastline surface structure or morphology, and due to the absence of any infrastructure at or near the surface, this method means that, unless the cable becomes exposed (during natural sediment transport processes), there is unlikely to be interaction with or therefore impact upon coastal processes. The impact is assessed in terms of the difference caused, relative to the normal range of natural variability.

6.8.15 The assessment considers the potential for the planned transition to remain stable and buried throughout its operational lifetime, for example, avoiding exposure due to natural coastal retreat. The potential impact of any associated activities will also be assessed if identified in the proposed design, for example, requirements for HDD exit pits in nearshore areas. The assessment has been undertaken as a desktop exercise by an experienced coastal geomorphologist utilising a range of historical and present-day data relating to the coastline at, and around, the landfall location.

Assessment of potential changes to the wave and hydrodynamic regimes

6.8.16 Potential changes to the wave and hydrodynamic (tidal) regime are associated with local interaction with the obstacles presented by the wind farm infrastructure. The potential impact of the proposed design of Rampion 2 has been assessed in conjunction with the built design of Rampion 1.

6.8.17 Project specific numerical modelling of waves has been undertaken to quantify the potential impact of maximum design scenarios for Rampion 2, together with the built design of Rampion 1 as part of the baseline. A full description of the model set-up is provided in **Appendix 6.2: Coastal processes model design and validation, Volume 4** of the ES (Document Reference: 6.4.6.2).

6.8.18 Previous impact assessments upon tidal currents for Rampion 1 used numerical modelling to consider a larger design scenario than was actually built; the EIA considered 80 gravity base structures and 95 large monopile structures (175 structures in total), whereas the wind farm was actually built with 116 relatively slender monopile foundations. The results of the previous modelling are used to inform an evidence-based assessment of the likely impact of Rampion 2 and Rampion 1. The impact is assessed in terms of the difference caused, relative to the normal range of natural variability in the wave climate and tidal regime.

6.8.19 There are no natural feature coastal processes receptors identified that are directly sensitive to changes to the wave or hydrodynamic regimes alone. Resulting changes to patterns of sediment transport and morphological evolution may potentially affect a limited number of coastal processes receptors (including nearby coastlines, sandbanks and areas of designated seabed), which are separately considered below. Potential for changes to recreational surfing wave climate are considered as a specific wave condition scenario for coastal processes and will also be assessed if needed by other relevant aspects.

6.8.20 The impact on other sensitive receptors, which are potentially affected by changes in coastal processes, for example in relation to benthic ecology, are considered within those specific Chapters of the ES, with the outputs of the coastal processes assessments providing data to inform those assessments.

Assessment of potential changes to the sediment transport regime

6.8.21 Potential changes to the rate and patterns of sediment transport into, through and from the study area have been assessed, including nearby coastlines, sandbanks and areas of designated seabed. The assessment is informed by the consideration of potential changes to the hydrodynamic (tidal currents) and wave regimes, in conjunction with standard quantitative relationships for prediction of sediment transport. Potential differences in the sediment transport regime are assessed in the context of the normal range of natural variability. The impact is assessed in terms of the difference caused, relative to the normal range of natural variability in sediment transport.

Assessment of potential seabed scour

6.8.22 Potential changes to the local seabed level in the form of scour are associated with the local interaction between currents and waves and the obstacle presented by wind farm infrastructure located above the seabed surface. This interaction causes locally enhanced transport of seabed sediments, leading to localised erosion. Once an equilibrium state is reached, scour pits are localised depressions that may have a different seabed texture to the surrounding seabed; however, they have no further net effect on sediment transport into, through or from the area. Standard relationships, supported by the available evidence base, have been used to estimate the likely dimensions of scour for unprotected infrastructure. Scour protection around foundations or cables will prevent the formation of primary scour around the protected item by design; however, a smaller amount of secondary scour may occur at the edges of the scour protection.

6.9 Assessment of effects: Construction phase

Increases in SSC and deposition of disturbed sediments to the seabed due to drilling for foundation installation

Overview

6.9.1 Monopile foundations and pin piles for jacket foundations will be installed into the seabed using standard piling techniques. In some locations, the geology may present some obstacle to piling, in which case, some or all of the seabed material might be drilled from within the pile footprint to assist in the piling process.

6.9.2 The impact of drilling operations mainly relates to the release of drilling spoil at or above the water surface which will put sediment into suspension and the subsequent re-deposition of that material to the seabed. The nature of this disturbance will be determined by the rate and total volume of material to be drilled, the seabed and subsoil material type, and the drilling method (affecting the texture and grain size distribution of the drill spoil). These changes are quantitatively assessed using the spreadsheet based numerical models as detailed in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

Magnitude of impact or change

6.9.3 Given that a mixture of sediment grain sizes are present, the overall spatial pattern of change due to drilling of a single monopile foundation is likely to be:

- The following increases are relative to a typical baseline SSC of 5 to 10mg/l in the middle and upper water column. However, the natural variation of SSC is such that it can be naturally much higher (order of tens to hundreds of mg/l) near to the seabed, especially during larger tidal ranges and stormier conditions where waves stir the seabed.
- SSC will be increased by tens to hundreds of thousands of mg/l at the point of sediment release (for a period of seconds to a few minutes), which is at or near the water surface.
- SSC will be increased by low tens of mg/l in a narrow plume (tens to a few hundreds of metres wide, up to one tidal excursion in length (up to 11 to 16km on spring tides and 5 to 8km on neap tides) aligned to the tidal stream downstream from the source.
- If drilling occurs over more than one flood or ebb tidal period, the plume feature may be present in both downstream and upstream directions.
- Outside of the area up to one tidal excursion upstream and downstream of the foundation location, SSC less than 10mg/l may occur more widely due to ongoing dispersion and dilution of material.
- Sufficiently fine sediment may persist in suspension for hours to days or longer, but will become diluted to very low concentrations (less than 5mg/l,

indistinguishable from natural background levels and variability) within timescales of around one day.

- Over longer timescales, net displacement of any fine-grained material persisting in suspension will generally be in an approximate easterly direction across from the array area in accordance with the direction of longer-term net tidal current drift.

6.9.4 Sediment deposition as a result of drilling for a single foundation installation is concluded to be:

- Deposits of mainly coarse grained and clastic sediment deposits will be concentrated within an area in the order of approximately 10 to 100m downstream / upstream and a few tens of metres wide from individual foundations, with an average thickness in the order of one to ten metres (limited to realistically likely values).
- Deposits of mainly sandy sediment deposits will be concentrated within an area (depending on the local water depth and current conditions at the time) in the order of approximately 150 to 650m downstream / upstream and tens to one hundred metres wide from individual foundations, with an average thickness in the approximate order of tens of centimetres to approximately one metre.
- Fine grained material will be dispersed widely within the surrounding region and will not settle with measurable thickness.
- The absolute width, length, shape and thickness of local sediment deposition as a result of drilling is estimated above. However, it cannot be predicted with certainty and it is likely to vary due to the nature of the drill spoil, the local water depth and the ambient environmental conditions during the drilling activity. Other possible combinations of shape, area and thickness of sediment deposition are provided in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

6.9.5 The local patterns of change to SSC and sediment deposition are described above, as a result of drilling activities for individual foundations of any type. In the array area, up to 33 (50 percent of 65) larger monopile foundations for WTGs may be installed using drilling, and up to three OSSs on jacket foundations may require drilling for all pin piles.

6.9.6 The potential total sediment volume released by drilling 50 percent of all WTG foundations has also been assessed with respect to the total potential extent and thickness of sediment deposition. The actual shape, width, length and thickness of local or regional sediment deposition as a result of drilling cannot be predicted with certainty and is likely to vary according to the final distribution of foundations, the local nature of the drill spoil, the local water depth and the ambient environmental conditions during the drilling activity. However, the maximum total compacted sediment volume that could theoretically be released from drilling 50 percent of all WTG foundations (33 monopiles), and three OSS jacket with pin pile foundations, is 317,768m^3 and it is found that:

- if the total volume of drill arisings from all foundations is distributed equally over the combined Offshore Array Areas (195.5km^2), the average increase in bed elevation will be approximately 0.0027m (3mm) (assuming a packing density of the deposited material of 0.6);

- if the total volume of drill arisings from all foundations is distributed equally over only the Western (116.4km^2) and/or Eastern (43.2km^2) Offshore Array Areas locally used for WTG foundations within the Proposed DCO Order Limits, the average increase in bed elevation will be approximately double the values above (up to approximately 0.006m or 6mm) (assuming a packing density of the deposited material of 0.6); and
- a maximum area equal to approximately 5.4 percent of the combined Offshore Array Areas (or up to 12 percent of only the area to be used for WTGs in the Western or Eastern Offshore Array Areas within the Proposed DCO Order Limits) could potentially be covered by an average thickness of 0.05m of material (assuming a packing density of the deposited material of 0.6).

6.9.7 When considering the potential for in-combination effects, given that the minimum spacing between the WTG foundations is 950[2] to 1,130m (for the smaller and larger WTG options, respectively), it is unlikely that coarse sands or gravels put into suspension will be dispersed far enough (namely between adjacent foundation locations) to cause any overlapping effects before being redeposited to the seabed. Only relatively fine sediment is likely to be advected far enough to potentially cause overlapping effects of SSC.

6.9.8 These results are consistent with similarly modelled patterns of change in assessments for other wind farms, and the wider monitoring evidence base which is discussed in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

6.9.9 There are no coastal processes receptors that are sensitive to increases in magnitude of SSC and deposition of disturbed sediments to the seabed due to drilling for foundation installation.

Sensitivity or value of receptor

6.9.10 All the identified coastal process receptors are insensitive to changes in SSC and changes in bed levels identified from the assessment. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 7: Other marine users, Volume 2** of the ES (Document Reference: 6.2.7) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8) (due to potential changes in seabed morphology, smothering and suspended sediments);

[2] Minimum turbine spacing at 950m represents the minimum spacing for this scenario, however for the purposes of the EIA, and specified within the DCO, a minimum of 830m has been used to provide for the possibility of smaller WTGs being employed; note, other relevant assessment parameters of such a scenario would not exceed those presented here, importantly including the maximum of 90 WTGs.

- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference: 6.2.10) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 11: Marine mammals, Volume 2** of the ES (Document Reference: 6.2.11) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects);
- **Chapter 12: Offshore and intertidal ornithology, Volume 2** of the ES (Document Reference: 6.2.12) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects); and
- **Appendix 26.3: Water Framework Directive compliance assessment, Volume 4** of the ES (Document Reference: 6.4.26.3) (due to suspended sediments).

Significance of residual effect

6.9.11 There are no coastal process receptors sensitive to the impact pathway and assessment of residual effect is not applicable.

Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to installing jacket foundations

Overview

6.9.12 To provide a stable footing for jacket foundations, standard dredging techniques may be used to remove or lower the level of the mobile seabed sediment veneer within a footprint slightly larger than the foundation base. Dredging has the potential to cause elevated SSC by sediment over-spill at the water surface during dredging and by the subsequent release of the dredged material from the dredger during spoil disposal at a nearby location. The subsequent settlement of the sediment disturbed by dredging will lead to sediment accumulation of varying thickness and extent on the seabed. These changes have been quantitatively assessed using spreadsheet based numerical models.

6.9.13 This section summarises the assessment of the increases in SSC and seabed deposition as a result of the bed preparation works for the jacket foundations.

Magnitude of impact or change

6.9.14 The influence of dredging overspill and spoil disposal on increasing SSC above ambient levels is assessed to be as follows:

- The following increases are relative to a typical baseline SSC of 5 to 10mg/l in the middle and upper water column. However, SSC can be naturally much higher (order of tens to hundreds of mg/l) near to the seabed, especially during larger tidal ranges and stormier conditions where waves stir the seabed.

- SSC levels will be highest (potentially tens to hundreds of thousands of mg/l) at the point of sediment release, which is at or near the water surface during dredging overspill and distributed through the whole water column during dredge spoil disposal. This feature will only be present during the periods of active dredging or during (the relatively short) dredge spoil disposal events.
- For fine material in dredging overspill, SSC levels will decrease rapidly through vertical and horizontal dispersion to low tens of mg/l within the order of hundreds of metres from the point of release.
- For fine material released into the passive plume phase during dredge spoil disposal, SSC levels will be initially higher than for overspill (due to the sudden nature of the sediment release). SSC levels will decrease through horizontal dispersion to a few thousand mg/l within the order of low hundreds of metres and a few tens of mg/l within the order of one thousand metres distance from the source.
- For sand and gravel material in dredging overspill, local SSC levels will decrease to low thousands or hundreds of mg/l locally (low tens of mg/l in a depth mean sense) through horizontal dispersion whilst settling to the seabed.
- For sand and gravel material released into the passive plume phase during dredge spoil disposal, local SSC levels will decrease from hundreds of thousands to tens of thousands of mg/l due to horizontal dispersion whilst settling to the seabed.
- Sands will deposit to the seabed within the order of hundreds of metres from the source (taking in the order of five to 15 minutes to settle from surface to seabed), and gravels likewise within tens of metres (0.5 to 1.5 minutes). The horizontal diameter of the main sand or gravel plume footprint within the water column and on the seabed is likely to be in the order of only tens of metres.
- Following cessation of dredging or spoil release, the influence of sands or gravels on SSC levels will reduce rapidly as described above and will end when the sediment is redeposited to the seabed (in the order of 0.5 to 15 minutes, depending on the grain size and water depth).
- Once redeposited to the seabed, the locally dredged overspill and spoil material are essentially the same as the local sediment type. The dredged material will therefore immediately re-join the natural sedimentary environment and will not contribute further to elevated SSC above naturally occurring levels.

6.9.15 The sediment deposition as a result of dredging is concluded as follows:

- Deposits of mainly gravel sized dredge overspill will be concentrated within a relatively small area in the order of tens of metres from the site of dredging, with an average thickness in the order of less than ten centimetres.
- Deposits of mainly sand sized dredge overspill sediment will be concentrated within an area in the order of 150 to 500m downstream/upstream and approximately tens to one hundred metres wide from individual foundations, with an average thickness in the order of less than a few centimetres.

- In comparison to overspill, spoil disposal will form more concentrated sediment deposits on the seabed. The main mass of sediment (90 percent of the total volume, falling as the active phase of the plume) will initially result in discrete mounds of sediment in the order of tens to hundreds of metres in diameter (depending on the pattern of settlement) and tens of centimetres to a few metres in local thickness. An area equivalent to a circle of approximately 500m in diameter might be covered to an average depth of 0.05m. Any larger area of change would correspond to a smaller average thickness. It is possible that consecutive disposal events may overlap on the seabed, resulting in a greater local thickness of sediment but a smaller overall area of influence.
- The smaller mass of material (10 percent of the total volume) falling as the passive phase of the spoil disposal plume will result in a narrow deposit downstream either hundreds of metres in length and a few centimetres or less thick (for sands), or, tens of metres in length and up to tens of centimetres to a few metres thick (for gravels).
- Fine grained material released as overspill or as the passive phase of spoil disposal will be dispersed widely within the surrounding region and will not settle locally with measurable thickness. Fine grained material in the active phase of spoil disposal will remain bound in the main sediment mass and will not be differently dispersed to that described above.
- The assessments undertaken and the summary provided above describe the influence of conservatively marginal scenarios where the material being dredged or disposed is entirely fines, sands or gravels. Based on these marginal cases, the following summary describes the overall influence of the same activities assuming that a mixture of sediment grain sizes is present.
- SSC of low tens of mg/l will be present in a narrow plume (tens to a few hundreds of metres wide, up to one tidal excursion in length (up to 11 to 16km on spring tides and 5 to 8km on neap tides) aligned to the tidal stream downstream from the source.
- If dredging occurs over more than one flood or ebb tidal period, the plume feature may be present in both downstream and upstream directions.
- Outside of the area up to one tidal excursion upstream and downstream of the foundation location, SSC less than 10mg/l may occur more widely due to ongoing dispersion and dilution of material.
- Most of the gravel and sand sized sediment will be deposited to the seabed within tens to hundreds of metres from the source, respectively. A larger proportion of such material in the plume may result in SSC reducing more rapidly in this region and reducing the length or extent of the plume feature overall.
- Sufficiently fine sediment may persist in suspension for hours to days or longer but will become diluted to very low concentrations (indistinguishable from natural background levels and variability) within timescales of around one day.

6.9.16 When considering the potential for in-combination effects, given that the minimum spacing between the WTG foundations is 950 to 1,130m (for the smaller and larger WTG options, respectively), it is unlikely that coarse sands or gravels put into suspension will be dispersed far enough (namely between adjacent foundation locations) to cause any overlapping effects before being redeposited to the seabed. Only relatively fine sediment is likely to be advected far enough to potentially cause overlapping effects on SSC.

6.9.17 These results are consistent with similarly modelled patterns of change in assessments for other wind farms, and the wider monitoring evidence base (including the dredging industry).

6.9.18 There are no coastal processes receptors that are sensitive to increases in magnitude of SSC and deposition of disturbed sediments to the seabed due to dredging for foundation installation.

Sensitivity or value of receptor

6.9.19 All the identified coastal process receptors are insensitive to changes in SSC and changes in bed levels identified from the assessment. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 7: Other marine users, Volume 2** of the ES (Document Reference: 6.2.7) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference: 6.2.10) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 11: Marine mammals, Volume 2** of the ES (Document Reference: 6.2.11) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects);
- **Chapter 12: Offshore and intertidal ornithology, Volume 2** of the ES (Document Reference: 6.2.12) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects); and
- **Appendix 26.3: Water Framework Directive compliance assessment, Volume 4** of the ES (Document Reference: 6.4.26.3) (due to potential changes in suspended sediments).

Significance of residual effect

6.9.20 There are no coastal process receptors sensitive to the impact pathway and assessment of residual effects is not applicable.

Increases in SSC and deposition of disturbed sediments to the seabed due to cable installation

Overview

6.9.21 Cable burial is the preferred option for cable protection. The cable burial will be informed by the cable burial risk assessment and detailed within the Cable Specification and Installation Plan (C-45) identified in **Table 6-12**. The potential effects of sediment release due to cable burial are typically localised to the cable route or the active cable burial location.

6.9.22 Jetting and mass flow excavation methods have the greatest potential to energetically fluidise and eject material from the trench into suspension and have therefore been considered in the assessment. The rate of disturbance is similarly defined for both tools by the MDS trench dimensions and burial rate. By contrast, the other cable installation techniques (for example, ploughing or cutting) are expected to re-suspend a smaller amount of material into the water column. Due to spatial variation in the geotechnical properties of the underlying geology within this region, it is possible that a combination of techniques may be used.

6.9.23 Following the pre-construction route survey and boulder clearance works, a Pre-Lay Grapnel Run (PLGR) and an associated route clearance survey of the final cable route will be undertaken. A vessel will be mobilised with a series of grapnels, chains, recovery winch and survey spread suitable for vessel positioning and data logging. Any items recorded will be recovered onto deck where possible and the results of this survey will be used to determine the need for any further clearance.

Magnitude of impact or change

6.9.24 The assessment includes that inter-array cables will be typically buried 1m below the seabed surface (C-41) with the installation method to be determined (C-42) identified in **Table 6-12**. The MDS assumes installation through jetting or mass flow excavation as these have the greatest potential to energetically fluidise and eject material from the trench into suspension. The maximum depth of burial in the export cable corridor is 1.5m as identified in **Table 6-11.**

6.9.25 The assessment has concluded that medium to coarse sand and gravels are likely to result in a temporally and spatially limited plume affecting SSC levels (and settling out of suspension) in close proximity to the point of release. SSC will be locally elevated within the plume close to active cable burial up to tens or hundreds of thousands of mg/l. However, the change will only be present for a very short time locally, in the order of seconds to tens of seconds for sand or gravel, before the material resettles to the seabed.

6.9.26 Depending on the height to which the material is ejected and the current speed at the time of release, changes in SSC and deposition will be spatially limited to within metres (up to 20m) downstream of the cable for gravels and within tens of metres (up to a few hundred metres) for sands.

6.9.27 Finer material will be advected away from the release location by the prevailing tidal current. High initial concentrations (similar to sands and gravels) are to be expected but will be subject to rapid dispersion, both laterally and vertically, to near-background levels (tens of mg/l) within hundreds to a few thousands of metres of the point of release. In practice, based on surveys, only a small proportion of the material disturbed is expected to be fines, with a corresponding reduction in the expected levels of SSC.

6.9.28 Irrespective of sediment type, the volumes of sediment being displaced and deposited locally are relatively limited (up to 3m³ per metre of cable burial) which also limits the combinations of sediment deposition thickness and extent that might realistically occur. Fundamentally, the maximum distance from each metre of cable trench over which three m³ of sediment can be spread to an average thickness of (for example) 0.05m is 60m (or to 0.15m is 20m); any larger distance would correspond to a smaller average thickness. In practice, the local thickness and extent is likely be variable, but always within these joint limits. The assessment suggests that the extent and so the area of deposition will normally be much smaller for sands and gravels (although leading to a greater average thickness of deposition in the order of tens of centimetres, up to around one metre) and that fine material will be distributed much more widely, becoming so dispersed that it is unlikely to settle in measurable thickness locally.

6.9.29 If cable burial, or any other activity causing sediment disturbance, is undertaken simultaneously at two or more locations that are aligned in relation to the ambient tidal streams, then there is potential for overlap between the areas of effect on SSC and sediment deposition. In the worst case of a direct overlap, the combined effect can be estimated as the sum of the parts in the area of overlap.

6.9.30 These results are consistent with similarly modelled patterns of change in assessments for other wind farms, and the wider monitoring evidence base.

6.9.31 There are no coastal processes receptors that are sensitive to increases in magnitude of SSC and deposition of disturbed sediments to the seabed due to cable installation.

Sensitivity or value of receptor

6.9.32 All the identified coastal process receptors are insensitive to changes in SSC and changes in bed levels identified from the assessment. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference: 6.2.10) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 11: Marine mammals, Volume 2** of the ES (Document Reference: 6.2.11) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects);

- **Chapter 12: Offshore and intertidal ornithology, Volume 2** of the ES (Document Reference: 6.2.12) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects); and
- **Appendix 26.3: Water Framework Directive compliance assessment, Volume 4** of the ES (Document Reference: 6.4.26.3) (due to potential changes in suspended sediments).

Significance of residual effect

6.9.33 There are no coastal process receptors sensitive to the impact pathway and the assessment of residual effect is not applicable.

Increases in SSC and deposition of sediment to the seabed due to HDD drilling fluid release

Overview

6.9.34 The subsea export cable ducts will be drilled underneath the beach using HDD techniques (C-43), as identified in **Table 6-12**. The potential effects of drilling fluid release during the creation of underground conduits for the export cables at the landfall are typically localised to the landfall area and will only be present at and for a short time following HDD punchout for each conduit.

Magnitude of impact or change

6.9.35 The assessment assumes that subsea export cable ducts will be drilled underneath the beach using HDD techniques (C-43), and that the HDD will be at least 5 m below the present day beach surface (C278), as identified in **Table 6-12**. The MDS conservatively assumes the maximum volume of drilling fluid that might be released at one time is equivalent to the total volume of the drilled conduit (312m^3) as identified in **Table 6-11.**

6.9.36 The release of drilling fluids (which contain a lubricating natural clay mineral such as bentonite) along with drill cuttings from the HDD process will result in a localised and temporary plume of elevated SSC (tens of thousands of mg/l within 10m of the release but decreasingly to low thousands or hundreds of mg/l within a few hundred metres of the release).

6.9.37 The majority of the plume will be advected in the direction of the ambient tidal currents, which are broadly aligned to the coast. The direction of transport (to the east or west) will depend on the state of the tide (flood or ebb) at the time of the release.

6.9.38 It is expected that the plume will be dispersed to relatively low concentrations (low hundreds to tens of mg/l) within hours of release and to background concentrations (less than 10mg/l) within a few tidal cycles.

6.9.39 The bentonite is expected to remain in suspension (at very low concentrations) for at least hours or days and will be widely dispersed before settling. Therefore, it is not expected to accumulate anywhere in measurable thicknesses. If punchout (in the intertidal area) occurs during a low water condition, drilling fluid and/or drill cuttings may accumulate initially in or around the HDD exit pit, in this case, the volume of the pit is sufficient to initially contain the majority of that material. Following tidal inundation, any remaining drilling fluid will be reworked and redistributed to not-measurable concentrations and thicknesses over time by wave and tidal action.

6.9.40 The drilling fluid has an overall density and viscosity similar to seawater and so is expected to behave (advect, mix and disperse) in a similar manner. If the drilling fluid behaves as a slightly denser fluid, it may either accumulate in the HDD exit pit or move over the adjacent seabed downslope under gravity, i.e. in an offshore direction and away from nearshore areas.

6.9.41 If HDD works, or any other activity causing sediment disturbance, is undertaken simultaneously at two or more locations that are aligned in relation to the ambient tidal streams, then there is potential for overlap between the areas of effect on SSC and sediment deposition. In the worst case of a direct overlap, the combined effect can be estimated as the sum of the parts in the area of overlap.

6.9.42 These results are consistent with similarly modelled patterns of change in assessments for other wind farms, and the wider monitoring evidence base.

6.9.43 There are no coastal processes receptors that are sensitive to increases in magnitude of SSC and deposition of disturbed sediments to the seabed due to HDD drilling fluid release.

Sensitivity or value of receptor

6.9.44 All the identified coastal process receptors are insensitive to changes in SSC and changes in bed levels identified from the assessment. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 7: Other marine users, Volume 2** of the ES (Document Reference: 6.2.7) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference: 6.2.10) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 11: Marine mammals, Volume 2** of the ES (Document Reference: 6.2.11) (due to potential changes in seabed morphology, smothering and suspended sediments, affecting prey species and other indirect effects);
- **Chapter 12: Offshore and intertidal ornithology, Volume 2** of the ES (Document Reference: 6.2.12) (due to potential changes in seabed

morphology, smothering and suspended sediments, affecting prey species and other indirect effects); and

- **Appendix 26.3: Water Framework Directive compliance assessment, Volume 4** of the ES (Document Reference: 6.4.26.3) (due to potential changes in suspended sediments).

Significance of residual effect

6.9.45 There are no coastal process receptors sensitive to the impact pathway and the assessment of residual effect is not applicable.

Changes to landfall morphology due to installation of export cable at the landfall

Overview

6.9.46 The Rampion 2 export cables will make landfall at Climping. The beach frontage here consists of mixed sand and shingle sediment with an approximate 1:7.5 slope to the sand foreshore and net sediment transport in an easterly direction. This mobile material overlies chalk bedrock which is located at or very close to the surface in this location (**Figure 6.3, Volume 3** of the ES (Document Reference: 6.3.6)). A failed seawall and groynes are also present at the landfall. The original shoreline management policy for this coastal unit (Unit 4d20) was for a strategy of ‘Managed Realignment’. However, this has evolved to 'Withdraw Management' and more recently, 'Do Minimum'. There is currently ongoing discussion regarding the most appropriate management policy for this stretch of coast.

6.9.47 The MDS for cable installation will involve trenching the four export cables into the shallow (sub-tidal) waters off the beach. From here, HDD will be used to install the cables under the beach to the transition jointing bays which will be set back from the beach, in a supra-tidal setting.

6.9.48 It is noted that TFPs of larger dimensions (than the HDD exit pits and nearshore trenches proposed for Rampion 2) were previously successfully used at the Rampion 1 landfall (at Lancing), without any adverse impacts arising at the location of the TFP or elsewhere. TFPs are not proposed for the Rampion 2 landfall. Cable trenching was undertaken in 2015/16, whilst excavation of TFPs was undertaken in 2016/17 to facilitate installation of the existing cables (with work carried out under Marine Licence L/2016/00217/4). A subsequent licence to extend the operational timespan of the TFPs from approximately six months to up to five years was made in 2017. The TFPs (5 to 5.5m deep) were backfilled following completion of the installation works using either the spoil from excavation of subsequent TFPs, or using material temporarily stored in the Proposed Development spoil disposal site. Post-construction monitoring surveys (Natural Power, 2019) found that one year later, “the seabed has been returned to near identical levels to those seen during pre-construction, with barely perceptible amounts of variation when compared to the pre-construction background substrate”. An analysis of beach topography pre-, during- and post-construction concluded “no noticeable effect of the Project on beach topography changes can be discerned”.

6.9.49 There are several source/pathways via which morphological receptors at the landfall could potentially be impacted:

- trenching through chalk;
- excavation of HDD exit pits;
- HDD drilling operations; and
- changes to the nearshore wave regime/ longshore sediment transport due to the presence of cable protection measures and/or any ancillary structures associated with cable installation.

Magnitude of impact or change

Trenching through chalk

6.9.50 Under the MDS, installation of four cables in the nearshore will require the excavation and side-casting of material along the trench:

- the trench will start near the proposed HDD exit points in water depths between zero and (approximately) 2.5m below LAT (**Figure 6.3, Volume 3** of the ES (Document Reference: 6.3.6)) extending offshore;
- the trenches will have a base width of approximately two metres and be up to 1.5m deep along most of their length;
- the trenches will be dredged using a spud legged backhoe dredging vessel with side-casting and could remain open for up to four months; and
- the side cast material will be used to infill the trench on completion of the cable installation works (commitment C-305 as identified in **Table 6-12**).

6.9.51 The potential pathways by which the excavation of the nearshore burial trench could bring about changes in the beach morphology are set out below:

- the trenches could potentially infill in response to trapping of alongshore and cross-shore movements of sediment (which probably occur on a seasonal basis in response to seasonal changes in the distribution of wave energy). This could theoretically lead to a localised reduction in beach volume; and
- side-casting of material during the excavation process will increase the local elevation of the seabed, potentially causing temporary modification of the nearshore wave regime (changes to wave height, period and direction through local wave diffraction, refraction, shoaling and breaking in response to the local change in water depth).

Change in beach morphology due to infilling of the trench

6.9.52 The proposed trenches will be broadly shore-normal in orientation and therefore some infilling can realistically be expected primarily due to the interception of longshore sediment transport. The potential rate of infilling is difficult to determine; however, baseline rates of sediment transport in the shallow sub-tidal areas at the landfall are expected to be small, due to the limited availability of mobile material (Gardline, 2020; **Figure 6.3, Volume 3** of the ES (Document Reference: 6.3.6)).

6.9.53 The inshore trench sections will be located within the theoretically active part of the cross-shore beach profile, broadly defined by the 6.2m below LAT contour which corresponds to the depth of closure along this frontage (ABPmer, 2016). This means that there is some potential for beach material to move offshore from the beach and into the trench during storm events. However, given that the trenches will be orientated broadly perpendicular to the shoreline and are both narrow and shallow (at two metres wide and 1.5m deep), the potential for large volumes of beach material to become trapped within the trench and leading to beach draw-down is considered to be low. The potential infill of beach material will be most likely in the trench sections in the shallowest water depths and will be small in absolute and relative terms (relative to the total beach volume).

6.9.54 The magnitude of change is considered **Very Low** as the changes will be temporary and spatially limited.

Change in beach morphology due to side-casting of material during trench excavation

6.9.55 The seabed across which the trenches will be excavated is located in a shallow sub-tidal setting. It is theoretically possible that any locally side-cast material could act similar to a submerged groyne, which could locally influence beach morphology through the re-distribution of wave energy and trapping of sediment. However, the extent to which morphological change could occur will be dependent upon a range of factors, including:

- the nature of the side-cast material (specifically whether it is mobile and therefore quickly eroded by waves);
- the degree of storminess during the time period when the side-cast material is present on the seabed;
- the composition of the seabed at this location (which is not considered to be highly susceptible to erosion); and
- the duration of time that the side-cast material is in place on the seabed and, or, the rate of alongshore sediment transport.

6.9.56 Review of evidence from the existing Rampion 1 TFPs, ABPmer (2017) identified that the chalk material to be side-cast is likely to be relatively resistant to erosion and so the local change to waves may occur up to the time that the HDD exits pits and trenches are closed and the material remaining in the mounds is either dispersed or used as backfill.

6.9.57 The effect on the morphology of the lower beach could theoretically be a very marginal local re-distribution of beach material, including accretion immediately updrift of the side-cast berm and erosion immediately down drift. However, the extent of accretion and erosion will be highly localised to the side-cast berm itself (no more than that of the nearby groynes in intertidal and shallow subtidal areas) and will be temporary with the sediment distribution returning to its original state once the sidecast material is either naturally or mechanically redistributed and the trench backfilled.

6.9.58 During storm conditions, the side-cast material may theoretically cause some re-distribution of wave energy. In reality, this is expected to be minimal in the nearshore, as only a small volume of material is being excavated (due to the narrow width and shallow depth) and the associated berms will be of low profile. Also, the side-cast berm will be approximately shore normal and broadly perpendicular to the wave crests of the larger storm waves (which will naturally refract to become shore parallel as they approach the coast). Accordingly, this will limit the influence of the berm on larger waves. Overall, any effect of the side-cast berm on the beach morphology and volume will be of relatively temporary duration with the beach and nearshore morphology recovering once the trench is either naturally or mechanically backfilled.

6.9.59 It is noted that material excavated from trenches might also be temporarily stored within the offshore array area or export cable corridor, if and where designated as a spoil disposal area.

6.9.60 The magnitude of change is considered **Low** as the changes will be temporary and spatially limited.

Excavation of HDD exit pits

6.9.61 Each of the four export cables may require an exit pit to be excavated at the punch-out location. These will be up to 30m long by 4m wide by 1.5m deep (total volume 720m^3 for all four pits). They will be located between 800 and 1,500m offshore in water depths between zero and (approximately) 2.5m below LAT (**Figure 6.3, Volume 3** of the ES (Document Reference: 6.3.6)) and up to four HDD exits pits could be simultaneously open for up to four months. The excavated material may be temporarily stored within the array area or export cable corridor, before being dredged again and used as backfill when the pits are closed.

6.9.62 The potential mechanisms by which the presence of these pits could impact the coast at the landfall is via the modification for waves and interception of sediment transport.

6.9.63 To assess the potential impact of the Rampion 2 HDD exit pits, as described in the overview, evidence from the analogous Rampion 1 landfall has been used. The Rampion 1 landfall successfully used a relatively greater number of individually larger TFPs to facilitate export cable installation. Prior to their installation, ABPmer (2016) undertook a coastal impact assessment in support of the Marine Licence Application to ascertain (amongst other things) whether the construction of TFPs close to the shore could alter the nearshore wave regime in the short-term (that is, weeks to months), leading to enhanced erosion (or 'slumping') of beach material. Using quantitative techniques, the assessment considered the likelihood of this occurring to be low and this finding has been supported by the pre- during- and post- construction monitoring reported in Natural Power (2019).

6.9.64 Although the total number (four) and dimensions of HDD exit pits is greater for Rampion 2 (compared with six TFPs, 50 to 100m width, 100 to 200m length, 5-5.5m deep at Rampion 1) the following key similarities are noted:

- the Rampion 2 HDD exit pits are expected to be located in very similar water depths, within similar hydrodynamic and wave regimes;
- seabed conditions are expected to be very similar (that is, hard chalk substrate with very thin veneer of surficial mobile material); and

- the total number of HDD exit pits open at any given time will be smaller (namely, four for Rampion 2 compared with six for Rampion 1).

6.9.65 Multibeam bathymetry data from the Rampion 1 TFPs showing change over the two-month period following excavation found that a small amount of infilling (typically zero to 0.2m) had occurred. This finding was consistent with the predictions set out in ABPmer (2016) and it can reasonably be assumed that infilling may occur at a broadly similar rate in the TFPs proposed for Rampion 2. The available monitoring evidence from the Rampion 1 TFPs does not enable the provenance of the material to be determined. Although it is theoretically possible that the material in the TFPs originated from the beach, it is arguably more likely that the material is of local origin and mobilised as bed load under the combined action of tide and wave induced currents. Accordingly, any temporary removal or redistribution of beach material along the Climping frontage is expected to be very small.

6.9.66 The magnitude of change is considered **Low** as any associated morphological change will be temporary and spatially limited.

HDD drilling operations

6.9.67 Potential impacts to coastal process receptors have been reduced with subsea cable ducts being drilled underneath the beach using HDD techniques (C-43), at least 5 m below the present day beach surface (C278), as identified in **Table 6-12**~~(**Table 6-12**)~~. The measures will be secured through implementation of the projects' COCP along with the DCO requirement and DML condition.

6.9.68 HDD works will likely be used to create an underground conduit for each of the four cables between the beach and onshore parts of the route. HDD will cause minimal direct disturbance to the existing coastline because, by design it will not interact directly with, or leave any infrastructure exposed in, the active parts of the beach (between the entry and exit points of the drill) and so will not impact upon littoral processes in these areas. Provided that the cable remains buried beyond the exit of the HDD, there is no possibility for it to interact with, or have any effect on nearshore beach processes or morphology. The design of the HDD operation will take this into account.

6.9.69 Owing to the uncertainty surrounding the future shoreline management policy at the landfall, it will be important for a full assessment of coastal variability to be undertaken under a range of coastal management and climate change scenarios (C-247 as secured by the DCO, see **Table 6-12**). This will enable appropriate set back distances for the transition jointing bays to ensure that they are unaffected by the possibility of coastal retreat due to either natural erosion or sea level rise due to climate change.

6.9.70 The magnitude of change is considered **Very Low** as there are no discernible change from background conditions.

Changes to the nearshore wave regime/ longshore sediment transport due to the presence of cable protection measures

6.9.71 The requirement for cable protection measures at the landfall is not presently known but will be confirmed as part of the Cable Protection Plan (in accordance with the **Outline Scour Protection and Cable Protection Plan** (Document Reference: 7.12) C-44 in **Table 6-12** as secured by the DCO). In theory, the installation of cable protection measures could cause a morphological response via (for instance) modification of the local nearshore wave regime and associated patterns of sediment transport. However, it is assumed that if cable protection is installed at the landfall it will be installed with a sufficiently low profile relative to the surrounding bed to present minimal barrier to the passage of waves and so cause no change to long term patterns of sediment transport.

6.9.72 The magnitude of change is considered **Low** as any associated morphological change will be barely discernible and spatially limited.

Sensitivity or value of receptor

6.9.73 The sensitivity of the Climping Beach SSSI as well as the wider coastal morphology at the landfall is considered to be **Medium**, reflecting that the receptor has some ability to tolerate the potential impacts and can reasonably be expected to recover to its baseline condition should morphological change occur.

Significance of residual effect

6.9.74 The assessment has concluded that the magnitude of impact on the morphology of the landfall arising from construction related activities is either Low or Very Low. Based upon the Medium sensitivity of the receptor identified above, the significance of residual effect is **Minor adverse** (**Not Significant**).

6.9.75 Effects will be indirect and temporary and **Not Significant** in EIA terms.

Changes to the tidal, wave, sediment transport regimes and seabed scour as a result of the presence of less than all windfarm infrastructure

Magnitude of impact or change

6.9.76 The installation of any WTG foundations, OSS foundations and cable protection measures all have the potential to result in a localised blockage of waves, tides and sediment transport. Only a partial amount of blockage, due to the presence of ‘less than all’ of the finally installed windfarm infrastructure, will be present when offshore construction begins, increasing incrementally up to the fully operational scenario. WTG and OSS foundation installation is expected to commence at the beginning of the second year of the construction programme and will last approximately 2 to 2.5 years.

6.9.77 The changes in the currents, wave and sediment transport regimes as a result of the fully operational Proposed Development are set out in **Section 6.10 paragraphs 6.10.1** to **6.10.8, paragraphs 6.10.11** to **6.10.17** and **paragraphs 6.10.21** to **6.10.34**, respectively. Changes to waves have been assessed by numerical modelling of various complete layouts and wave climate scenarios and changes to currents and sediment transport have been assessed (in conjunction with the assessment of waves) using an evidence-based approach, as presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

6.9.78 The magnitude of change to these parameters will not be exceeded during the construction (or decommissioning) phase since the number of installed foundations will be less than for the fully operational Proposed Development.

Sensitivity or value of receptor

6.9.79 The receptors which could be affected by changes in the tidal, wave and sediment transport regimes through the presence of Proposed Development infrastructure are considered as follows:

- nationally and internationally designated sites are considered to have a **Medium** sensitivity: although designated, they do have moderate capacity to accommodate the proposed form of change;
- recreational surfing venues are considered to have a **Medium** sensitivity. They have a low capacity to accommodate the proposed form of change and have moderate socioeconomic importance;
- coastline morphology considered to have a **Medium** sensitivity. They have a moderate capacity to accommodate the proposed form of change but is considered to be of regional level importance with respect to its value for biodiversity, socio-economics and coastal defence; and
- nearby offshore sandbanks which are not designated are considered to have a **Low** sensitivity. They have a moderate capacity to accommodate change.

Significance of residual effect

6.9.80 The changes in the wave, tide and sediment transport regimes (including scour) as a result of the fully operational Proposed Development are set out in **Section 6.10** below.

6.10 Assessment of effects: Operation and maintenance phase

Changes to the tidal regime due to presence of windfarm infrastructure

Overview

6.10.1 The interaction between the tidal regime and the foundations of the wind farm infrastructure will result in a general reduction in current speed and an increase in levels of turbulence locally due to frictional drag and the shape of the structure. Resistance posed by the array (due to the sum of all foundation drag) to the passage of water at a large scale may distort the progression of the tidal wave, also potentially affecting the phase and height of tidal water levels.

6.10.2 Changes to the tidal regime may potentially (indirectly) influence seabed morphology in several ways. In particular, the causal relationship between flow speed and bedform type can be expected (Belderson *et al*., 1982) and thus any changes to flows have the potential to alter seabed morphology over the lifetime of the Proposed Development. More generally, changes in flow may alter the balance between sediment erosion and deposition as well as the rate and direction of sediment transport.

6.10.3 The changes in the tidal regime have been assessed and results presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

Magnitude of impact or change

6.10.4 The Rampion 2 foundation options are considered collectively and individually to be too small and widely dispersed to affect the movement of water at the array scale and therefore will have no measurable effect on the progression of the tidal wave or on associated water levels (tidal or residual surge) at either the local or regional scale. There is no evidence from other operational offshore wind farms to suggest a measurable array scale effect on water levels. This assertion is entirely consistent with numerical modelling undertaken to inform Round 3 developments of broadly comparable (or larger) size to Rampion 2 (for example, East Anglia Offshore Wind, 2012; Moray Offshore Renewables Ltd, 2012, Navitus Bay Development Ltd, 2014).

6.10.5 The presence of the foundations will interfere with passage of tidal currents as a consequence of local drag and blockage effects, which would be expected to lead to a reduction in flow speed behind the structure and the development of a wake.

6.10.6 The lateral dimensions of the wake are likely to be initially similar to the effective blockage width of the structure (e.g. ~30m for a 45 x 45m WTG jacket). This is likely to increase (widen) with distance downstream due to diffusion and dispersion of the effect; this is also the normal and natural mechanism for the recovery of time mean current speed and turbulence towards ambient conditions. Using an integrated mean blockage cross section of approximately 30m for the WTG jacket foundation, and estimating the maximum measurable wake length as 80 diameters, then the likely extent of a measurable / detectable wake is estimated to be in the order of 2.4km, orientated along the local flood or ebb tidal current axis. This wake length distance is significantly less than the corresponding tidal excursion distance in the array area (11 to 16km, the distance over which water is displaced during each flood or ebb tide).

6.10.7 If these effects described above occurred from the outer limits of the proposed development area, then they are in such a direction that they would not overlap, or would remain too short to reach:

- the adjacent coastlines;
- more than a very small number of other foundations in the adjacent Rampion 1 array area, and only then where two foundations are closely aligned on the local tidal axis; and
- any adjacent sandbank features with designated nature conservation areas.

6.10.8 There are no coastal processes receptors that are sensitive to a change in the tidal regime.

Sensitivity or value of receptor

6.10.9 All the identified coastal process receptors are insensitive to changes in the tidal regime. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to potential changes in current speed or turbulence).

Significance of residual effect

6.10.10 There are no coastal process receptors sensitive to the impact pathway and the assessment of residual effect is not applicable.

Changes to the wave regime through presence of wind farm infrastructure

Overview

6.10.11 The general effect of the wind farm infrastructure is to cause a local reduction in wave height at each foundation, and an array scale reduction in wave height in proportion to the overall blockage density presented by the WTG and substation foundations. The magnitude of the array scale effect on wave height gradually increases with distance downwind from the upwind edge through the array area. The effect then extends downwind of the array, gradually recovering to background values with distance.

6.10.12 The changes in the wave regime have been assessed through the numerical modelling of various completed layouts and wave climate scenarios as presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3) along with figures of numerical model results.

Magnitude of impact or change

6.10.13 The magnitude of change in the wave climate is shown in **Figure 6.4, Volume 3** of the ES (Document Reference: 6.3.6) and is concluded to be the following.

- A very localised area of wave shadowing might occur immediately behind individual foundations, but wave heights are expected to recover rapidly (within a few tens of metres of the foundation) due to normal lateral spreading of the ambient wave energy.
- Associated changes to wave period and direction in the wave shadow are not measurable (namely, less than approximately 0.1 seconds and three degrees, respectively). Where present, the small magnitude of change follows a similar spatial pattern and footprint of effect as wave height, recovering to baseline

conditions with distance (order of tens to a few hundreds of metres) downwind from the array.

- The relatively slender WTG monopiles and the single jacket OSS installed in Rampion 1 alone cause little to no effect on wave height greater than 2.5 percent of the baseline condition, either locally around each foundation, or as an array scale effect. A very localised effect between 2.5 and 5 percent is occasionally visible at the location of the Rampion 1 OSS.
- The greatest relative magnitude of effect of the MDS jacket WTG and OSS foundations in Rampion 2 and relatively slender WTG monopiles and the smaller single jacket OSS installed in Rampion 1 together is between five and ten percent of the baseline wave height, within and immediately downwind of the Rampion 2 array area, associated with the 50 percent exceedance return period scenario, for each of the wave directions tested. The magnitude of effect reduces to less than five percent within a short distance (three to 4km) downwind of the array area. Even the smallest potentially measurable effects on wave height (more than 2.5 to five percent) do not extend to any of the adjacent coastlines.
- The relative magnitude and extent of the effect is greatest for the 50 percent exceedance return period scenario (the lowest energy wave height condition considered), and progressively decreases through higher return period scenarios for all of the wave directions tested. This occurs because wave energy is proportional to the product of the wave height and the square of the wave period. A reduction in wave energy at higher energy levels will therefore result in a smaller proportional reduction in wave height. For a given return period, the relative magnitude and extent of the effect is similar for the range of wave directions simulated.

6.10.14 With respect to changes in the wave regime at nearby offshore sandbanks the following is concluded.

- Waves will not be measurably changed (less than five percent wave height, 0.1 seconds for wave period and three degrees for wave direction) at the location of East Bank or the northern part of the Outer Owers Bank. This is partly due to the small scale of change, but also due to the very limited number of wave directions where any change might extend to this particular location.
- The southern part of the Outer Owers Bank (also called Hooe Bank) is closer to and slightly overlaps the far north-west end of the Western Offshore Array Area. Within a relatively narrow corridor extending a few hundred metres downwind of individual WTG foundations sufficiently close to these banks, a local change (reduction) in wave height of up to five to 7.5 percent (but no associated measurable change in wave period or direction) might occur. Outside the narrow downwind corridor, and as a result of more diffuse array scale effects, waves will not be measurably changed (less than 2.5 to five percent wave height, 0.1 seconds for wave period and three degrees wave direction).
- The potential for any interaction is naturally limited by the location of the banks relative to the Rampion 2 array area. Interaction between Rampion 2 and sandbanks around Selsey Bill can only logically occur if foundations for

Rampion 2 are located in the western end of the Proposed DCO Order Limits, and sufficiently close to the banks for a meaningful change to extend that far.

- The predominant wave climate controlling the evolution of the sandbanks around Selsey Bill (waves from the south-west and south-southwest, occurring approximately 60 percent of the time) will not pass through the Offshore Array Area and so will not be changed at all in any case. Realistically, only waves coming from the south-east or east-southeast (occurring approximately 12 percent of the time) have the potential to interact with Rampion 2 and then with the various sandbanks around Selsey Bill.

6.10.15 An assessment of the significance of effect with regards to impacts to the morphology of sandbanks around Selsey Bill is provided in relation to changes in sediment transport during the operational phase (**Section 6.10 paragraphs 6.10.32** to **6.10.33**).

6.10.16 An assessment of the significance of effect with regards to impacts to the nearby coastlines during the operational phase is also provided (**Section 6.10 paragraph 6.10.34**).

6.10.17 With respect to the recreational surfing venues the following is concluded.

- Wave direction is naturally variable over time and only locations directly downwind of the Rampion 2 array area will have any pathway for change under a particular wave condition and therefore intermittent over time. The model results show that the array scale effects extending outside of the array area are relatively dispersed and do not lead to a focussed effect at any particular location.
- Wave height, period and direction (for a wide range of typical everyday to severe storm conditions) will not be measurably changed at any coastal locations, including any recreational surfing venues. The magnitude of impact to recreational surfing venues is therefore considered **Very Low** with no discernible change from background conditions.

Sensitivity or value of receptor

6.10.18 The receptors which could be affected by changes in the wave regime through the presence of Proposed Development infrastructure are considered as follows:

- Recreational surfing venues are considered to have a **Medium** sensitivity. They have a low capacity to accommodate the proposed form of change and have moderate socioeconomic importance.

Significance of residual effect

6.10.19 Taking into consideration the magnitude of change and the sensitivity of the recreational surfing venue receptor, the significance of effect is concluded as **Minor adverse** (**Not Significant**).

6.10.20 The effects will be direct and permanent for the operational phase of the Proposed Development and **Not Significant** in EIA terms.

Changes to the sediment transport regime due to presence of wind farm infrastructure

Overview

6.10.21 Potential changes to the sediment transport regime could occur in response to the presence of the WTG foundations, sub-stations and cable protection measures. These structures may present a direct blockage to the transport of sediment or interact with the tide and wave regimes as follows.

- WTG foundations could potentially result in a reduction in normal current speed and wave energy resulting in wake effects behind WTGs.
- Elevated turbulence may also be present in the wake behind foundations, potentially enhancing the potential sediment transport rate and contributing to the formation of scour (considered in **Section 6.10 paragraphs 6.10.38** to **6.10.42**).
- Persistent changes to wave and currents over larger areas could potentially cause changes over time to patterns of net sediment transport (rates and directions) with resulting changes to sedimentary bedform morphology and general seabed bathymetry.

6.10.22 The sensitivity of morphological features to these patterns of change depends upon the relative importance of currents and/or waves, the magnitude and extent of any change to them and the degree to which the system is presently in balance. Detailed analysis of the potential change resulting from the Rampion 2 infrastructure is outlined in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3) and is summarised below.

Magnitude of impact or change

Overview

6.10.23 Within the array and deeper offshore sections of the offshore export cable corridor, sediment transport is dominated by the action and asymmetry of tidal currents. The primary change as a result of the wind farm infrastructure is that time averaged current speed will be reduced, but turbulence intensity will also be increased in a narrow wake extending downstream from each foundation. The net effect on bedload sediment transport is a balance of the decrease in overall flow speed and increase in flow turbulence. Very close to the foundation, time mean flow is most reduced, however, the additional turbulence dominates, causing an increase in local sediment transport rate, contributing to local scour.

6.10.24 Time mean current speed may also be increased (typically by only a few centimetres per second) between rows of foundations if the final grid layout is aligned to the tidal axis. However, the difference is very small in absolute and relative terms, within the range of natural variability and not measurable in practice. Little to no net difference in the total flow rate of water through the array is predicted. No measurable changes to sediment transport patterns are expected or have been reported at any other wind farm (including a wide range of environmental settings).

6.10.25 Very localised changes in flow speed could influence overall rates of bedload transport within and nearby to the array area will depend upon the magnitude of change relative to sediment mobilisation thresholds. The overall result of these slight changes in flow speed could potentially be a very small reduction in the net volume of material transported as bedload through the array area. The reduction would likely not be measurable in practice and would be within the range of natural variability in sediment transport rates.

6.10.26 With respect to SSC, changes to tidal currents (which primarily control the rate and direction in which suspended sediment is transported) due to the operation of Rampion 2 is assessed to be very limited in absolute magnitude and spatially restricted to the array area plus a small distance downstream in the main flood and ebb directions.

6.10.27 During large storm events, waves may stir the seabed within shallower parts of the array area, naturally causing an additional short-term contribution to SSC levels. As discussed in **Section 6.10 paragraphs 6.10.11** to **6.10.17**, Rampion 2 will potentially cause a small reduction in wave heights within and nearby to the array area and it is therefore possible that there will be a corresponding small reduction in the rate at which sediment is locally re-suspended from the seabed.

6.10.28 The change described above will only be apparent during larger storm events (if at all) and will potentially slightly reduce SSC from the baseline. However, levels of SSC will remain dominated by regional scale inputs that are not affected by the presence of the wind farm. No measurable changes to SSC outside the range of natural variability are expected to occur within or nearby to the array area.

6.10.29 The embedded environmental measures have sought where possible for cable burial to be the preferred option for cable protection (C-45) as identified in **Table 6-12**. However, installation of cable protection is likely to be required in some locations due to geophysical and morphological constraints. The cable protection (rock or alternative) could result in a locally raised obstacle up to 1.0m above the present-day seabed level. Cable protection would be placed onto the seabed surface above the cable and could therefore directly trap or block sediment in transport, locally impacting down-drift locations. The spatial extent and location of the cable protection actually required will be calculated and confirmed at a later stage as part of the Cable Protection Plan.

6.10.30 Following installation and under favourable conditions, an initial period of sediment accumulation may be expected to occur. The largest likely volume of sediment that could accumulate will be associated with the filling of any open surface voids and the creation of a smooth stable sediment slope against or over the cable protection. Given the relatively high potential sediment transport rates within the study area, this process of accumulation may take place over a period as short as a few weeks to months, depending on the net rate of sediment transport onto (less any scour or erosion from) the cable protection.

6.10.31 Accordingly, for all areas in which cable protection is used (including where sandwaves are present), it is not expected that the presence of cable protection will continue to affect patterns of sediment transport following any initial period of accumulation. It follows that any changes to seabed morphology away from the cable protection will also be very small. The presence of cable protection measures does not cause a long-term blockage to sediment transport where used within the export cable corridor or array areas.

Sandbanks (East Bank & northern Outer Owers Bank)

6.10.32 Waves will not be measurably changed (less than five percent wave height, 0.1 seconds for wave period and three degrees in wave direction) at the location of East Bank or the northern part of the Outer Owers Bank, due to the presence of MDS foundations in Rampion 2, and built foundations in Rampion 1. This is partly due to the small scale of change, but also due to the very limited number of wave directions where any change might extend to this particular location. Magnitude of impact is therefore considered to be **Very Low** at these locations with changes not discernible from background conditions.

Sandbanks (Hooe Bank & southern Outer Owers)

6.10.33 The southern part of the Outer Owers Bank (also called Hooe Bank) is closer to and slightly overlaps the far north-western end of the Offshore Array area of the Proposed DCO Order Limits. Within a relatively narrow corridor extending a few hundred metres downwind of individual WTG foundations that could be potentially sufficiently close to these banks, a local change (reduction) in wave height of up to five to 7.5 percent (but no associated measurable change in wave period or direction) might occur. Outside the narrow downwind corridor, and as a result of more diffuse array scale effects, waves will not be measurably changed (less than 2.5 to five percent wave height, 0.1 seconds for wave period and three degrees in wave direction). The magnitude of impact is therefore considered to be **Low** at these locations as the changes are not considered to be sufficiently persistent to result in any morphological change of the banks.

Regional coastline morphology

6.10.34 With respect to changes at the coast, based upon the quantitative analysis of potential changes to the wave regime (**Section 6.10 paragraphs 6.10.11** to **6.10.17**) there will be no measurable reduction in wave height at adjacent coastlines. This is because the reductions in wave height along the downwind margin of the array area will be less than 2.5 percent. Changes in wave height of this magnitude are small in both absolute and relative terms. Such small differences are not measurable in practice and would be indistinguishable from normal short term natural variability in wave height (both for individual wave heights and in terms of the overall sea state). Accordingly, these changes are not predicted to have any measurable influence on alongshore or cross-shore sediment transport. Magnitude of impact is therefore considered to be **Very Low** at these locations with changes not discernible from background conditions.

Sensitivity or value of receptor

6.10.35 The receptors which could be affected by changes in the sediment transport regime through the presence of Proposed Development infrastructure are considered as follows:

- nationally and internationally designated sites are considered to have a **Medium** sensitivity: although designated, they have moderate capacity to accommodate the proposed form of change;
- coastline morphology considered to have a **Medium** sensitivity. They have a moderate capacity to accommodate the proposed form of change but are considered to be of regional level importance with respect to its value for biodiversity, socio-economics and coastal defence; and
- recreational surfing venues are considered to have a **Medium** sensitivity. They have a low capacity to accommodate the proposed form of change and have moderate socioeconomic importance; and
- nearby offshore sandbanks which are not designated are considered to have a **Low** sensitivity because they have a moderate capacity to accommodate change in the sediment transport regime.

Significance of residual effect

6.10.36 The assessment has concluded that the magnitude of impact of windfarm infrastructure on the sediment transport regime, and hence morphology, for all receptors is Low. Based upon the sensitivities identified above, the significance of residual effect is as follows:

- nationally and internationally designated sites: **Minor adverse** (**Not Significant**);
- coastline morphology: **Minor adverse** (**Not Significant**);
- recreational surfing venues: **Minor adverse** (**Not Significant**);
- nearby offshore sandbanks (East Bank & northern Outer Owers Bank: **Negligible** (**Not Significant**); and
- nearby offshore sandbanks (Hooe Bank & southern Outer Owers Bank: **Minor adverse** (**Not Significant**).

6.10.37 These effects will be indirect and permanent for the duration of the windfarm.

Seabed scour due to the presence of windfarm infrastructure

Overview

6.10.38 There is the potential for the seabed around marine structures to become modified from its natural state through scour. This can occur through:

- a different (coarser) surface sediment grain size distribution developing due to winnowing of finer material by the more energetic flow within the scour pit;
- a different surface character will be present if scour protection (for example, rock protection) is used;
- seabed slopes may be locally steeper in the scour pit; and
- flow speed and turbulence may be locally elevated.

6.10.39 Scour can also potentially impact other aspect receptors through habitat alteration and the volume and rate of additional sediment resuspension.

6.10.40 The magnitude of any change will vary depending upon the foundation type, the local baseline oceanographic and sedimentary environments and the type of scour protection implemented (if needed). In some cases, the modified sediment character within a scour pit may not be so different from the surrounding seabed; however, changes relating to bed slope and elevated flow speed and turbulence close to the foundation are still likely to apply.

Magnitude of impact or change

6.10.41 A detailed scour assessment is provided in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3). The assessment assumes that embedded environmental measures in the form of scour protection (C-39) (**Table 6-12**) will be installed subject to the conclusions of the Outline Scour Protection and Cable Plan (C- 44). The outcomes of the assessment are:

- Scour development within the Rampion 2 array area is expected to be dominated by the action of tidal currents.
- Scour will only occur if and where scour protection is not applied.
- Some or all scour may occur in timescales of hours to days (so before the placement of scour protection) depending on the strength of tidal currents in that place and time. If applied, scour protection will likely cover at least the expected footprint of any scour.
- Scour development within the Rampion 2 array area is expected to be dominated by the action of tidal currents but occasional wave contribution is possible for jackets on pin piles or jacket on suction buckets in shallower parts of the site.
- Erosion resistant (pre-Holocene) material is present at or close to the seabed in most parts of the western array area of the Proposed DCO Order Limits and in the northern part of the eastern array area of the Proposed DCO Order Limits. In practice, this is likely to lead to a natural limitation of scour depth and a related reduction in the footprint and volume of seabed affected by scour in these areas, both for individual foundations and for that proportion of the array as a whole. The following assessment conservatively assumes no such limit to the dimensions of scour.
- The greatest area of local scour (per WTG foundation) is associated with the larger WTG monopile, with a potential area of 3,669m^2 susceptible to scour development.
- The greatest volume of local scour (per WTG foundation) is associated with the larger WTG type WTG monopile, with a potential scoured volume of 24,950m^3 per foundation.
- For the Rampion 2 array as a whole, the greatest total footprint of local scour will be associated with an array of 65 x larger WTG type, monopile foundations and three OSS jacket with pin pile foundations. The potential spatial extent of

this scour (excluding the footprint of the foundations) is 247,384m^2, corresponding to approximately 0.13 percent of the total Rampion 2 array area.

- For the Rampion 2 array as a whole, the greatest total footprint of global scour will be associated with an array of 65 x larger WTG type jacket with pin pile foundations and three OSS jacket with pin pile foundations. The potential spatial extent of this scour is 503,452m^2, corresponding to approximately 0.26 percent of the total Rampion 2 array area.

6.10.42 There are no coastal processes receptors that are sensitive to the effects of scour.

Sensitivity or value of receptor

6.10.43 All the identified coastal process receptors are insensitive to the scour described in this section. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 8: Fish and shellfish ecology, Volume 2** of the ES (Document Reference: 6.2.8) (due to changes in local seabed level and surface sediment texture in the scour pit);
- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** of the ES (Document Reference: 6.2.9) (due to changes in local seabed level and surface sediment texture in the scour pit); and
- **Chapter 10: Commercial fisheries, Volume 2** of the ES (Document Reference: 6.2.10) (due to changes in local seabed level and surface sediment texture in the scour pit).

Significance of residual effect

6.10.44 There are no coastal process receptors sensitive to scour and the assessment of residual effect is not applicable.

6.11 Assessment of effects: Decommissioning phase

Changes to SSC, bed levels and sediment type due to removal of foundations

Overview

6.11.1 The following decommissioning activities could potentially give rise to increases in SSC and associated deposition of material within the Rampion 2 array area and export cable corridor:

- removal of foundation structures;
- cutting off of (monopile or jacket) foundation legs;
- cutting off export, array and interconnector cables and leaving in-situ; and/or
- (possible) removal of cables from the intertidal zone or other specific locations.

6.11.2 However, any changes will be comparable (or less than) to those already identified and described for the construction phase (**Section 6.9**).

Magnitude of impact or change

6.11.3 Changes to the wave, tidal or sediment transport regimes as a consequence of the decommissioning phase are mainly related to the local change associated with individual foundations. Changes associated with less than the total number of foundations and amount of cable protection will vary in proportion to the amount installed or removed, and so will only ever be less than the operational phase results during the construction and operation phases.

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

6.11.5 Post-decommissioning, the Rampion 2 array area and export cable corridor is expected to return to baseline conditions, within the range of natural variability and allowing for some measure of climate change.

6.11.6 There are no coastal processes receptors that are sensitive to increases in magnitude of SSC and deposition of disturbed sediments to the seabed due to removal of windfarm infrastructure.

Sensitivity or value of receptor

6.11.7 All the identified coastal process receptors are insensitive to changes in SSC and changes in bed levels identified from the assessment. There is the potential for these changes to affect other aspect receptors, in particular:

- **Chapter 7: Other marine users, Volume 2** of the ES (Document Reference: 6.2.7) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 8: Fish and shellfish ecology, Volume 2** (Document Reference: 6.2.8) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 9: Benthic, subtidal and intertidal ecology, Volume 2** (Document Reference: 6.2.9) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 10: Commercial fisheries, Volume 2** (Document Reference: 6.2.10) (due to potential changes in seabed morphology, smothering and suspended sediments);
- **Chapter 11: Marine mammals, Volume 2** (Document Reference: 6.2.11) (due to potential changes in suspended sediments affecting prey species and other indirect effects);
- **Chapter 12: Offshore and intertidal ornithology, Volume 2** (Document Reference: 6.2.12) (due to potential changes in seabed morphology,

smothering and suspended sediments, affecting prey species and other indirect effects); and

- **Chapter 26: Water environment, Volume 2** (Document Reference: 6.2.26) (due to potential changes in suspended sediments).

Significance of residual effect

6.11.8 There are no coastal process receptors sensitive to the impact pathway and assessment of residual effect is not applicable.

Changes to landfall morphology due to removal of export cable at the landfall

Magnitude of impact or change

6.11.9 At the point of decommissioning, it is expected that the export cable at and near to the landfall will be buried along its full length, either within a cable trench in the subtidal area (with or without cable protection) or within the HDD conduit under the beach (including any coastal defences and the coastal hinterland).

6.11.10 If and where cables are decommissioned in situ (cut and left buried), they will have no potential to affect coastal processes for as long as they remain buried.

6.11.11 If and where cables are decommissioned by removal, they may need to be pulled or excavated from the seabed, and pulled back through the HDD conduit. The excavation processes will be no greater than that required for the original installation. The dimensions, duration and locations of excavated pits will be no larger than the HDD exit pits described in relation to construction.

6.11.12 If and where cable protection has been present during the operational phase and is removed during decommissioning, the adjacent seabed and beach will have reached a new equilibrium morphology. The removal of the protection will allow further natural evolution of the beach towards a new equilibrium state controlled by the future baseline condition of the beach, including changes in the position and shape of the surrounding coastline, and the nature of a future coastal management strategy.

6.11.13 The magnitude of change will not exceed that described in relation to the construction phase.

Sensitivity or value of receptor

6.11.14 The sensitivity of the Climping Beach SSSI as well as the wider coastal morphology at the landfall is considered to be **Medium**, reflecting that the receptor has some ability to tolerate the potential impacts and can reasonably be expected to recover to its baseline condition should morphological change occur.

Significance of residual effect

6.11.15 The assessment has concluded that the magnitude of impact on the morphology of the landfall arising from decommissioning related activities is either Low or Very

Low. Based upon the Medium sensitivity of the receptor identified above, the significance of residual effect is **Minor adverse** (**Not Significant**).

6.11.16 Effects will be indirect and temporary and **Not Significant** in EIA terms.

Changes to the tidal, wave, sediment transport regimes and seabed scour due to removal/presence of less than all windfarm infrastructure

6.11.17 The installation of any WTG foundations, OSS foundations and cable protection measures all have the potential to result in a localised blockage of waves, tides and sediment transport. This blockage will commence when offshore construction begins, increasing incrementally up to fully operational Proposed Development and then reduce as decommissioning commences. WTG and OSS foundation decommissioning may take up to four years in total to complete.

6.11.18 The changes in the wave, tide and sediment transport regimes (including seabed scour) as a result of the fully operational Proposed Development are set out in **Section 6.10** above. This has been assessed through the numerical modelling of various completed layouts and wave climate scenarios as presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3).

6.11.19 The magnitude of change to these parameters will not be exceeded during the construction (or decommissioning) phase since the number of installed foundations and the amount of cable protection will be less than for the fully operational Proposed Development.

6.11.20 During decommissioning, the removal of some or all infrastructure will result in a partial or complete reduction in the associated potential changes during the operational phase. Although returning to a state closer to the (future) natural baseline condition, this will be experienced as a relative change. Where the local environment has evolved to a new equilibrium with the installed infrastructure during the operational phase, there will be a period of adjustment back to a new natural equilibrium condition in the context of the future baseline environment. The scale and timescale of adjustment will be driven by similar processes and so will occur in a similar manner and rate to that described for the construction and operation phases.

Sensitivity or value of receptor

6.11.21 The receptors which could be affected by changes in the tidal, wave and sediment transport regimes through the presence of Proposed Development infrastructure are considered as follows:

- nationally or internationally designated sites are considered to have a **Medium** sensitivity: although designated, they have moderate capacity to accommodate the proposed form of change;
- recreational surfing venues are considered to have a **Medium** sensitivity. They have a low capacity to accommodate the proposed form of change and have moderate socioeconomic importance;

- coastline morphology considered to have a **Low** sensitivity. It has a moderate to high capacity to accommodate the proposed form of change but is not designated; and
- nearby offshore sandbanks are considered to have a **Low** sensitivity. They have a moderate capacity to accommodate change.

Significance of residual effect

6.11.22 The changes in the wave, tide and sediment transport regimes (including seabed scour) as a result of the fully operational Proposed Development are set out in **Section 6.10** above.

6.12 Assessment of cumulative effects

Approach

6.12.1 A cumulative effects assessment (CEA) examines the combined impacts of Rampion 2 in combination with other developments on the same single receptor or resource and the contribution of Rampion 2 to those impacts. The overall method followed in identifying and assessing potential cumulative effects in relation to the onshore environment is set out in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference: 6.2.5).

6.12.2 The offshore screening approach is based on the Planning Inspectorate's Advice Note Nine (Planning Inspectorate, 2018) and Advice Note Seventeen (Planning Inspectorate, 2019), with relevant components of the RenewableUK (RenewableUK, 2013) accepted guidance, which includes aspects specific to the marine elements of an offshore wind farm, addressing the need to consider mobile wide-ranging species (foraging species, migratory routes etc).

Cumulative effects assessment

6.12.3 For coastal processes, the ZOI has been applied for the CEA to ensure direct and indirect cumulative effects can be appropriately identified and assessed. The ZOI for changes to currents and any sediment disturbance related effects is defined by the 'tidal excursion' buffer which describes the greatest distance that water (and any effect it is carrying) is likely to be displaced outside of the array area during a mean spring tidal condition. The wider study area ZOI includes the offshore areas and coastlines that might potentially experience changes to wave conditions as a result of waves passing through the array area. The coastal processes ZOI is shown in **Figure 6.1, Volume 3** of the ES (Document Reference: 6.3.6).

6.12.4 A short list of 'other developments' that may interact with the Rampion 2 ZOIs during their construction, operation or decommissioning is presented in **Appendix 6.3: Coastal processes technical report: Impact assessment, Volume 4** of the ES (Document Reference: 6.4.6.3) and **Appendix 5.4: Cumulative effects assessment shortlisted developments, Volume 4** of the ES (Document Reference: 6.4.5.4). This list has been generated applying criteria set out in **Chapter 5: Approach to the EIA, Volume 2** of the ES (Document Reference:

6.2.5) and has been collated up to the finalisation of the ES through desk study, consultation and engagement.

6.12.5 Only those 'other developments' in the short list that fall within the coastal processes ZOI have the potential to result in cumulative effects with the Proposed Development on coastal processes. All 'other developments' falling outside the coastal processes ZOI are excluded from this assessment. The following types of 'other development' have the potential to result in cumulative effects on coastal processes.

6.12.6 In terms of the potential for cumulative changes to SSC, bed levels and sediment type, the screening approach is informed using modelled spring tidal excursion ellipses. This is because meaningful sediment plume interaction generally only has the potential to occur if the activities generating the sediment plumes are located within one spring tidal excursion ellipse from one another and occur at the same time.

6.12.7 Given the length and orientation of tidal excursion ellipses in the vicinity of Rampion 2, it is the case that the potential for sediment plume interaction would be limited to instances in which Rampion 2 construction activities occur simultaneously with**:**

- dredge disposal activities; and
- aggregation extraction operations.

6.12.8 On the basis of the above, the 'other developments' that are scoped into the coastal processes CEA are outlined in **Table 6-13**.

Table 6-13 Developments considered as part of the coastal processes CEA

ID	Development type	Development name	Application reference	Status	Confidence in assessment	Tier[3]	Distance to Rampion 2 (km)
D6	Unknown waste type	AQUIND	Open disposal site - AQUIND Cable Site A	Open	High – Third-party project details published in the public domain and confirmed as being ‘accurate’ by the developer.	Tier 1	0km to Rampion 2 array area, 5km to Rampion 2 offshore export cable corridor
A396/1	Aggregates	Aggregate dredging licence area	396/1 Inner Owers – Tarmac Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being ‘accurate’ by the developer.	Tier 1	0km to Rampion 2 array area, 0.1km to Rampion 2 offshore export cable corridor
A396/2	Aggregates	Aggregate dredging licence area	396/2 Inner Owers – Tarmac Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and	Tier 1	3.42km to Rampion 2 array area,

[3] Chapter 5: Approach to the EIA, Volume 2 of the ES (Document Reference 6.2.5) sets out the full definitions of the tiers. Tier 1: high level of certainty or information availability (including under construction or where a planning application has been approved or is awaiting decision). Tier 2: medium level of certainty or information (such as developments on PINS Programme of Projects where a Scoping Report has been submitted). Tier 3: low level of certainty or information available (no planning applications submitted or identified for potential future development only).

ID	Development type	Development name	Application reference	Status	Confidence in assessment	Tier[3]	Distance to Rampion 2 (km)
					confirmed as being 'accurate' by the developer.		2km to Rampion 2 offshore export cable corridor
A435/1	Aggregates	Aggregate dredging licence area	435/1 Inner Owers – Hanson Aggregates Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	Tier 1	0.7km to Rampion 2 array area, 2.7km to Rampion 2 offshore export cable corridor
A435/2	Aggregates	Aggregate dredging licence area	435/2 Inner Owers – Hanson Aggregates Marine Ltd	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	Tier 1	1.5km to Rampion 2 array area, 6.4km to Rampion 2 offshore export cable corridor
A488	Aggregates	Aggregate dredging licence area	488 Inner Owers North – Tarmac Marine Ltd.	Active (end date 07/07/2030)	High – Third-party project details published in the public domain and confirmed as being 'accurate' by the developer.	Tier 1	5.4km to Rampion 2 array area, 0.5km to Rampion 2 offshore export cable corridor

ID	Development type	Development name	Application reference	Status	Confidence in assessment	Tier[3]	Distance to Rampion 2 (km)
A453	Aggregates	Aggregate dredging licence area	453 Owers Extension – CEMEX UK Marine Ltd.	Active (end date 31/03/2032)	High – Third-party project details published in the public domain and confirmed as being ‘accurate’ by the developer.	Tier 1	5.4km to Rampion 2 array area, 0.4km to Rampion 2 offshore export cable corridor

6.12.9 The cumulative Project Design Envelope is described in **Table 6-14**.

Table 6-14 Cumulative Project Design Envelope for coastal processes

Project phase and activity/impact	Scenario	Justification
Cumulative temporary increases in SSC and associated sediment deposition	Tier 1: Construction phase AQUIND Interconnector cable reburial activities. Tier 1: Construction phase Aggregate dredging activities at nearby license areas. The above - simultaneously and in sufficiently close proximity to construction activities in Rampion 2 also causing sediment disturbance.	The AQUIND Interconnector cable may require localised reburial or maintenance activities temporarily causing localised sediment disturbance. Aggregate dredging is routinely carried out in these areas. Although the exact magnitude, duration and timing of the other development effects are unknown, they are individually likely to be localised, short-term and temporary.

6.12.10 The following other developments have the potential to result in cumulative effects on coastal processes, the locations of which are shown in **Figure 6.5, Volume 3** of the ES (Document Reference: 6.3.6):

- the interaction between sediment plumes generated by Rampion 2 cable or foundation installation activities and dredge disposal operations associated with the AQUIND interconnector; and
- active aggregate dredging licence areas (Inner Owers, Inner Owers North and Inner Owers Extension) are sufficiently close (within one tidal excursion distance) that an overlapping plume effect could occur.

6.12.11 The CEA for coastal processes is set out in the following sections.

Dredge disposal activities

6.12.12 The AQUIND interconnector cable corridor (which would be installed across the seabed in the south-western part of the western array area of the Proposed DCO Order Limits) is a licenced dredge disposal site ('AQUIND Cable Site A'). Although it is understood that the interconnector will be installed by the end of 2023 (well before construction of Rampion 2), it is possible that future cable reburial activities may require disposal of material at this site. Should Rampion 2 construction activities be occurring at the same time as dredge disposal activities at this site, there could be the potential for cumulative changes in SSC and bed levels.

6.12.13 The interaction between sediment plumes generated by Rampion 2 cable or foundation installation activities and those from nearby dredge disposal operations could occur in two ways:

- where plumes generated from the two different activities meet and coalesce to form one larger plume; or
- where a vessel or barge is disposing of material within the plume generated by Rampion 2 construction activities (or vice versa).

6.12.14 Given the very close proximity of the two activities, it is considered that both types of plume interaction could potentially occur. However, it is noted that in line with UNCLOS, (The United Nations Convention on the Law of the Sea), cable installation vessels typically request a one nautical mile (circa 1.85km) vessel safety zone when installing or handling cables. In addition to direct communications between the ships, this process will likely be managed via vessel management plans and official bulletins, such as notice to mariners. Accordingly, whilst plume interaction may still occur, the potential for much higher concentration and/or more persistent plumes than that previously described in the Proposed Development-alone assessments of SSC is small.

6.12.15 Cumulative increases in bed level could also theoretically occur although the potential for this to occur is expected to be very low, given the expected separation distance of the vessels.

Aggregate dredging activities

6.12.16 Only a small number of active aggregate dredging license areas (namely: Inner Owers; Inner Owers North; and Inner Owers Extension) are sufficiently close to Rampion 2 (within one tidal excursion distance) that an overlapping plume effect is at all likely.

6.12.17 The aggregate dredging sites are located immediately to the north of the array area and immediately to the east of the export cable corridor. The orientation of the tidal axis means that interaction between plumes created by aggregate dredging and activities in the array area are very unlikely. Some overlap of plumes might occur in relation to export cable burial in the offshore end of the export cable corridor only, however, as assessed in **Section 6.9 paragraphs 6.9.21** to **6.9.31**, the extent and duration of sediment plumes from cable burial are very limited.

6.12.18 Any cumulative increase in either the spatial footprint or peak concentration of sediment plumes are therefore likely to be indistinguishable from background levels. Any associated cumulative changes in bed level (different to that already assessed for Rampion 2 alone) are also unlikely to be measurable in practice.

6.13 Transboundary effects

6.13.1 Transboundary effects arise when impacts from a development within one European Economic Area (EEA) states affects the environment of another EEA state(s). A screening of transboundary effects has been carried out and is presented in Appendix B of the Scoping Report (RED, 2020).

6.13.2 No transboundary effects have been identified. This is because the predicted changes to the key coastal process pathways (i.e. tides, waves, and sediment transport) are not anticipated to be sufficient to influence identified receptors at this distance from Rampion 2.

6.14 Inter-related effects

6.14.1 The inter-related effects assessment considers likely significant effects from multiple impacts and activities from the construction, O&M and decommissioning phases of Rampion 2 on the same receptor, or group of receptors.

6.14.2 Inter-related effects could potentially arise in one of two ways. The first type of inter-related effect is a Proposed Development lifetime effect, where multiple phases of the Proposed Development interact to create a potentially more significant effect on a receptor than in one phase alone. The phases for Rampion 2 are construction, O&M, and decommissioning. All Proposed Development lifetime effects are assessed in **Chapter 30: Inter-related effects, Volume 2** of the ES (Document Reference: 6.2.30).

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

6.14.4 The coastal processes assessments inherently consider inter-related effects within the range of parameters and impact types set out within this Chapter, with the assessments presenting information on what essentially comprise impact pathways for other topics (for example increased SSC and deposition representing a potential impact pathway for benthic ecology receptors). As such, there is limited potential for inter-related effects to arise on coastal processes.

6.14.5 Full results of the receptor-led effects assessment can be found in **Chapter 30: Inter-related effects, Volume 2** of the ES (Document Reference: 6.2.30).

6.15 Summary of residual effects

6.15.1 **Table 6-15** presents a summary of the assessment of significant impacts, any relevant embedded environmental measures and residual effects on coastal processes receptors.

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Table 6-15 Summary of assessment of residual effects

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Construction				
Increases in SSC and deposition of disturbed sediments to the seabed due to drilling for foundation installation	Potential pathway of effect for other aspects			
Increases in SSC and deposition of disturbed sediments to the seabed due to dredging for seabed preparation prior to installing jacket foundations	Potential pathway of effect for other aspects			
Increases in SSC and deposition of disturbed sediments to the seabed due to cable installation	Potential pathway of effect for other aspects			
Increases in SSC and deposition of sediment to the	Potential pathway of effect for other aspects			

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
seabed due to HDD drilling fluid release				
Changes to landfall morphology due to installation of export cable at the landfall	**Low**	Local coastline morphology - **Medium** Designated sites - **Medium**	C-41, C-42, C-43, C44, C45	Minor adverse (**Not Significant**)
Changes to the tidal, wave, sediment transport regimes and seabed scour as a result of the presence of less than all windfarm infrastructure	**Very low**	Designated sites – **Medium**	C-38, C-39, C-40, C-41, C-42, C-43, C44, C45	Minor adverse (**Not Significant**)
		Regional coastline morphology - **Medium**		Minor adverse (**Not Significant**)
		Recreational surfing venues - **Medium**		Minor adverse (**Not Significant**)
		Offshore sandbanks - **Low**		Negligible (**Not Significant**)
Operation and maintenance				

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Changes to the tidal regime due to presence of windfarm infrastructure	Potential pathway of effect for other aspects			
Changes to the wave regime (presence of wind farm infrastructure)	**Low**	Hooe Bank and southern Outer Owers - **Low**	C-38, C-39, C-40, C-41, C-42, C-43, C44, C45	Minor adverse (**Not Significant**)
	Very Low	East Bank and northern Outer Owers Bank - **Low**		Negligible (**Not Significant**)
	Very Low	Surfing Venues - **Medium**		Minor adverse (**Not Significant**)
Changes to the sediment transport regime due to presence of wind farm infrastructure	**Very low**	Designated sites - **Medium**	C-38, C-39, C-40, C-41, C-42, C-43, C44, C45	Minor adverse (**Not Significant**)
	Very low	Regional coastline morphology - **Medium**		Minor adverse (**Not Significant**)
	Very low	Recreational surfing venues - **Medium**		Minor adverse (**Not Significant**)

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
	Very low	East Bank and northern Outer Owers Bank - **Low**		Negligible (**Not Significant**)
	Low	Hooe Bank and southern Outer Owers - **Low**		Minor adverse (**Not Significant**)
Seabed scour due to the presence of windfarm infrastructure	Potential pathway of effect for other aspects			
Decommissioning				
Changes to SSC, bed levels and sediment type due to removal of foundations	Potential pathway of effect for other aspects			
Changes to landfall morphology due to removal of export cable at the landfall	**Low**	Local coastline morphology - **Medium**	C-42, C-43, C44, C45	Minor adverse (**Not Significant**)
	Low	Nationally designated sites - **Medium**	C-42, C-43, C44, C45	Minor adverse (**Not Significant**)

Activity and impact	Magnitude of impact	Receptor and sensitivity or value	Embedded environmental measures	Assessment of residual effect (significance)
Changes to the tidal, wave, sediment transport regimes and seabed scour due to removal/presence of less than all windfarm infrastructure	**Very low**	Designated sites - **Medium**	C-38, C-39, C-40, C-41, C-42, C-43, C44, C45	Minor adverse (**Not Significant**)
		Regional coastline morphology - **Medium**		Minor adverse (**Not Significant**)
		Recreational surfing venues - **Medium**		Minor adverse (**Not Significant**)
		Offshore sandbanks - **Low**		Negligible (**Not Significant**)

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6.16 Glossary of terms and abbreviations

Table 6-16 Glossary of terms and abbreviations – coastal processes

Term (acronym)	Definition
Accretion	Build-up (accumulation) of material solely by the deposition of water or airborne material through natural processes.
Astronomical tide	The tide levels and character which would result from the gravitational effects of the earth sun and moon without any atmospheric influences.
Baseline	Refers to existing conditions as represented by latest available survey and other data which is used as a benchmark for making comparisons to assess the impact of development.
Baseline conditions	The environment as it appears (or would appear) immediately prior to the implementation of the Proposed Development together with any known or foreseeable future changes that will take place before completion of the Proposed Development.
Beach	A deposit of non-cohesive material (for example, sand, gravel) situated on the interface between dry land and the sea (or other large expanse of water) and actively "worked" by present-day hydrodynamic processes (for instance waves, tides and currents) and sometimes by winds.
Beach profile	A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or seawall, extend over the backshore, across the foreshore, and seaward underwater into the nearshore zone.
Bedforms	Features on the seabed (for example, sandwaves, ripples) resulting from the movement of sediment over it.
Bedload	Sediment particles that travel near or on the bed.
Benthic	A description for animals, plants and habitats associated with the seabed. All plants and animals that live in, on or near the seabed are benthos.
Biodiversity	Biodiversity is an all-inclusive term to describe the living organisms of the planet.

Term (acronym)	Definition
Centre for Environment, Fisheries and Aquaculture Science (Cefas)	The UK government's marine and freshwater science experts. https://www.cefas.co.uk/
Climate change	A long term trend in the variation of the climate resulting from changes in the global atmospheric and ocean temperatures and affecting mean sea level, wave height, period and direction, wind speed and storm occurrence.
Coast	A strip of land of indefinite length and width that extends from the seashore inland to the first major change in terrain features.
Coastal processes	Collective term covering the action of natural forces on the coastline and adjoining seabed.
Coastal retreat	Natural recession of a coastline over time.
Code of Construction Practice (COCP)	The code sets out the standards and procedures to which developers and contractors must adhere to when undertaking construction of major projects. This will assist with managing the environmental impacts and will identify the main responsibilities and requirements of developers and contractors in constructing their projects.
Construction (Effects)	Used to describe both temporary effects that arise during the construction phases as well as permanent existence effects that arise from the physical existence of development (for example new buildings).
(candidate) Special Area of Conservation (cSAC)	A candidate area for designation as a Special Area of Conservation (SAC).
Cumulative effects	Additional changes caused by a Proposed Development in conjunction with other similar developments or as a combined effect of a set of developments.
Cumulative Effects Assessment (CEA)	Assessment of impacts as a result of the incremental changes caused by other past, present and reasonably foreseeable human activities and natural processes together with the Proposed Development.
DCO Application	An application for consent under the Planning Act 2008 to undertake a Nationally Significant Infrastructure Project made to the Planning Inspectorate who will consider the application and make a recommendation to the Secretary of State, who will decide on whether development consent should be granted for the Proposed Development.

Term (acronym)	Definition
Decommissioning	The period during which a development and its associated processes are removed from active operation.
Development Consent Order (DCO)	This is the means of obtaining permission for developments categorised as Nationally Significant Infrastructure Projects, under the Planning Act 2008.
Embedded environmental measures	Equate to ‘primary environmental measures’ as defined by Institute of Environmental Management and Assessment (2016). They are measures to avoid or reduce environmental effects that are directly incorporated into the design of the Proposed Development.
Environmental Impact Assessment (EIA)	The process of evaluating the likely significant environmental effects of a proposed project or development over and above the existing circumstances (or ‘baseline’).
Environmental measures	Measures which are proposed to prevent, reduce and where possible offset any significant adverse effects (or to avoid, reduce and if possible, remedy identified effects.
Environmental Statement (ES)	The written output presenting the full findings of the Environmental Impact Assessment.
Erosion	Movement of material by such agents as running water, waves, wind, moving ice and gravitational creep.
Expert Topic Group (ETG)	A group of topic experts who will meet to discuss the development of the PEIR and ES documents. Typically including representatives from the wind farm developer, the lead EIA consultant, EIA topic consultants, and relevant regulatory stakeholder groups.
Eustatic (changes to mean sea level)	Changes in local mean sea level as a result of changes to the volume of water present in the global ocean, or regional sea, due to climate change.
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach and the information required to support the EIA and HRA for certain aspects.
Future baseline	Refers to the situation in future years without the Proposed Development.
Habitat	The place in which a plant or animal lives. It is defined for the marine environment according to geographical location, physiographic features and the physical and

Term (acronym)	Definition
	chemical environment (including salinity, wave exposure, strength of tidal streams, geology, biological zone, substratum, 'features' (for example, crevices, overhangs, rockpools) and 'modifiers' (for example, sand-scour, wave-surge, substratum mobility).
Hindcast	The retrospective prediction of historical (wind and wave) conditions.
Horizontal Directional Drill (HDD)	A trenchless crossing engineering technique using a drill steered underground without the requirement for open trenches. This technique is often employed when crossing environmentally sensitive areas, major water courses and highways. This method is able to carry out the underground installation of pipes and cables with minimal surface disruption.
Hydrodynamic regime	The characteristic patterns and statistics of variation in water levels and currents for a given location or area. Potentially includes tidal, surge and other residual flow processes; (does not include waves).
Impact	The changes resulting from an action.
Indirect effects	Effects that result indirectly from the Proposed Development as a consequence of the direct effects, often occurring away from the site, or as a result of a sequence of interrelationships or a complex pathway. They may be separated by distance or in time from the source of the effects. Often used to describe effects on landscape character that are not directly impacted by the Proposed Development such as effects on perceptual characteristics and qualities of the landscape.
Intertidal zone	The zone between the highest and lowest tides. May also be referred to as the littoral zone.
Isostatic (changes to mean sea level)	Changes in local mean sea level as a result of changes to the local height of the coastline, due to geological processes.
Lowest Astronomical Tide (LAT)	The lowest tidal water level locally occurring during an approximately 18.6 year period.
Likely Significant Effects	It is a requirement of Environmental Impact Assessment Regulations to determine the likely significant effects of the Proposed Development on the environment which

Term (acronym)	Definition
	should relate to the level of an effect and the type of effect.
Littoral processes	The movement of beach material in the littoral zone by waves and currents. Includes movement parallel (longshore transport) and perpendicular (onshore-offshore transport) to the shore.
Longshore transport	Or alongshore or littoral drift or transport. Movement of sand and shingle along the shore. It takes place in two zones, at the upper limit of wave activity and in the breaker zone. Movement of beach (sediments) approximately parallel to the coastline.
Magnitude (of change)	A term that combines judgements about the size and scale of the effect, the extent of the area over which it occurs, whether it is reversible or irreversible and whether it is short term or long term in duration'. Also known as the 'degree' or 'nature' of change.
Marine Conservation Zone (MCZ)	An area designated for protection of certain characteristic features under various UK regulations.
Maximum Design Scenario (MDS)	The design scenario corresponding to the greatest potential impacts, out of the range of design options being considered.
Morphological evolution	Change in the dimensions or orientation of a morphological feature as a result of net changes in the volume or location of the material it comprises, for example: the seabed; sediment bedforms; sandbanks; coastlines.
Morphology	Of or relating to the form, shape and structure of landforms
Neap tides	Tides with the smallest range between high and low water, occurring at the first and third quarters of the moon.
National Policy Statement (NPS)	National Policy Statements are produced by the UK government to describe reasons and objectives for the development of nationally significant infrastructure in a particular sector and state.
Marine Management Organisation (MMO)	The MMO's purpose is to protect and enhance the UK marine environment, and to support UK economic growth by enabling sustainable marine activities and development.

Term (acronym)	Definition
	https://www.gov.uk/government/organisations/marine-management-organisation
Operation and Maintenance (O&M)	The operational phase of the wind farm, following construction and up to decommissioning. The wind farm is operational (generating electricity); routine and unplanned maintenance will be undertaken as needed throughout this period.
Ordnance Datum Newlyn (ODN)	An Ordnance Datum is the vertical datum used to define heights in maps from the UK Ordnance Survey. ODN is the Ordnance Datum for Ordnance Surveys in Britain (defined as the mean sea level between 1915 and 1921 at the tide gauge in Newlyn, Cornwall).
Offshore Substation (OSS)	An electrical substation, typically mounted on a foundation, in the offshore environment.
Palaeo-channels	a geological term describing the remains of an inactive river or stream channel that has been filled or buried by younger sediment
Passive dispersion	When the sediment is dispersing by ambient tidal and wave conditions, and turbulence (the dispersion is not influenced by the activity causing the plume).
Planning Inspectorate (PINS)	The Planning Inspectorate deals with planning appeals, national infrastructure planning applications, examinations of local plans and other planning-related and specialist casework in England and Wales.
Preliminary Environmental Information Report (PEIR)	The written output of the Preliminary Environmental Impact Assessment undertaken for the Proposed Development. It was developed to support Statutory Consultation and presented the preliminary findings of the assessment to allow an informed view to be developed of the Proposed Development, the assessment approach that was undertaken, and the preliminary conclusions on the likely significant effects of the Proposed Development and environmental measures proposed.
Proposed DCO Order Limits	The proposed DCO Order Limits combines the search areas for the offshore and onshore infrastructure associated with the Proposed Development. It is defined as the area within which the Proposed Development and associated infrastructure will be located, including the temporary and permanent construction and operational work areas.

Term (acronym)	Definition
Proposed Development	The development that is subject to the application for development consent, as described in **Chapter 4: The Proposed Development** of the ES (Document Reference 6.2.4).
Receptor	These are as defined in Regulation 5(2) of The Infrastructure Planning 'Environmental Impact Assessment' Regulations 2017 and include population and human health, biodiversity, land, soil, water, air, climate, material assets, cultural heritage and landscape that may be at risk from exposure to direct and indirect impacts as a result of the Proposed Development.
Regime	The behaviour, statistical properties and trends characterising the variability of hydrodynamic, meteorological, sedimentological and morphological parameters.
Return period	In statistical analysis an event with a return period of N years is likely, on average, to be exceeded only once every N years.
Special Area of Conservation (SAC)	An area designated for protection of certain characteristic features under various UK regulations.
Salinity	Measure of all the salts dissolved in water.
Sandwave asymmetry	Shape of the sandwave as a result of tidal asymmetry
Site of Community Importance (SCI)	An area designated for protection of certain characteristic features under various UK regulations.
Scoping Opinion	A Scoping Opinion is adopted by the Secretary of State for a Proposed Development.
Scoping Report	A report that presents the findings of an initial stage in the Environmental Impact Assessment process.
Scour	Local erosion of sediments caused by local flow acceleration around an obstacle and associated turbulence enhancement.
Seastate	The state of the sea as described using the Douglas sea scale, based on wave height and swell, ranging from 1 to 10, with accompanying descriptions.
Secretary of State	The senior minister who makes the decision to grant development consent.

Term (acronym)	Definition
Sediment	Particulate matter derived from rock, minerals or bioclastic debris.
Sediment deposition	Settlement of sediment in suspension back to the seabed, causing a localised accumulation.
Sediment plume	A sediment plume is a cloud of water containing higher suspended sediment concentration than the surrounding water body. The plumes form as a result of seabed disturbance activities (for example excavation or dredging). Plumes usually begin either at the bottom where the dredging/excavation takes place, or at the surface from either overflow from dredging equipment or disposal of dredged material in a different location.
Sediment transport	The movement of sediment by natural processes, as individual grains or as a collective volume.
Sediment transport pathway	The routes along which net sediment movements occur.
Sensitivity	A term applied to specific receptors, combining judgements of the susceptibility of the receptor to the specific type of change or development proposed and the value associated to that receptor.
Shoreline Management Plan (SMP)	A Shoreline Management Plan (SMP) is a large-scale assessment of the risks associated with coastal processes. It aims to lessen these risks to people and the developed, historic and natural environments.
Significance	A measure of the importance of the environmental effect, defined by criteria specific to the environmental aspect.
Significant effects	It is a requirement of the EIA Regulations 2017 to determine the likely significant effects of the development on the environment which should relate to the level of an effect and the type of effect. Where possible significant effects should be mitigated. The significance of an effect gives an indication as to the degree of importance (based on the magnitude of the effect and the sensitivity of the receptor) that should be attached to the impact described. Whether or not an effect should be considered significant is not absolute and requires the application of professional judgement.

Term (acronym)	Definition
	Significant – 'noteworthy, of considerable amount or effect or importance, not insignificant or negligible' (The Concise Oxford Dictionary). Those levels and types of landscape and visual effect likely to have a major or important / noteworthy or special effect of which a decision maker should take particular note.
Significant wave height	The average height of the highest of one third of the waves in a given sea state.
Site of Special Scientific Interest (SSSI)	An area designated for protection of certain characteristic features under various UK regulations.
Special Protection Area (SPA)	An area designated for protection of certain characteristic features under various UK regulations.
Spring tides	Tides with the greatest range which occurs at or just after the new and full moon.
Storm surge	A rise in water level in the open coast due to the action of wind stress as well as atmospheric pressure on the sea surface.
Surficial sediment material	Sediments located at the seabed surface (not necessarily of the same character as underlying sediments).
Surge	In water level as a result of meteorological forcing (wind, high or low barometric pressure) causing a difference between the recorded water level and that predicted using harmonic analysis, may be positive or negative.
Suspended load	The material moving in suspension in a fluid, kept up by the upward components of the turbulent currents or by the colloidal suspension.
Suspended sediment concentration (SSC)	Mass of sediment in suspension per unit volume of water.
Swell waves	Wind-generated waves that have travelled out of their generating area. Swell characteristically exhibits a more regular and longer period and has flatter crests than waves within their fetch.
Temporal Scope	The temporal scope covers the time period over which changes to the environment and the resultant effects are predicted to occur and are typically defined as either being temporary or permanent.

Term (acronym)	Definition
Temporary or permanent effects	Effects may be considered as temporary or permanent. In the case of wind energy development the application is for a 30 year period after which the assessment assumes that decommissioning will occur and that the site will be restored. For these reasons the development is referred to as long term and reversible.
The Applicant	Rampion Extension Development Limited (RED)
Tidal asymmetry	1) Relative difference in peak current speed or duration of adjacent flood and ebb half tidal cycles; and/or 2) Relative difference in high or low water levels or duration of adjacent flood and ebb half tidal cycles.
Tidal excursion	The Lagrangian movement (the physics of fluid motion as an individual fluid parcel moves through space and time) of a water particle during a tidal cycle.
Tidal excursion ellipse	The path followed by a water particle in one complete tidal cycle.
Tide	The periodic rise and fall in the level of the water in oceans and seas; the result of gravitational attraction of the sun and moon.
Turbidity	Turbidity is a measure of the degree to which the water loses its transparency due to the presence of suspended particles. Suspended sediment concentration (SSC) refers to the mineral fraction of the suspended solids load whilst SPM includes both the in-organic and organic component.
United Kingdom Climate Projections (UKCP)	UKCP18 is the name given to the latest UK Climate Projections. UKCP18 provides information on plausible changes in 21st century climate for land and marine regions in the United Kingdom.
Water Framework Directive (WFD)	Laws and regulations regarding the quality of water bodies.
Wind Turbine Generator (WTG)	The combined tower, nacelle and blades of a wind turbine, designed to house and drive a generator to create electricity.
Zone of Influence (ZoI)	The area surrounding the Proposed Development which could result in likely significant effects.

6.17 References

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