Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Disposal Site Characterisation Report

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Glossary of Acronyms

BAC	Background Assessment Concentration
CCME	Canadian Council of Ministers of the Environment
Cefas	Centre for Environment, Fisheries and Aquaculture Science
CEMP	Coordinated Environmental Monitoring Programme
CSCB	Cromer Shoal Chalk Beds
CSQG	Canadian Sediment Quality Guidelines
DBT	Dibutyltin
DCO	Development Consent Order
DEL	Dudgeon Extension Limited
DEP	Dudgeon Offshore Wind Farm Extension Project
DML	Deemed Marine Licences
DOW	Dudgeon Offshore Wind Farm
EAC	Environmental Assessment Criteria
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EQS	Environmental Quality Standards
ERL	Effects Range-Low
ES	Environmental Statement
ETG	Expert Topic Group
GBS	Gravity Base Structure
GIS	Geographic Information System
HDD	Horizontal Direction Drilling
HVAC	High-Voltage Alternating Current
km	Kilometre
MBT	Monobutyltin
MCZ	Marine Conservation Zone
MMO	Marine Management Organisation
MW	Megawatts
NSIP	Nationally Significant Infrastructure Project
OSP	Offshore Substation Platform
OSPAR	Oslo and Paris Convention
PAH	Polycyclic Aromatic Hydrocarbons

PEIR	Preliminary Environmental Information Report
PEL	Probable Effect Levels
SEL	Scira Extension Limited
SEP	Sheringham Shoal Offshore Wind Farm Extension Project
SOW	Sheringham Shoal Offshore Wind Farm
SSC	Suspended Sediment Concentrations
TBT	Tributyltin
TEL	Threshold Effect Levels
THC	Total Hydrocarbons
WFD	Water Framework Directive
UK	United Kingdom
US	United States

Glossary of Terms

Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP North array area	The wind farm site area of the DEP offshore site located to the north of the existing Dudgeon Offshore Wind Farm
DEP South array area	The wind farm site area of the DEP offshore site located to the south of the existing Dudgeon Offshore Wind Farm
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
European site	Sites designated for nature conservation under the Habitats Directive and Birds Directive. This includes candidate Special Areas of Conservation, Sites of Community Importance, Special Areas of Conservation and Special Protection Areas, and is defined in regulation 8 of the Conservation of Habitats and Species Regulations 2017.
Infield cables	Cables which link the wind turbine generators to the offshore substation platform(s).
Interlink cables	Cables linking two separate project areas. This can be cables linking: DEP South array area and DEP North array area DEP South array area and SEP DEP North array area and SEP 1 is relevant if DEP is constructed in isolation or first in a phased development.

	2 and 3 are relevant where both SEP and DEP are built.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Integrated Grid Option	Transmission infrastructure which serves both extension projects.
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water.
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore scoping area	An area presented at Scoping stage that encompassed all planned offshore infrastructure, including landfall options at both Weybourne and Bacton, allowing sufficient room for receptor identification and environmental surveys. This has been refined following further site selection and consultation for the PEIR and ES.
Offshore substation platform (OSP)	A fixed structure located within the wind farm site/s, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
Offshore Temporary Works Area	An Offshore Temporary Works Area within the offshore Order Limits in which vessels are permitted to carry out activities during construction, operation and decommissioning encompassing a 200m buffer around the wind farm sites and a 750m buffer around the offshore cable corridors. No permanent infrastructure would be installed within the Offshore Temporary Works Area.
Order Limits	The area subject to the application for development consent, including all permanent and temporary works for SEP and DEP.

Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).
SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
The Applicant	Equinor New Energy Limited. As the owners of SEP and DEP, Scira Extension Limited and Dudgeon Extension Limited are the named undertakers that have the benefit of the DCO. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of SEL and DEL as the undertakers of SEP and DEP.

DISPOSAL SITE CHARACTERISATION REPORT

1.1 Introduction

1. The SEP wind farm site will cover an area of approximately 97.0km^2 and the DEP wind farm site will cover an area of approximately 114.75km^2. The closest point to the coast is 15.8km from SEP and 26.5km from DEP. Depths range from 14m below Lowest Astronomical Tide (LAT) in the northwest of the SEP wind farm site to 36m in the northwest of the DEP North array area.
2. As the owners of SEP and DEP, Scira Extension Limited (SEL) and Dudgeon Extension Limited (DEL) are the named undertakers that have the benefit of the DCO. References in this document to obligations on, or commitments by, 'the Applicant' are given on behalf of SEL and DEL as the undertakers of SEP and DEP.
3. Water depths within the offshore export cable corridor range from 25-27m in the offshore part closest to SEP, shallowing to about 16m near the eastern tip of Sheringham Shoal sand bank and then decreasing progressively to 0m at the coast.
4. Once built, SEP and DEP would comprise the following offshore components:
    - The offshore wind turbines and their associated foundations;
    - Scour protection around foundations as required;
    - Offshore substation platform/s (OSP/s) supporting required electrical equipment, possibly also incorporating offshore facilities; and
    - Subsea cables comprising infield, interlink and offshore export cables and associated external cable protection as required.
5. The detailed design of SEP and DEP (e.g. numbers of wind turbines, layout configuration, foundation type and requirement for scour protection) will be determined post-consent. Therefore, the key parameters presented in **Table 1** are indicative based on current information and assumptions.
6. The earliest any offshore construction works would start is assumed to be 2027.
7. Offshore construction works would require up to two years per Project (excluding pre-construction activities such as surveys), assuming SEP and DEP were built at different times. If built at the same time, offshore construction could be completed in two years.
8. It should be noted that the construction programme is dependent on numerous factors including consent timeframes and funding mechanisms.

1.1.1 Key Relevant Parameters

Table 1: Key Relevant Parameters

Parameter	Details		
	SEP	DEP	Combined
Approximate offshore construction duration	2 years	2 years	2 to 4 years
Wind farm site area	97.0	114.75	221.75

Parameter	Details		
	SEP	DEP	Combined
Distance from wind farm site to coast (closest point) (km)	15.8	26.5	15.8
Number of wind turbines	13-23	17-30	30-53
Maximum length of export cable SEP to landfall (per cable) (km)	n/a	40	n/a
Maximum length of export cable DEP to landfall[1] (per cable) (km)	62	n/a	62
Maximum number of export cables and trenches	1 & 1	1 & 1	2 & 2
Maximum total length of all interlink cables (km)	66	n/a	154[2]
Maximum turbine rotor diameter (m)	300	300	300
Maximum tip height above Highest Astronomical Tide (HAT) (m)	330	330	330
Minimum clearance (air gap) above HAT (m)	30	30	30
Rotor swept area (km^2)	1.20-1.30	0.92-1.00	2.12-2.30
Indicative minimum and maximum separation between wind turbines (inter-row) (km)	1.05-3.3	1.05-3.3	1.05-3.3
Maximum infield cable length (not incl. interlink cables) (km)	135	90	225
Number of OSP/s	One	One	Up to two
Wind turbine foundation type options	• Piled monopile; • Suction bucket monopile; • Piled jacket; • Suction bucket jacket; and • Gravity base structure (GBS).		
OSP foundation type options	• Piled jacket; or • Suction bucket jacket.		
Number of piles per foundation for wind turbines	Monopile = 1 Piled jacked = 4		

[1] Applies either to a DEP in isolation development scenario, or for SEP and DEP with a separate OSP in the DEP North array area.
[2] Applies to the scenario with one OSP in the SEP wind farm site and assuming only the DEP North array area is developed.

Parameter	Details		
	SEP	DEP	Combined
Maximum number of piles for wind turbines	Monopiles = 23 Piled jacket = 92	Monopiles = 30 Piled jacket = 120	Monopiles = 53 Piled jacket = 212
Maximum number of piles for OSPs	2 x 4 leg-jacket = 8 pin piles	2 x 4 leg-jacket = 8 pin piles	4 x 4 leg-jacket = 16 pin piles
Hammer energies (kilojoules) (kJ)	Maximum hammer energy for monopiles: • Up to 5,000kJ for 15 MW wind turbines • Up to 5,500kJ for 18+MW wind turbines Maximum hammer energy for pin-piles: up to 3,000kJ		
Maximum pile diameter (m)	• 3.5-4m for piled jackets • 13-16m for monopiles		

1.2 Project Development Scenarios

9. As set out in **ES Chapter 1 Introduction** (document reference 6.1.1), whilst SEP and DEP have different commercial ownerships and are each Nationally Significant Infrastructure Projects (NSIPs) in their own right, a single application for development consent is being made for both wind farms, and the associated transmission infrastructure for each. A single planning process and DCO application is intended to provide for consistency in the approach to the assessment, consultation and examination, as well as increased transparency for a potential compulsory acquisition process.

10. The Applicant is seeking to coordinate the development of SEP and DEP as far as possible. The preferred option is a development scenario with an integrated transmission system, providing transmission infrastructure which serves both of the wind farms, where both Projects are built concurrently. However, given the different commercial ownerships of each Project, alternative development scenarios such as a separated grid option (i.e. transmission infrastructure which allows each Project to transmit electricity entirely separately) will allow SEP and DEP to be constructed in a phased approach, if necessary. Therefore, the DCO application seeks to consent a range of development scenarios in the same overall corridors to allow for separate development if required, and to accommodate either sequential or concurrent build of the two Projects.

11. Reasons for the requirement to retain separate and phased (sequential) development scenarios alongside more coordinated approaches are further described in the Scenarios Statement (document reference 9.28).

12. The range of development scenarios considered for SEP and DEP can be broadly categorised as:

- In isolation – where only SEP or DEP is constructed;
- Sequential – where SEP and DEP are both constructed in a phased approach with either SEP or DEP being constructed first; or
- Concurrent – where SEP and DEP are both constructed at the same time.

13. Whilst SEP and DEP are the subject of a single DCO application (with a combined Environmental Impact Assessment (EIA) process and associated submissions), the assessment considers both Projects being developed in isolation, sequentially and concurrently, so that mitigation is specific to each development scenario.

14. Under each scenario where SEP and DEP are both constructed it is possible that the electrical infrastructure could be integrated as described above which would offer benefits to the operation of the electrical infrastructure system.

15. An integrated transmission system would also offer the opportunity to reduce from two OSPs (one for SEP, one for DEP) to a single OSP serving both wind farms (located in SEP).

16. **Table 2** provides a summary of the development scenarios.

Table 2: Development Scenarios

Development scenarios	OSP option
The construction of SEP or DEP only, where the other Project does not proceed to construction	1 OSP only
SEP and DEP sequential	2 OSPs, one for SEP and one for DEP
SEP and DEP concurrent	2 OSPs; or
	1 OSP (located in SEP)

17. In the concurrent development scenario there will need to be collaboration between the two Projects to optimise construction logistics and to share certain temporary works such as the haul road and construction compounds. This applies to a concurrent build regardless of whether the transmission systems are integrated. The extent of coordination will be determined post consent.

18. Each of the development scenarios offer a range of benefits, with the preferred option (integrated transmission system built concurrently) particularly benefitting the planning and construction of the Projects, being likely to reduce the overall environmental impact and disruption to local communities, and responding to concerns regarding the lack of a holistic approach to offshore wind development in general. For example, the preferred option would only require one haul road for construction activities, half the number of work fronts, a smaller onshore substation and only one OSP.

1.2.1.1 Design Options

19. The EIA is being undertaken on the basis of a 'Rochdale Envelope' approach as described in **ES Chapter 5 EIA Methodology** (document reference 6.1.5). The consent will therefore be granted on the basis of a range of parameters to allow flexibility in the final detailed design of the Projects. A key design decision for DEP is whether to use all of the DEP North and DEP South array areas, or whether to use the DEP North array area only. This will be determined based on a number of technical and commercial factors such as wind yield, wake losses and ground conditions. The DCO application is based on the possibility of using either both DEP North and DEP South array areas, or the DEP North array area only.

20. **Table 3** provides a summary of how this design option has been considered within the EIA.

Table 3: Design Option

Design Option	Consideration in the ES worst-case scenarios
DEP North array area only	Each offshore EIA topic considers the option of the DEP North and DEP South array areas both being used; and the DEP North array area only being used. The worst-case scenario will be different for different topic assessments, e.g. for Shipping and Navigation the worst-case scenario is full build out across the whole of the DEP North and DEP South array areas; for Ornithology the worst-case scenario may be the build out in the DEP North array area only with a higher density of turbines there.

21. The development scenarios, including the associated configurations of export and/or interlink cables, are illustrated in in **Figures 4.5** to **4.8** of **Chapter 4 Project Description** (document reference 6.2.4).

22. The EIA considers the appropriate realistic worst-case associated with the different development scenarios and options, and presents the results accordingly. The information provided in each topic specific ES chapter and this document, is designed to clearly show how the project design envelope would differ depending on which scenario may be taken forward.

23. For the purposes of this disposal site characterisation report where specific magnitudes of effect or impact significances are stated, these are based on a worst-case assuming both SEP and DEP are built since this would result in the greatest volume of sediment being disposed and thus result in the greatest potential for impacts on physical characteristics, water and sediment quality, and benthic receptors.

24. In summary, the following principles set out the framework for how SEP and DEP may be developed:

- SEP and DEP may be constructed at the same time, or at different times;
- If built at the same time both SEP and DEP could be constructed in four years;
- If built at different times, either Project could be built first;
- If built at different times the first Project would require a four-year period of construction and the second Project a four-year period of construction;
- If built at different times, the duration of the gap between the start of construction of the first Project, and the start of construction of the second Project may vary from two to four years;
- Taking the above into account, the maximum construction period over which the construction of both Projects could take place is eight years.

25. The impact assessments for the offshore topics consider the following development scenarios and sub-options in determining the worst-case scenario for each topic:

- Build SEP or build DEP in isolation – therefore one OSP only; and
- Build SEP and DEP concurrently or sequentially – with either two OSPs, one for SEP and one for DEP, or with one OSP only to serve both SEP and DEP.

26. For each of these scenarios it has been considered whether the build out of both the DEP North and DEP South array areas, or the build out of the DEP North array area only, represents the worst-case for any ES receptor topic.

1.3 Purpose of this Document

27. The Applicant is applying to designate the following areas for the disposal of material arising as a result of construction activities (i.e. sea bed preparation (dredging) or drilling for wind turbine foundations and sand wave levelling (pre-sweeping)). The proposed disposal areas (**Figure 1**) are:

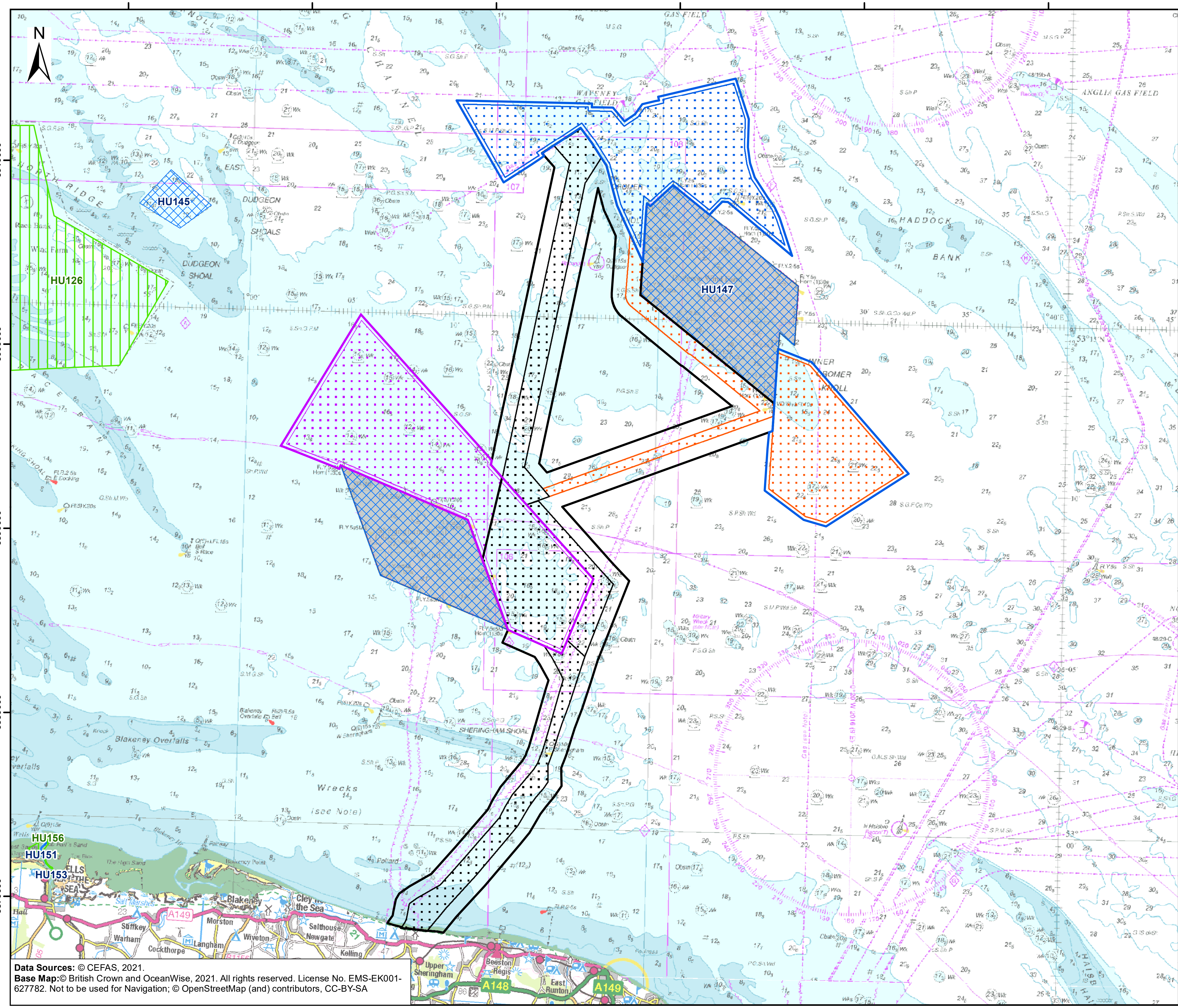
- The SEP wind farm site;
- The DEP North array area;
- The DEP South array area and associated interlink cable corridors; and
- The offshore export cable corridors.

28. This document provides the necessary information to characterise the disposal requirements for SEP and DEP. The proposed disposal site locations are shown in **Figure 1** (and the coordinates to delineate them are provided in **Annex 1**). As detailed above, SEP or DEP may be built in isolation and therefore the requirement for disposal at either wind farm site will not be known until detailed design at the post consent stage. Similarly, the requirement to build out the DEP South array area and the associated interlink cable corridors between the DEP South array area and the DEP North array area, and the DEP South array area and the SEP wind farm site, will not be known until detailed design at the post consent stage. In order to streamline the disposal site characterisation and licensing process, this document provides the necessary information for all areas to be licensed as disposal sites. It is proposed that these areas are included within the SEP and DEP Deemed Marine Licences (DML) however if any of these areas are not required following detailed design then the Applicant can agree with the Marine Management Organisation (MMO) and the Centre for Environment, Fisheries and Aquaculture Science (Cefas) that the licensed activities will not be undertaken in these areas.

29. As shown on **Figure 1** the existing DOW wind farm site is licensed as a closed disposal site (HU147) and while the GIS data layer from Cefas for disposal sites does not indicate that the SOW wind farm site was a disposal site, the Applicant understands this to be the case and therefore **Figure 1** shows this as being a closed disposal site.

30. The purpose of this document is to provide the information required to enable disposal site designation. Accordingly, this document sets out:

- The need for disposal of material;
- The location of the disposal sites;
- The types of material to be disposed of;
- The quantity of the material to be disposed; and
- Potential impacts of disposal.



Data Sources: © CEFAS, 2021.

Sheringham Shoal and Dudgeon Extension Projects

Title:

Figure 1 Disposal Site Characterisation

Document:

DCO Document
Disposal Site Characterisation Report

Application Doc. no.: 9.15

Legend:

- Dudgeon Offshore Wind Farm Extension Site
- Sheringham Shoal Offshore Wind Farm Extension Site
- Offshore Cable Corridors
- Existing Offshore Wind Farm Export Cable
- Existing Offshore Wind Farm

Disposal Sites

- Closed
- Open

Proposed Disposal Sites

- DEP North Array Area Disposal
- SEP Wind Farm Disposal Site
- SEP and DEP Offshore Cable Corridor Disposal Site
- DEP South Array Area and Interlink Cable Corridor Disposal Site

Coordinate Reference System: WGS 1984 UTM Zone 31N
Transformation WGS84: OSGB_1936_To_WGS_1984_7

0 6 12 km
0 3 6 Miles

Scale: 1:200,000 Scale at size: A3

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B	18/08/2022	Second Issue	GC	PM	PM
A	17/01/2022	First Issue	AZ	PM	PM

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1.4 The Need for Disposal of Material

31. The type of foundation(s) and installation method(s) required for the SEP and DEP wind turbines and OSP/s are yet to be determined. However, installation will result in the generation of spoil material and therefore, practicable options for the disposal of “capital” dredged or drilled material must be assessed.

32. The Marine and Coastal Access Act (MCAA) Section 66 states that it is a licensable marine activity to carry out any form of dredging within the UK marine licensing area. For the purposes of this document, “disposal” means the deposit of dredged sediment at the sea surface or at the sea bed using a fall pipe; or the deposit of subsurface sediment at the sea bed released during any drilling required for wind turbine foundation installation.

33. Offshore disposal of dredged sediment will take place in the vicinity of the disposal location where it would be dispersed by natural processes as described in the **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6). Sediment would not be disposed of in or nearby known sensitive benthic habitats such as Annex I reef and where possible will be redeposited within areas of similar sediment type (see **ES Chapter 8 Benthic Ecology** (document reference 6.1.8)). The worst-case scenario assumes that, where required, sediment would be dredged and returned to the water column at the sea surface as overflow from a dredger vessel.

34. In addition, sediments below the sea bed within SEP or DEP would become disturbed during any drilling activities that may be needed at the location of piled foundations. The disposal of any sediment that would be disturbed or removed during drilling for foundation installation would occur in close proximity to each foundation.

1.4.1 Foundation Installation

35. Foundation types currently under consideration are:

- Monopiles fixed to the sea bed either by a suction bucket (also termed a caisson) or a single pile;
- GBS which rely on the weight of the structure to anchor it to the sea bed;
- Jackets (up to four legs) on:
    - Piles – in the case of a single pile solution, the piles may be either driven or drilled, or a combination of the two;
    - Suction buckets;
    - A jack-up foot; or
    - Up to two screw piles.

36. The OSP foundation type will be a jacket, as installed, for example, at DOW (see **Plate 4-8** of **ES Chapter 4 Project Description** (document reference 6.1.4)). The jacket will have up to four legs and will be secured to the sea bed with either up to two piles at each leg, or one suction bucket at each leg. In the case of a piled solution, the piles may be either driven or drilled, or a combination of the two.

37. Monopiles and jacket foundations for wind turbines and OSPs would be positioned in such a way to avoid the need for sea bed preparation and therefore no sediment disposal is required for these foundation types. However, drilling may be required for monopile or pin pile foundations.

38. Each of the different wind turbine foundation types would require varying levels of sea bed preparation to provide a more level formation for installation. The volumes of sediment excavated differs depending on the foundation type and whether a 15MW or 18+MW wind turbine is used.

39. **Table 4** presents a summary of the physical properties of each foundation option to enable a direct comparison between them, to assist with defining the worst-case scenario.

Table 4: Comparison of Physical Parameters for Different Foundation Types

Foundation Type	Wind Turbine Nameplate Capacity (MW)	Maximum Foundation Dimensions (m/foundation)	Maximum Volume of Surface Sediment Release from Sea Bed Preparation (m^3/foundation)	Maximum Volume of Sub-surface Sediment Release from Foundation Drilling (m^3/foundation)
Monopile (single steel pile)	15	13 (diameter)	0	5,973
	18	16 (diameter)	0	10,053
Monopile (suction bucket)	15	36 (diameter)	0	N/A
	18	45 (diameter)	0	N/A
Gravity base structure	15	45 (base plate diameter at the sea bed)	9,543	N/A
	18	60 (base plate diameter at the sea bed)	16,964.6	N/A
Jacket with pin piles	15	3.5 (leg diameter)	0	1,414
	18	4 (leg diameter)	0	2,309
Jacket with suction buckets	15	18 (diameter per bucket)	0	N/A
	18	20 (diameter per bucket)	0	N/A

1.4.2 Cable Installation

40. Sand wave levelling (pre-sweeping) to a stable reference sea bed level may be undertaken in areas with large ripples and sand waves to reduce the potential that cables become unburied over the life of the project. **Figure 4.9** of **ES Chapter 4 Project Description** (document reference 6.2.4) shows the locations within the offshore cable corridors where sand wave levelling (pre-sweeping) is anticipated to be required.

41. The sediment throughout the SEP, SOW and DOW wind farm sites is primarily sandy gravel. The DEP wind farm is primarily sand interspersed with areas of sandy gravel (see **Figures 7.3** and **7.4** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.2.7)) and therefore it is expected that the majority of the offshore cables will be buried using a cable plough, jetting or mechanical cutting method (see **Section 4.4.7.5** of **ES Chapter 4 Project Description** (document reference 6.1.4)). This means that for the majority of the cable corridors, no excavation and subsequent disposal of sediment would be required.

42. Anticipated sediment volumes for the levelling (pre-sweeping) of sand waves are provided in **Section 1.6.1**.

1.4.3 Mitigation and Best Practice

43. The Applicant has committed to a number of areas of mitigation and best practice in order to minimise the potential impacts from disposal of sediment at SEP and DEP. The following examples of embedded mitigation are of relevance to sediment disposal:

- For piled foundation types, such as monopiles and jackets with pin piles, pile driving is the most likely installation method and will be used in preference to drilling where it is practicable to do so (i.e. where ground conditions allow). This would minimise the quantity of sub-surface sediment that is released into the water column and deposited from the installation process.
- Monopiles and jacket foundations for wind turbines and OSPs would be positioned in such a way to avoid the need for sea bed preparation.
- Micro-siting will be used to minimise the requirement for sea bed preparation prior to GBS foundation installation.

1.5 Type of Material to be Disposed

1.5.1 Sea Bed Sediment Type

44. Grab samples collected in August 2020 from within the SEP and DEP wind farm sites (see **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) show that sea bed composition is primarily sand (DEP wind farm site) or sandy gravel (SEP wind farm site). Throughout the cable corridors, the proportion of gravel was generally higher than in the wind farm sites.

45. The geographical distribution of these different sediment types did not appear to have any distinct spatial pattern. Although the proportion of fine sediments was generally low throughout the entire survey area, higher proportions were present at sample station EC_16 in the offshore export cable corridor and in the western part of the SEP wind farm site (**Figure 7.3** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.2.7)).

46. Spoil material generated by drilling might be different from surface material generated by other sources of sea bed preparation, being finer than the near-surface sediments and therefore having the potential to disperse more widely.

1.5.2 Sediment Contamination Analysis

47. The locations of the SEP and DEP sediment contamination sample sites are shown in **Figure 7.5** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.2.7) and contaminant data for heavy and trace metals are summarised in **Table 5**.[3] Seven grab samples were taken for chemical analysis during benthic surveys. Ten samples were originally planned, however, at three sites (SS_18, D_04 and EC_07), sampling was unsuccessful because of repeated failure of the grab to take a sample due to rocks in the grab jaws and insufficient sediment recovered.

48. The context of the contaminants found within sediments is established through the use of recognised guidelines and action levels, in this case the Cefas Action Levels have been applied as a first stage because they provide good coverage of contaminants, across a broad range of contaminant types (MMO, 2018).

49. The majority of the material assessed against these standards arises from dredging and disposal activities as part of the MMO's marine licensing process for disposal of material to sea and are also considered a good way of undertaking an initial risk assessment with respect to determining risks to water quality from other marine activities as part of the EIA and associated Water Framework Directive (WFD) compliance assessment process.

[3] The full data set is presented in **Appendix 8.1 DEP Benthic Characterisation Report** (document reference 6.3.8.1) (Fugro, 2020a) and **Appendix 8.2 SEP Benthic Characterisation Report** (document reference 6.3.8.2) (Fugro, 2020b).

50. If, overall, levels do not generally exceed the lower threshold values of these guideline standards (i.e. Action Level 1), then contamination levels are considered to be low risk in terms of the potential for impacts on water quality. This approach is recommended by the Environment Agency in their WFD compliance assessment guidance ‘Clearing the Waters for All’, for example (Environment Agency, 2017). Whilst the sediment sampling was not undertaken by an MMO accredited lab (required for licensing procedures), the Cefas Action Levels can be applied to the data where contaminants correlate with those in the MMO’s list of contaminants of concern. In addition, it should be noted that Fugro, i.e. the company which undertook the contaminants analysis, have a proven track record of delivering high-quality analytical results to oil and gas clients, marine renewables, ports and harbours, mineral and aggregates as well as government agencies for over 30 years.

51. Fugro has a fully integrated quality, health, safety, security and environmental management system certified to the international standards ISO 9001, ISO 14001 and OHSAS 18001. The Fugro sediment and benthic laboratories in Portchester and chemistry laboratory in Edinburgh are UKAS accredited testing laboratories (ISO/IEC 17025:2017, Laboratory No. 0919). In addition to in-house quality checks, the Fugro environmental laboratories participate in a range of external proficiency tests including the National Marine Biological Analytical Quality Control, QUASIMEME, CONTEST and Aquacheck. Fugro’s laboratories are MMO validated for particle size analysis.

52. Analysis was undertaken for the following contaminants:

- Metals - aluminium, arsenic, barium, mercury, cadmium, chromium, copper, iron, lithium, lead, nickel and zinc;
- Aromatic compounds naphthalenes (2 ring aromatics), 3 to 6 ring Polycyclic Aromatic Hydrocarbons (PAHs) and the dibenzothiophenes (sulphur containing heteroaromatics) including the United States Environmental Protection Agency’s (US EPA) 16 PAHs – these are 16 priority PAHs designated as high priority pollutants based on their potential human and ecological health effects. Individual aromatic hydrocarbon concentrations and their alkyl homologue concentrations were also recorded for naphthalene, phenanthrene/anthracene, dibenzothiophene, fluoranthene/pyrene, benzphenanthrenes/benzanthracenes;
- Organotins (monobutyltin (MBT), dibutyltin (DBT) and tributyltin (TBT)); and
- Total hydrocarbons (THC).

53. The data for parameters which correlate with the MMO’s list of contaminants of concern is presented in **Table 5**. It can be seen that no samples exceed the lower Cefas Action Level 1 and the sediment contaminant concentrations are deemed to be low risk from a sediment disposal perspective.

54. It is noted that the MMO consider adequate evidence has been gathered and presented which show that the working area (wind farm sites and cable corridors) is sufficiently coarse so as not to warrant additional contaminant analysis, and that the area is likely low risk for contaminant release (see **Table 7-1** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)).

Table 5: SEP and DEP Site Specific Sediment Contamination Analysis Results Compared to Cefas Action Levels (mg/kg)

Contaminant	Sample site (all in mg/kg)							Cefas Action Levels (mg/kg)	
	CC-06	D-17	D-26	EC-04	EC-05	EC-15	SS-03	1	2
Arsenic	5.90	8.73	11.3	10.5	14.3	9.42	9.41	20	100
Cadmium	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	<0.0800	0.4	5
Chromium	4.53	3.94	10.2	8.67	10.2	5.03	10.0	40	400
Copper	1.44	<0.0800	1.10	1.80	2.06	0.915	1.75	40	400
Nickel	3.27	1.86	4.70	4.82	5.04	3.24	5.13	20	200
Mercury	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	<0.0400	0.3	3
Lead	7.28	4.59	7.53	6.34	9.93	5.34	8.34	50	500
Zinc	9.12	6.43	14.7	16.2	18.7	11.6	17.7	130	800
TBT	0.00105	0.00126	<0.0004	<0.0004	<0.0004	<0.0004	<0.0004	0.1	1
DBT	0.00167	<0.0004	<0.0004	<0.0004	0.000568	<0.0004	<0.0004	0.1	1
MTB	<0.0004	<0.0004	0.0399	0.00042	<0.0004	<0.0004	<0.0004	0.1	1
Naphthalene	0.0007	0.0005	0.0021	0.0042	0.0037	0.0002	0.0035	0.1	-
C1 Naphthalene	0.0019	0.0017	0.0048	0.0098	0.0093	0.0005	0.0081	0.1	-
C2 Naphthalene	0.0031	0.0030	0.0045	0.0142	0.0125	0.0007	0.0116	0.1	-
C3 Naphthalene	0.003	0.0032	0.0072	0.014	0.0137	0.0008	0.0108	0.1	-
Acenaphthylene	<0.0001	<0.0001	<0.0001	0.0001	0.0001	<0.0001	<0.0001	0.1	-
Acenaphthene	0.0001	0.0001	0.0001	0.0004	0.0003	<0.0001	0.0003	0.1	-
Fluorene	0.0002	0.0002	0.0004	0.0011	0.0009	0.0001	0.0008	0.1	-
Phenanthrene	0.0027	0.0028	0.0061	0.0086	0.0089	0.0005	0.0073	0.1	-

Contaminant	Sample site (all in mg/kg)							Cefas Action Levels (mg/kg)	
	CC-06	D-17	D-26	EC-04	EC-05	EC-15	SS-03	1	2
C1 Phenanthrene	0.0026	0.0024	0.0067	0.0088	0.0088	0.0005	0.0073	0.1	-
Anthracene	0.0001	0.0001	0.0004	0.0008	0.0009	0.0001	0.0005	0.1	-
Fluoranthene	0.0013	0.0015	0.0048	0.0058	0.0053	0.0005	0.0041	0.1	-
Pyrene	0.0012	0.0012	0.0041	0.0054	0.0049	0.0004	0.0038	0.1	-
Benzo(a)anthracene	0.0007	0.0006	0.0019	0.0028	0.0026	0.0002	0.0022	0.1	-
Chrysene	0.0011	0.0008	0.0026	0.0032	0.0028	0.0003	0.0027	0.1	-
Benzo(b)fluoranthene	0.0019	0.0020	0.0047	0.0066	0.0059	0.0012	0.0056	0.1	-
Benzo(k)fluoranthene	0.0005	0.0005	0.001	0.0017	0.0015	0.0003	0.0014	0.1	-
Benzo(a)pyrene	0.0006	0.0006	0.0017	0.0030	0.0028	0.0002	0.0022	0.1	-
Indeno(1,2,3-cd)pyrene	0.0008	0.0008	0.0017	0.0031	0.0030	0.0004	0.0024	0.1	-
Benzo(ghi)perylene	0.0014	0.0015	0.0031	0.0046	0.0045	0.0004	0.0038	0.1	-
Dibenzo(a,h)anthracene	0.0002	0.0002	0.0005	0.0008	0.0008	<0.0001	0.0007	0.1	-
Total Hydrocarbons	1.4	1.4	3.3	4.0	3.6	1.2	2.4	100	-

1.5.2.1 Comparison with Canadian Sediment Quality Guidelines

55. The data has also been compared to the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life (CSQG) (Canadian Council of Ministers of the Environment (CCME), 2002) as an additional stage in the assessment (see **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)). These guidelines involved the derivation of Interim Marine Sediment Quality Guidelines (ISQGs) or Threshold Effect Levels (TEL) and Probable Effect Levels (PEL) from an extensive database containing direct measurements of toxicity of contaminated sediments to a range of aquatic organisms exposed in laboratory tests and under field conditions (CCME, 2002). It should be noted that these guidelines were designed specifically for Canada and are based on the protection of pristine environments. The findings of the comparison should therefore be treated with caution and are indicative only.

56. Selected Canadian guidelines correlating with the contaminants included in the site specific survey are presented in **Table 7-14** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7). The lower level is referred to as the TEL and represents a concentration below which adverse biological effects are expected to occur only rarely (in some sensitive species for example). The higher level, the PEL, defines a concentration above which adverse effects may be expected in a wider range of organisms.

57. Sediment contamination data (Fugro, 2020a and 2020b and **Table 7-14** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)) and shows that only marginal exceedances of TEL for arsenic concentrations are present but all other parameters are below their respective lower TEL concentration. This confirms the conclusions in **Section 1.5.2** that sediments are relatively low risk in terms of potential risks to water quality. Additionally, it can also be concluded that the sediments present relatively low risks to marine organisms. Whilst arsenic is indicated as being elevated, the TEL concentration of 7.24mg/kg is considerably lower than the Cefas Action Level 1 for Arsenic at 20mg/kg which is considered by Cefas to be suitably protective to the UK marine environment in making offshore disposal to sea licensing decisions (Cefas, 2020).

1.5.2.2 Comparison with Other Sediment Quality Guidelines

58. Consultation with Natural England following submission of the final Sea bed expert topic group (ETG) meeting minutes (see **Table 7-1** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)) for comment still highlighted concerns with the analysis undertaken and sediment guidelines used therefore additional information as presented in the **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) is repeated here with respect to PAH parameters, as these were the specific parameters queried.

59. PAHs are natural components of coal and oil and are also formed during the combustion of fossil fuels and organic material. PAHs enter the marine environment through atmospheric deposition, road run-off, industrial discharges and oil spills. In the marine environment, PAHs become trapped in lower layers unless the sediments are disturbed.

60. The OSPAR Hazardous Substances Strategy aims to achieve concentrations in the marine environment to near natural background values for naturally occurring substances and close to zero for man-made synthetic substances. Due to their persistence in the marine environment, their potential to bioaccumulate and their toxicity, analyses of PAH concentrations in sediment is reported in the OSPAR coordinated environmental monitoring programme (CEMP) (see **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7)).

61. PAHs are hydrocarbons composed of two or more fused aromatic rings, encompassing both parent (non-alkylated) compounds and alkylated homologues. Most datasets contain analysis for parent compounds only, with the exception of the MMO contaminant list for disposal to sea which requires analysis of three alkylated homologues of naphthalene (C1 to C3) and one of phenanthrene (C1).

62. CEMP compare selected PAH concentrations against two assessment criteria: the OSPAR Background Assessment Concentration (BAC) and the US EPA's Effects Range-Low (ERL). The ERL value is defined as the lower tenth percentile of the data set of concentrations in sediments which were associated with biological effects. Adverse effects on organisms are rarely observed when concentrations fall below the ERL value. The ERL developed by the US EPA is used in the CEMP assessments because there are no OSPAR Environmental Assessment Criteria (EAC) currently available. It is also acknowledged that there is a need for EACs to be developed for both alkylated and parent PAHs in sediment.

63. BAC are statistical tools defined in relation to the background concentrations which enable statistical testing of whether observed concentrations can be considered to be near background concentrations.

64. The PAH parameters for which ERLs and BACs are available is presented in **Table 6**. It can be seen that all parameters are below the BAC, the lower of the guideline values.

Table 6: Data from Site Specific Survey Compared to the CEMP BAC and ERLs

Contaminant	Sample site (all in mg/kg)							CEMP sediment guidelines applied to sediment data (mg/kg) by OSPAR	
	CC-06	D-17	D-26	EC-04	EC-05	EC-15	SS-03	BAC	ERL
Naphthalene	0.0007	0.0005	0.0021	0.0042	0.0037	0.0002	0.0035	0.008	0.160
Phenanthrene	0.0027	0.0028	0.0061	0.0086	0.0089	0.0005	0.0073	0.032	0.240
Anthracene	0.0001	0.0001	0.0004	0.0008	0.0009	0.0001	0.0005	0.005	0.085
Fluoranthene	0.0013	0.0015	0.0048	0.0058	0.0053	0.0005	0.0041	0.039	0.600
Pyrene	0.0012	0.0012	0.0041	0.0054	0.0049	0.0004	0.0038	0.024	0.665
Benzo(a)anthracene	0.0007	0.0006	0.0019	0.0028	0.0026	0.0002	0.0022	0.016	0.261
Chrysene	0.0011	0.0008	0.0026	0.0032	0.0028	0.0003	0.0027	0.020	0.384
Benzo(a)pyrene	0.0006	0.0006	0.0017	0.0030	0.0028	0.0002	0.0022	0.030	0.430
Indeno(1,2,3-cd)pyrene	0.0008	0.0008	0.0017	0.0031	0.0030	0.0004	0.0024	0.103	0.240
Benzo(ghi)perylene	0.0014	0.0015	0.0031	0.0046	0.0045	0.0004	0.0038	0.080	0.085

1.5.2.3 Contaminants Baseline Summary

65. From the information and data presented above it can be concluded that the baseline water and sediment quality for the offshore and coastal waters surrounding the wind farm sites and offshore export cable corridors is good and site-specific information in relation to the sediment contaminant concentrations do not contain elevated levels of contaminants likely to present a risk to water quality if disturbed.

1.6 Quantity of Material to be Disposed

66. Material to be disposed of may arise from the following sources:

- Sand wave levelling (pre-sweeping) for offshore cable installation (not required for a SEP in Isolation scenario);
- Sea bed preparation and levelling for GBS foundations; and
- Drill arisings associated with installing piled foundations.

1.6.1 Sea Bed Preparation

1.6.1.1 Wind Turbines

67. The greatest volumes of near-surface sediment disturbance due to sea bed preparation activities during construction of individual wind turbines is associated with GBS foundations. The worst-case sea bed preparation volume for a single 18MW GBS foundation with a 60m base plate diameter = 16,966.6m^3. The worst-case for a single 15MW GBS foundation with a 45m base plate diameter = 9,543m^3 (see **Table 4**). There could be up to 19 18MW wind turbines at SEP and up to 24 18MW wind turbines at DEP (compared to 23 15MW wind turbines at SEP and 30 15MW wind turbines at DEP). Therefore, the overall worst-case disposal volume for sea bed preparation activities for wind turbines would be 322,327m^3 at SEP, 407,150m^3 at DEP or **729,477m^3** for SEP and DEP.

1.6.1.2 Offshore Substation Platforms

68. Jacket foundations for OSPs would be positioned in such a way to avoid the need for sea bed preparation.

1.6.1.3 Sand Wave Levelling (Pre-Sweeping)

69. The area affected by the works will vary between 50m and 100m in width depending on the cable corridor in question and the number of cables. The sea bed footprint and volume of sediment affected due to pre-sweeping is described in **Table 7**, with a total sea bed footprint of 929,719m^2 across all four areas and a total volume of up to **376,400m^3** (based on a two OSP scenario). Dredged sediment will be deposited within the wind farm sites and/or cable corridors, all within the permanent works areas and where possible in an area of similar sediment type and avoiding any known sensitive habitats such as Annex I reef. Sediment may either be released at or near the sea surface, or at the sea bed using a fall pipe.

70. For a SEP in isolation build out scenario no sand wave levelling (pre-sweeping) would be required.

*Table 7: Cable Corridor Pre-Sweeping Footprints and Volumes (**Figure 4.9** of **Chapter 4 Project Description** (document reference 6.2.4)*

Area ID and location	Pre-sweep corridor length (m)	Pre-sweep corridor width (m)	Sea bed footprint (m^2)	Dredge volume (m^3)
Area 1: DEP North array area to SEP interlink cable corridor (dredge volume associated with transmission assets)	3,374.95	100	337,495	144,200
Area 2: DEP North to DEP South array area interlink cable corridor (dredge volume associated with transmission assets)	2,387.82	50	119,391	44,300
Area 3: DEP South array area (dredge volume associated with generation assets)	3,019.35	100	301,935	171,700
Area 4: DEP North array area (dredge volume associated with generation assets)	3,417.96	50	170,898	16,200
Total	**12,200.08**	**-**	**929,719**	**376,400**

1.6.1.4 Sea Bed Disturbance/Displacement Volumes from Offshore Cable Installation

71. Offshore electrical cables are required to transmit electricity from the wind turbines to OSPs and then onwards to the National Grid. The electrical cables that make up the offshore transmission system include:

- Offshore export cables (linking the OSP/s to the landfall); and
- Interlink cables (linking two separate wind farm areas).

72. Additionally, infield cables link the wind turbine generators to the OSP/s.

73. Burial of the offshore cables will be through any combination of ploughing, jetting or mechanical cutting; however, infield cable burial is more likely to be undertaken by jetting or mechanical cutting.

74. The export cables will be installed in separate installation campaigns as the installation vessel can only install one cable at a time (bundle lay is not possible with High Voltage Alternating Cables (HVAC)).

75. **Section 4.4.7.5** of **ES Chapter 4 Project Description** (document reference 6.1.4) provides further details on each possible offshore cable installation technique.

76. For the purposes of the ES assessments, worst-case volumes of sediment anticipated to be disturbed/displaced through installation of each of the offshore cable types are estimated. However, it is important to note that in the context of this Disposal Site Characterisation Report, those volumes do not represent sediment that would be 'disposed of' since the disturbance would occur at the sea bed and not as overflow from a surface dredger vessel. Therefore, the volumes in **Table 8** are provided for information only since they informed the ES assessments which considered wider sea bed disturbance impacts, not those solely associated with sediment disposal, which is the focus of the assessments in **Section 1.7**. The primary source of sediment disposal for offshore cable installation is through sand wave levelling (pre-sweeping), as described in **Section 1.6.1.3**.

Table 8: Sea Bed Disturbance/Displacement (Not Disposal) Volumes from Offshore Cable Installation

Offshore Cable Type	DEP in Isolation (m^3)	SEP in Isolation (m3)	SEP and DEP
Infield	151,875	101,250	253,125
Interlink	74,250	0	160,875
Export	31,000	20,000	51,000
Total	**257,125**	**121,250**	**465,000**

1.6.1.5 HDD Exit Point

77. The offshore export cables make landfall at Weybourne, to the west of Weybourne beach car park in proximity to the Muckleburgh Military Collection. The offshore export cables will be connected to the onshore export cables in a transition joint bay, having been installed under the intertidal zone by Horizontal Directional Drilling (HDD) (**Figure 4.4** of **ES Chapter 4 Project Description** (document reference 6.2.4)). This technique has been selected by the Applicant in order to avoid any impact on the features of the Cromer Shoal Chalk Beds (CSCB) Marine Conservation Zone (MCZ) in this area. Chalk is known to outcrop on the sea bed close to shore, where it forms one of the key interest features of the MCZ (see **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6) and **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) for further details). The HDD process will allow the complete avoidance of the nearshore outcropping chalk feature.

78. At the HDD exit point in the subtidal zone there is a requirement for a transition zone between where the ducts exit the sea bed and the point at which it is possible for the burial tool to start the process of burying the cables. There are two options for the transition zone and both options need to be retained in the project envelope pending detailed design studies. However, only the following described option is relevant to this Disposal Site Characterisation Report since it is the only option that would require sediment to be excavated and disposed of (see **ES Chapter 4 Project Description** (document reference 6.1.4) for further details on the other option). This option would involve the excavation of an initial trench up to 20m wide, 30m long and 1m deep (600m^3 excavated material, allowing for up to two cables), with a further transition zone trench of up to 50m in length, 1m wide and up to 1m deep per cable (100m^3 excavated material in total), at the end of which the burial tool would be able to take over the cable burial process. Therefore, the total worst-case volume of sediment required to be excavated at the HDD exit point would be **700m^3**.

1.6.2 Drilling

1.6.2.1.1 Wind Turbine Foundations

79. Whilst pile driving is the most likely installation method, in the event that ground conditions prove to be unsuitable for piling, monopiles may be drilled, or both drilled and driven, into the sea bed. Unsuitable ground conditions are more likely to be associated with, for example, high density chalk or chalk rock, Botney Cut Formation (e.g. sand-rich or organic-rich sandy mud channel infills), and Egmond Ground Formation (very dense fine sand). Such ground conditions will be avoided where possible, to be confirmed through pre-construction survey and the drivability assessment.

80. As a worst-case, it is estimated that up to 5% of the wind turbine locations could need drilling i.e. up to two for each of SEP and DEP. For a 15MW turbine, requiring a drill diameter of 13m and a drill penetration depth of 45m, the amount of monopile drill arisings would be approximately 5,973m^3 per foundation, or a total of 11,946m^3 for SEP or DEP in isolation and **23,892m^3** for SEP and DEP.

81. The drill arisings (spoil) would be disposed of adjacent to the foundation location, above or slightly below the sea surface, from where they would be expected to settle onto the sea bed in the immediate vicinity of each foundation (see **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6) for further details).

1.6.2.1.2 OSP Foundations

82. As with the other piled foundation solutions and whilst considered unlikely, in the event of drilling being required, the OSP jacket pin piles may be drilled or drilled-driven into the sea bed. For this purpose, it is assumed that drilling may be required for both OSPs, but only at one pile at each. In this manner, the amount of pin pile drill arisings would be approximately 425m^3 per OSP/for SEP or DEP in isolation or a total of **850m^3** for SEP and DEP (i.e. up to two OSPs).

1.6.3 Summary of Sediment Disposal Quantities

83. **Table 9** provides a summary of the worst-case sediment disposal quantities for SEP and DEP

Table 9: Summary of Worst-Case Sediment Disposal Quantities at SEP and DEP

Activity	Quantity of Sediment to be Disposed (m^3)
Sea bed preparation – wind turbines (m^3)	729,477
Sea bed preparation – OSPs (m^3)	0
Sand wave levelling (pre-sweeping) (m^3)*	376,400
Drilling – wind turbines (m^3)	23,892
Drilling – OSPs (m^3)	850
HDD exit point	700
Total	**1,131,319**

* Note that for a SEP in isolation scenario no sand wave levelling would be required

1.6.4 Programme

84. The earliest any offshore construction works would start is assumed to be 2027.

85. Offshore construction works would require up to two years per project (excluding pre-construction activities such as surveys), assuming SEP and DEP were built at different times. If built at the same time, offshore construction could be completed in two years.

1.7 Potential Impacts of Disposal

86. The impact of disposal of material within SEP and DEP wind farm sites has been incorporated into impacts assessed within the SEP and DEP ES; specifically, within **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6), **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7) and **ES Chapter 8 Benthic Ecology** (document reference 6.1.8). It should be noted however that the impacts presented within the ES assess the impacts of SEP and DEP as a whole and so the specific parts of the assessment that consider disposal of sediment have been drawn out and are presented below.

87. **ES Chapter 5 EIA Methodology** (document reference 6.1.5) presents an overarching method for enabling assessments of the potential impacts arising from SEP and DEP on the receptors under consideration. The assessments presented in this report use the assessment methodologies presented in **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6) (for potential impacts assessed in **Section 1.7.1**), **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7) (for potential impacts assessed in **Section 1.7.2**) and **Chapter 8 Benthic Ecology** (document reference 6.1.8) (for potential impacts assessed in **Section 1.7.3**). Within **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6), impacts on the physical characteristics of the site have been assessed. The impacts which contain relevant information for this assessment are as follows:

- Changes in suspended sediment concentrations (SSC) due to sea bed preparation for foundation installation (wind farm site) (**Section 1.7.1.2.1**);
- Changes in SSC due to drill arisings for installation of piled foundations for wind turbines and OSPs (**Section 1.7.1.2.2**);
- Changes in sea bed level due to sea bed preparation for foundation installation (**Section 1.7.1.3.1**);
- Changes in sea bed level due to drill arisings for installation of piled foundations for wind turbines and OSPs (**Section 1.7.1.3.2**);
- Change in SSC due to export cable installation (**Section 1.7.1.2.3**);
- Change in sea bed level due to deposition from the suspended sediment plume during export cable installation within the offshore cable corridor (**Section 1.7.1.3.3**);
- Change in SSC due to offshore cables installation (infield and interlink cables) (**Section 1.7.1.2.4**); and
- Change in sea bed level due to offshore cable installation (infield and interlink cables) (**Section 1.7.1.3.4**).

88. **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.1.7) incorporates the potential effects of disposal on water and sediment quality. This assessment directly builds upon the assessment in **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6). The impacts which contain relevant information for this assessment are as follows:

- Deterioration in water quality due to an increase in SSCs (**Section 1.7.2.1**);
- Deterioration in water quality due to an increase in suspended sediment associated with drill arisings for foundation installation of piled foundations (**Section 1.7.2.2**); and
- Deterioration in water quality due to the release of contaminated sediment (**Section 1.7.3.2**).

89. **ES Chapter 8 Benthic Ecology** (document reference 6.1.8) incorporates the potential effects of disposal on the biological characteristics of SEP and DEP. This assessment also builds upon the assessment in **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6). The impacts which contain relevant information for this assessment are as follows:

- Temporary increases in SSCs and deposition (**Section 1.7.3.1**); and
- Remobilisation of contaminated sediments (**Section 1.7.3.2**).

1.7.1 Potential Impacts of Sediment Disposal on Physical Characteristics

90. The assessment provided in **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6) is supported by an evidence-base obtained from research into the physical impacts of marine aggregate dredging on sediment plumes and sea bed deposits (Whiteside *et al*., 1995; John *et al*., 2000; Hiscock and Bell, 2004; Newell *et al*., 2004; Tillin *et al.*, 2011; Cooper and Brew, 2013).

1.7.1.1 Identified Receptors for the Physical Processes Assessment

91. The principal receptors with respect to marine geology, oceanography and physical processes are those features with an inherent geological or geomorphological value or function which may potentially be affected by SEP and DEP. These are the CSCB MCZ, sand banks (and associated sand waves) and the East Anglian coast (gravel and sand beaches, dunes and cliffs). The wind farm sites and interlink cable corridor are located north of the MCZ, but the export cable corridor passes through it, and the landfall is at Weybourne on the north Norfolk coast. Sand banks and sand waves are present in the northwest parts of the DEP North and DEP South array areas (**Figure 6.1** of the **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.2.6).

92. The specific features defined within these three receptors as requiring further assessment at the EIA stage for SEP and DEP are listed in **Table 10**.

Table 10: Marine Geology, Oceanography and Physical Processes Receptors Relevant to the Project

Receptor Group	Extent of Coverage	Description of Features	Distance from SEP and DEP
CSCB MCZ (waves, tidal currents and sediment transport)	Weybourne to Happisburgh	• Moderate energy infralittoral rock; • high energy infralittoral rock; • moderate energy circalittoral rock; • high energy circalittoral rock; • subtidal chalk; • subtidal coarse sediment; • subtidal mixed sediments; • subtidal sand, peat and clay exposures; and • north Norfolk coast (subtidal geological feature).	Export cable corridor passes through the MCZ
Sand banks (and associated sand waves)	Northwest parts of DEP North array area and in DEP South array area and in the north of the cable corridor between the	Sand banks and sand waves	Bedforms are within the boundaries of the DEP North and DEP South array area and in the north of the cable corridor between the DEP

Receptor Group	Extent of Coverage	Description of Features	Distance from SEP and DEP
	DEP North array area and SEP		North array area and SEP
East Anglian coast (waves and sediment transport)	King’s Lynn to Felixstowe	Gravel and sand beaches, dunes and cliffs	16km from the nearest point of SEP with the export cable making landfall at Weybourne

1.7.1.2 Changes in Suspended Sediment Concentrations

93. According to HR Wallingford *et al.* (2002), typical mean summer suspended sediment concentrations across SEP and DEP are less than 10mg/l whereas mean winter concentrations are 30mg/l, although concentrations may increase significantly during storm events.

94. More recently, Cefas (2016) published average suspended sediment concentrations between 1998 and 2015 for the seas around the UK (**Figure 6.10** of **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.2.6)). They showed that over this time period, the average suspended sediment concentrations across SEP and DEP were 5-10mg/l.

1.7.1.2.1 Changes in SSCs due to Sea Bed Preparation for Foundation Installation (Wind Farm Site)

95. Sea bed preparation for the installation of wind turbine foundations has the potential to disturb sediments from the sea bed (near-surface sediments). The worst-case scenario involves the dredge and disposal of a maximum volume of up to **729,495m^3** of near-surface sediment at or near the sea surface (or at the sea bed using a fall pipe) in the vicinity of the disposal location (**section 1.6.1**).

96. Conceptual evidence-based assessment suggests that, due to the predominance of medium and coarse grained sand across SEP and DEP offshore sites, the sediment disturbed by the drag head of the dredger at the sea bed would remain close to the bed and settle back to the bed rapidly. Most of the sediment released at the water surface from the dredger vessel would fall rapidly (minutes or tens of minutes) to the sea bed as a highly turbid dynamic plume immediately upon its discharge (within a few tens of metres along the axis of tidal flow).

97. Some of the finer sand fraction from this release and the very small proportion of mud that is present are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a measurable but modest concentration plume (tens of mg/l) for around half a tidal cycle (up to six hours). Sediment would eventually settle to the sea bed in proximity to its release (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours to days). Whilst lower suspended sediment concentrations would extend further from the dredged area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels.

98. The magnitude of effect would be at worst medium however overall there would be **no impact** upon the identified receptors groups for marine geology, oceanography and physical processes (see **Section 1.7.1.1**). This is because the receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column.

1.7.1.2.2 Changes in SSCs due to Drill Arisings for Installation of Piled Foundations for Wind Turbines and OSPs

99. Up to **24,742m^3** (23,892m^3 for wind turbines and 850m^3 for OSPs) of deeper sub-surface sediments within the SEP and DEP wind farm sites would become disturbed during any drilling activities that may be needed at the location of each piled foundation (**Section 1.6.1.4**).

100. If, required, the drilling process would cause localised and short-term increases in suspended sediment concentrations at the point of discharge of the drill arisings at two locations only. Released sediment may then be transported by tidal currents in suspension in the water column. Due to the small quantities of fine-sediment released (most of the sediment will be sand or aggregated clasts), the fine-sediment is likely to be widely and rapidly dispersed. This would result in only low suspended sediment concentrations and low changes in sea bed level when the sediments ultimately come to deposit. The disturbance effects at each wind turbine location are only likely to last for a few days of construction activity within the overall construction programme lasting up to 6 months in total if the projects are built sequentially, or 4 months if both projects are built concurrently.

101. The conceptual evidence-based assessment suggests that away from the immediate release locations, elevations in suspended sediment concentration above background levels for only two foundations would be very low (less than 10mg/l) and within the range of natural variability. Net movement of fine-grained sediment retained within a plume would be to the northwest or southeast, depending on state of the tide at the time of release. Sediment concentrations arising from one foundation installation are unlikely to persist for sufficiently long for them to interact with subsequent operations, and therefore no cumulative effect is anticipated from multiple installations.

102. The changes in SSCs (magnitudes, geographical extents and durations of effect) that are anticipated above, would move across the SEP and DEP wind farm sites with progression of the construction sequence as the point of sediment release (and hence geographic location of the zone of effect) changes with the installation of foundations at different wind turbine locations. The magnitude of effect would be negligible and overall there would be **no impact** upon the identified receptors groups for marine geology, oceanography and physical processes. This is because the receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column.

1.7.1.2.3 Changes in SSCs due to Export Cable Installation

103. The assessment of changes in suspended sediment concentrations during export cable installation has been considered separately from those for the infield and interlink cables because parts of the offshore cable corridor are in shallower water and closer to the identified morphological receptor groups.

104. The detail of the export cabling is dependent upon the final project design, but present estimates are that the maximum length of export cable could be up to 62km for DEP and 40km for SEP. The worst-case cable laying technique is considered to be jetting due the greater width of disturbance compared to ploughing.

105. Sand wave levelling (pre-sweeping) may be required at the northern end of the export cable corridor at the DEP North array area prior to export cable installation (**Figure 4.9** of **ES Chapter 4 Project description** (document reference 6.2.4)). No sand wave levelling is expected for a SEP in isolation scenario because there are no sand waves along the export cable corridor. The worst-case scenario assumes that sediment would be dredged and returned to the water column at the sea surface as overflow from a dredger vessel. This process would cause localised and short-term increases in suspended sediment concentrations both at the point of dredging at the sea bed and, more importantly, at the point of its discharge back into the water column.

106. Mobilised sediment from these activities may be transported by wave and tidal action in suspension in the water column. The sediment released at any one time would depend on the capacity of the dredger. Any sediment excavated during sand wave levelling would be disposed of within the export cable corridor, meaning there will be no net loss of sand from the site.

107. These effects on suspended sediment concentrations due to export cable installation within the offshore cable corridor would have **no impact** upon the identified receptors groups for marine geology, oceanography and physical processes. This is because the receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column.

1.7.1.2.4 Changes in SSCs due to Offshore Cables Installation (Infield and Interlink Cables)

108. Sand wave levelling (pre-sweeping) may be required in the DEP North array area, DEP South array area and adjacent sections of offshore cable corridors prior to infield and interlink cable installation (**Figure 4.9** of **ES Chapter 4 Project Description** (document reference 6.2.4)). No sand wave levelling is expected for a SEP in isolation scenario. The worst-case scenario assumes that sediment would be dredged and returned to the water column at the sea surface as overflow from a dredger vessel. This process would cause localised and short-term increases in suspended sediment concentrations both at the point of dredging at the sea bed and, more importantly, at the point of its discharge back into the water column.

109. Mobilised sediment from these activities may be transported by wave and tidal action in suspension in the water column. The disturbance effects at each location are likely to last for no more than a few days. The sediment released at any one time would depend on the capacity of the dredger. Any sediment excavated during sand wave levelling would be disposed of within the DEP wind farm sites and export cable corridor, meaning there will be no net loss of sand from the sites.

110. The types and magnitudes of effects that could be caused have previously been assessed within an industry best practice document on cabling techniques (BERR, 2008). This document has been used to support the evidence-based assessment of site conditions to inform the below.

111. Conceptual evidence-based assessment indicates that the changes in suspended sediment concentration due to infield and interlink cable installation would be similar to those that have been assessed in relation to the disturbance of near-surface sediments during foundation installation activities

112. The magnitude of effect would be at worst medium however overall, there would be **no impact** upon the identified receptors groups for marine geology, oceanography and physical processes. This is because the receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column.

1.7.1.2.5 Magnitude of Effect and Impact Significance for Changes in SSCs

113. The likely magnitudes of effect of worst-case changes in suspended sediment concentrations due to foundation installation, offshore export, infield and interlink cable installation are summarised in **Table 11**.

Table 11: Magnitude of Effect on Suspended Sediment Concentrations Under the worst-case Scenarios

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Sea Bed Preparation for Foundation Installation					
Near-field*	High	Negligible	Negligible	Negligible	Medium
Far-field	Low	Negligible	Negligible	Negligible	Low
Drill Arisings for Installation of Piled Foundations for Wind Turbines and OSPs					
Near-field*	Medium	Negligible	Negligible	Negligible	Negligible

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible
Offshore Export Cable Installation					
Near-field* (nearshore)	Low	Negligible	Negligible	Negligible	Negligible
Near-field* (offshore)	Low	Negligible	Negligible	Negligible	Negligible
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible
Infield and Interlink Cable Installation					
Near-field*	High	Negligible	Negligible	Negligible	Medium
Far-field	Low	Negligible	Negligible	Negligible	Low

*The near-field effects are confined to a small area of sea bed (likely to be of the order of several hundred metres up to a kilometre from each foundation location or cable corridor) and would not cover the whole SEP and DEP wind farm site or offshore cable corridor.

114. The effects on SSCs due to sea bed preparation for foundation installation, drill arisings from foundation installation, and export, infield and interlink cable installation will have **no impact** upon the identified receptors groups for marine geology, oceanography and physical processes. This is because the receptors are dominated by processes that are active along the sea bed and are not affected by sediment suspended in the water column. However, the effects do have the potential to impact upon other receptors, discussed in **sections 1.7.2** and **1.7.3**.

1.7.1.2.6 Cumulative Impacts

115. The receptors that have been identified in relation to marine geology, oceanography and physical processes are the East Anglian coast, CSCB MCZ and sand banks (and associated sand waves). The potential impacts on SSCs that have been assessed for SEP or DEP in isolation are all anticipated to result in **no impact** to the above-mentioned receptors. This is primarily because these receptors are located remotely from the zones of influence arising from most of the effects and no pathway has been identified that can link the source to the receptor in most cases.

116. Due to there being no impact at the project alone level for SSCs, there is no potential for cumulative impacts with other projects or activities.

1.7.1.3 Changes in Sea Bed Level

1.7.1.3.1 Changes in Sea Bed Level due to Sea Bed Preparation for Foundation Installation

117. The increased suspended sediment concentrations have the potential to deposit sediment and raise the sea bed elevation slightly.

118. The conceptual evidence-based assessment suggests that coarser sediment disturbed during sea bed preparation would fall rapidly to the sea bed (minutes or tens of minutes) as a highly turbid dynamic plume immediately after it is discharged. Deposition of this sediment would form a 'mound' local to the point of release. Due to the coarser sediment particle sizes observed across the site (predominantly medium-grained sand), a large proportion of the disturbed sediment would behave in this manner.

119. The resulting mound would be a measurable protrusion above the existing sea bed (likely to be tens of centimetres to a few metres high) but would remain local to the release point. The geometry of each of these produced mounds would vary across SEP and DEP, depending on the prevailing physical conditions, but in all cases the sediment within the mound would be like (but not exactly the same as) both the sea bed that it has replaced and the surrounding sea bed. Given the shallow nature within some areas of SEP and DEP, the **Offshore IPMP** (document reference 9.5) includes proposals for monitoring of any mounds of sediment created during sea bed preparation for GBS foundations in water less than 15m deep, if required. The baseline particle size distribution data for the DEP North array area and the DEP South array area shows that the sea bed is dominated by medium sand with overall compositional variations related to the volumes of coarser sand and gravel. Mud content is always less than 10%. This would mean that there would be a small but insignificant change in sea bed sediment type, likely to be caused by differences in the volume of the coarser fraction in the mound compared to the natural sea bed.

120. The sea bed across SEP is dominated by sandy gravel with a wider range of compositions than DEP. However, for the most part, mud content is less than 10%. There is greater likelihood of differences in mound and sea bed composition in SEP. However, the overall composition of the sea bed once the mound has been placed would still be dominated by a mix of medium to coarse sand and gravel (and so would have little effect on the benthic communities that inhabit this type of coarse granular sea bed).

121. Also, the overall change in elevation of the sea bed is small compared to the absolute depth of water (up to 36m below LAT in the northwest of the DEP North array area). The change in sea bed elevation is within the natural change to the bed caused by sand waves and sand ridges and hence the blockage effect on physical processes would be negligible.

122. The mound will be mobile and be driven by the physical processes, rather than the physical processes being driven by it. This means that over time the sediment comprising the mound will gradually be re-distributed by the prevailing waves and tidal currents.

123. In addition to localised mounds, the very small proportion of mud would form a passive plume and become more widely dispersed before settling on the sea bed. The worst-case thickness of sediment deposited from the plume would not likely exceed a maximum of 1mm and be less than 0.1mm over larger areas of the sea bed.

124. The changes in sea bed levels due to foundation installation under the worst-case sediment dispersal scenario are likely to have the magnitudes of effect shown in **Table 12**.

Table 12: Magnitude of Effects on Sea Bed Level Changes Due to Deposition Under the Worst-Case Scenario for Sediment Dispersal Following GBS Foundation Installation

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field*	Medium	Negligible	Negligible	Negligible	Low
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible

*The near-field effects are confined to a small area of sea bed likely to be up to a kilometre from each foundation location and would not cover the whole of SEP or DEP.

125. The overall impact of sea bed preparation for foundation installation activities for SEP and DEP under a worst-case scenario on sea bed level changes for the East Anglian Coast and CSCB MCZ is considered to be **negligible adverse** impact. This is because there is a separation distance of at least 17km (DEP South array area) and 6.2km (SEP) between the nearest sediment release point and the CSCB MCZ or the East Anglian coast.

126. The overall impact of sea bed preparation for foundation installation activities for the project under a worst-case scenario on sea bed level changes for the sand banks within DEP North and DEP South is considered to be **negligible adverse** impact. This is because the predicted thickness of sediment resting on the sea bed would only amount to a maximum of 1mm. After this initial deposition, this sediment will be continually re-suspended to reduce the thickness even further to a point where it will be effectively zero. This will be the longer-term outcome once the sediment supply from foundation installation has ceased.

127. The overall impact of sea bed preparation for foundation installation activities for the project under a worst-case scenario on sea bed level changes for the sand banks within the DEP North and DEP South array areas is considered to be **negligible adverse** impact. This is because the predicted thickness of sediment resting on the sea bed would only amount to a maximum of 1mm. After this initial deposition, this sediment will be continually re-suspended to reduce the thickness even further to a point where it will be effectively zero. This will be the longer-term outcome once the sediment supply from foundation installation has ceased.

128. The worst-case scenario assumes that sea bed preparation activities would be the maximum for the given water depth. In practice, the volumes of sediment released would be lower than the worst-case at many wind turbine locations because the detailed design process would optimise the foundation type and installation method to the site conditions.

1.7.1.3.2 Changes in Sea Bed Level due to Drill Arisings for Installation of Piled Foundations for Wind Turbines and OSPs

129. Drilling of piled foundations could potentially occur through five different geological units; Holocene deposits potentially overlying a series of four Pleistocene units comprised of consolidated clay and sand resting on Upper Cretaceous Chalk. The coarser sediment fractions (medium and coarse sands and gravels) and aggregated 'clasts' of mud of the Bolders Bank Formation would settle out of suspension in proximity to each foundation location.

130. The coarser sediment sand/gravel would be deposited near to the point of release up to thicknesses of approximately 3cm over a sea bed area local to each foundation (within 200 metres). For the most part, the deposited sediment layer across the wider sea bed area would be very thin, and confined to a maximum of two foundations in DEP and two foundations in SEP.

131. If the drilling penetrates underlying mud deposits, then a worst-case scenario is considered whereby the sediment released from the drilling is assumed to be wholly in the form of larger aggregated 'clasts' which would settle rapidly. These clasts would remain on the sea bed (at least initially), rather than being disaggregated into individual fine-grained sediment components immediately upon release. Under this scenario, the worst-case scenario assumes that a 'mound' would reside on the sea bed near the site of its release.

132. For drill arisings from SEP and DEP as a whole, the worst-case is for two x 15MW monopile foundations in each of SEP and DEP (5,973m^3 per turbine x 4 = 23,892^3) and one OSP per site (425m^3 x 2 = 850) equating to **24,742m^3**. These mounds would be composed of sediment with a different particle size and would behave differently (they would be cohesive) to the surrounding sandy sea bed, and therefore represent the worst-case scenario for mound formation during construction.

133. Because of their potential size, future transport of the aggregated clasts would be limited, and most would remain static within the mound. However, over time the flow of tidal currents over the mound would gradually winnow (there would be a gradual disaggregation of the clasts into their constituent particle sizes) topmost clasts and over time the mound would lower through erosion. No specific calculations have been undertaken to understand how long it would take for the mounds to fully erode.

134. The changes in sea bed levels due to foundation installation under the worst-case sediment dispersal scenario and sediment mound scenario are likely to have the magnitudes of effect shown in **Table 13** and **Table 14**, respectively.

Table 13: Magnitude of Effects on Sea Bed Level Changes due to Deposition Under the Worst-Case Scenario for Sediment Dispersal Following Piled Foundation Installation

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field*	Low	Low-Medium	Low-Medium	Negligible	Low
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible

*The near-field effects are confined to a small area of sea bed likely to be up to a kilometre from each foundation location and would not cover the whole of SEP or DEP.

Table 14: Magnitude of Effects on Sea Bed Level Changes due to Deposition Under the Worst-Case Scenario for Sediment Mound Creation Following Piled Foundation Installation

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field[+]	Low	Low-Medium	Low-Medium	Medium	Low
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible

+The near-field effects are confined to a small area of sea bed (likely to be immediately adjacent to each wind turbine location), and would not cover the whole of SEP or DEP.

135. As the impacts are restricted to the near field impacts of the dispersal and the formation of the mounds, the overall impact of foundation installation activities under a worst-case scenario on sea bed level changes for the MCZ and East Anglian coast is considered to be **no impact**. This is because there is a separation distance of at least 6.2km between the nearest sediment release point and the CSCB MCZ or the East Anglian coast. Also, transport of the aggregated clasts in the mounds would be limited, and so there would be no pathway between the source (mounds) and the receptors (MCZ and coast). Similarly, there would be **no impact** from foundation installation activities associated with sediment mound creation as they will be remote from sand bank receptors. The overall impact associated with sediment dispersal scenario on sand banks would be **negligible adverse** as the deposited sediment layer across the wider sea bed area would be approximately 3cm over a sea bed area local to each foundation (within 200 metres), which could potentially deposit on a sand bank in proximity to the foundation. After this initial deposition, this sediment will be continually re-suspended to reduce the thickness even further to a point where it will be effectively zero. This will be the longer-term outcome, once the sediment supply from foundation installation has ceased.

1.7.1.3.3 Changes in Sea Bed Level due to Deposition from the Suspended Sediment Plume During Export Cable Installation within the Offshore Export Cable Corridor

136. The increases in SSCs associated with offshore export cable installation have the potential to result in changes in sea bed level as the suspended sediment deposits.

137. The plume modelling simulations for SOW and DOW (Scira, 2006; DOW, 2009) indicate that sand-sized material would settle out of suspension within less than 20m from the point of installation within the offshore export cable corridor and persist in the water column for less than half an hour. Almost no sand was predicted to be carried more than 100m from the cable. As there is already significant ambient sand transport in the vicinity, the small amounts of additional resettled sand will not change the local transport to any significant degree. Due to the coarse sediment particle sizes observed across the site (predominantly medium-grained sand), a large proportion of the disturbed sediment would behave in this manner.

138. The low amount of mud-sized material present at SEP and DEP (**Figure 7.3** of **ES Chapter 7 Marine Water and Sediment Quality** (document reference 6.2.7)) would be advected a greater distance and persist in the water column for hours to days, before depositing to form a thin layer on the sea bed. However, it is anticipated that under the prevailing hydrodynamic conditions, this sediment would be readily re-mobilised, especially in the shallow inshore area where waves would regularly agitate the bed. Accordingly, outside the immediate vicinity of the offshore cable trench, bed level changes and any changes to sea bed character are expected to be not measurable in practice. Also, although chalk plumes may extend some distance, there is no evidence that the very low levels of suspended load have any impact on marine habitats or species (DOW, 2009).

139. The worst-case changes in sea bed level due to export cable installation within the offshore export cable corridor are likely to have the magnitudes of effect described in **Table 15**.

Table 15: Magnitude of Effects on Sea Bed Level Changes Due to Export Cable Installation Within the Offshore Export Cable Corridor Under the Worst-Case Scenario for SSCs

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field*	Low	Negligible	Negligible	Negligible	Low
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible

*The near-field effects are confined to a small area of sea bed likely to be up to a kilometre from the offshore cable corridor, and would not cover the whole offshore export cable corridor.

140. Based on the DOW plume modelling simulations, conceptual evidence-based assessment of deposition from the plume generated from cable installation indicates that the changes in sea bed elevation are effectively immeasurable within the accuracy of any numerical model or bathymetric survey. This means that given these very small magnitude changes in sea bed level arising from export cable installation, the impacts on the identified morphological receptors (i.e. East Anglian Coast, CSCB MCZ and sand banks, all of which are assigned a sensitivity of negligible for this potential impact) would not be significant. Hence, the overall impact of offshore export cable installation activities under a worst-case scenario on bed level changes for the identified morphological receptor groups is considered to be **no impact** for the East Anglian Coast and **negligible adverse** impact for CSCB MCZ and sand banks in the north of the export cable corridor close to DEP North.

141. In many parts of the offshore export cable corridor the export cable installation is unlikely to result in the release of the volumes of sediment considered under this worst-case scenario (see **Section 1.6.1.4**). In addition, the optimisation of the offshore export cable corridor selection within the corridor, depth and installation methods during detailed design would ensure that impacts are minimised.

1.7.1.3.4 Change in Sea Bed Level due to Offshore Cable Installation (Infield and Interlink Cables

142. The increases in suspended sediment concentrations associated with the impact assessed in **Section 1.7.1.2.4** have the potential to result in changes in sea bed levels as the suspended sediment deposits.

143. Given that interlink cables will only be required in a DEP in isolation or SEP and DEP scenario, changes in sea bed level due to interlink cable installation are not assessed for SEP in isolation.

144. The evidence-based assessment suggests that coarser sediment disturbed during cable installation would fall rapidly to the sea bed (minutes or tens of minutes) as a highly turbid dynamic plume immediately after it is discharged. Deposition of this sediment would form a linear mound (likely to be tens of centimetres high) parallel to the cable as the point of release moves along the excavation. Due to the coarser sediment particle sizes observed across the site (predominantly medium-grained sand), a large proportion of the disturbed sediment would behave in this manner and be similar in composition to the surrounding sea bed. This would mean that there would be no significant change in sea bed sediment type.

145. A very small proportion of mud would also be released to form a passive plume and become more widely dispersed before settling on the sea bed. The conceptual evidence-based assessment suggests that due to the dispersion by tidal currents, and subsequent deposition and re-suspension, the deposits across the wider sea bed would be very thin (millimetres).

146. Evidence-based assessment indicates that changes in sea bed level due to infield and interlink cable installation (including any deposition arising from spilled sediment from sand wave levelling) would be minor and are likely to have the magnitudes of effect shown in **Table 16**.

Table 16: Magnitude of Effect on Sea Bed Level Changes due to Deposition Under the worst-case Scenario for Sediment Dispersal Following Infield Cable Installation (Including Sand Wave Levelling)

Location	Scale	Duration	Frequency	Reversibility	Magnitude of Effect
Near-field*	Low	Negligible	Negligible	Negligible	Low
Far-field	Negligible	Negligible	Negligible	Negligible	Negligible

*The near-field effects are confined to a small area of sea bed likely to be up to a kilometre from the cable, and would not cover the whole of SEP or DEP.

147. These effects on sea bed level are considered highly unlikely to have the potential to impact directly upon the identified receptor groups for marine geology, oceanography and physical processes. Any impacts will be of lower magnitude than those sea bed level impacts already considered for the installation of foundations. Consequently, the overall impact of infield and interlink cable installation under a worst-case scenario on sea bed level changes for the East Anglian Coast and CSCB MCZ is considered to be **negligible adverse** impact due to the separation distance between these receptors and infield and interlink cables. The overall impact of infield and interlink cable installation under a worst-case scenario on sea bed level changes for sand banks is therefore considered to be **negligible adverse** for SEP or DEP.

1.7.1.3.5 Cumulative Impacts

148. The receptors that have been identified in relation to marine geology, oceanography and physical processes are the East Anglian coast, CSCB MCZ and sand banks (and associated sand waves). The potential impacts on sea bed level that have been assessed for SEP and DEP alone are all anticipated to result in either **no impact** or **negligible adverse** impact to the above-mentioned receptors. This is primarily because these receptors are located remotely from the zones of influence arising from most of the effects and no pathway has been identified that can link the source to the receptor in most cases. This assessment remains valid for both SEP or DEP in isolation and for SEP and DEP.

149. **Section 6.7** of **ES Chapter 6 Marine Geology, Oceanography and Physical Processes** (document reference 6.1.6) provides the cumulative impact assessment. Potential cumulative construction and operation impacts with Hornsea Project Three are assessed however the assessment concludes that these would not be significant.

1.7.1.3.6 Summary of Impacts of Sediment Disposal on Physical Characteristics

150. The assessment conclusions of all relevant impacts on physical characteristics was that there would be **no impact** from an increase in SSCs and **no impact** or **negligible adverse** impact on the identified receptors resulting from changes to sea bed level. Therefore, there would be no discernible effect on the physical characteristics of the proposed SEP and DEP disposal sites (see **Figure 1**), should they be designated.

1.7.2 Potential Impacts of Sediment Disposal on Water and Sediment Quality

1.7.2.1 Deterioration in Water Quality due to an Increase in SSCs

151. As discussed in **Section 1.7.1**, foundation installation and offshore cable installation have the potential to disturb sea bed surface or shallow near-surface sediments. Mobilised sediment from these activities, including material removed by means of dredging and returned to the water column at its surface layer, may be transported by wave and tidal action in suspension in the water column forming a plume.

152. The worst-case scenario changes in SSCs due to foundation installation (including drilling) and offshore cable installation are predicted to be low in magnitude due to the localised and short term nature of the predicted sediment plumes. Baseline conditions of SSCs are expected to return to normal rapidly following cessation of activity, therefore any impact would only be present during the installation process. The sensitivity in the SEP and DEP Wind Farm site is deemed to be low due to the large volume of the receiving water and the capacity for dilution and flushing. Therefore, a **negligible adverse** impact is predicted.

1.7.2.2 Deterioration in Water Quality Due to Re-Suspension of Sediment Bound Contaminants

153. Any sediment that is disturbed and released during construction, could give rise to impacts on water quality via the release of contaminants bound to the sediment particles. The data in **Table 5** shows that the levels of contaminants within SEP and DEP are all below relevant Cefas Action Level 1 concentrations and levels of arsenic only marginally exceed CSQG TEL levels in six of the seven sampled locations (see **Section 1.5.2.1**). Regional information available indicates that these levels are below the range identified as being typical for the area.

154. Sediments remaining in suspension for long periods of time are not predicted given that the sea bed material is predominantly sand/gravel thus reducing the risk of exposure to the water column for partitioning to occur.

155. The magnitude of effect is therefore considered to be negligible. Since the receptor is considered to be of low sensitivity, an increase in suspended sediment from dredging and disposal activities is expected to have a **negligible adverse** impact on water quality.

1.7.2.3 Cumulative impacts

156. The potential impacts on SSCs that could result in the deterioration of water quality have been assessed for SEP and DEP alone and are anticipated to result in **negligible adverse** impact. Neither of the above impacts are considered to have potential to interact cumulatively with other plans and projects and therefore there would be no potential for cumulative impacts with regard to this assessment.

1.7.3 Potential Impacts of Sediment Disposal on Benthic Ecology

1.7.3.1 Temporary Increases in SSC and Deposition

157. As discussed in **section 1.7.1**, foundation installation and sand wave levelling for offshore cable installation have the potential to increase suspended sediment concentrations within the water column. This increase has the potential to affect the benthic ecology receptors through blockage to the sensitive filter feeding apparatus of certain species and / or smothering of sessile species upon deposition of the sediment.

158. As described in **section 1.7.1**, conceptual evidence-based assessment suggests that, due to the predominance of medium and coarse grained sand across the SEP and DEP wind farm sites, the sediment disturbed by the drag head of the dredger at the sea bed would remain close to the bed and settle back to the bed rapidly. Most of the sediment released at the water surface from the dredger vessel would fall rapidly (minutes or tens of minutes) to the sea bed as a highly turbid dynamic plume immediately upon its discharge (within a few tens of metres along the axis of tidal flow).

159. Some of the finer sand fraction from this release and the very small proportion of mud that is present are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a measurable but modest concentration plume (tens of mg/l) for around half a tidal cycle (up to six hours). Sediment would eventually settle to the sea bed in proximity to its release (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours to days). Whilst lower suspended sediment concentrations would extend further from the dredged area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels.

160. The sensitivity of benthic receptors at SEP and DEP to increases in suspended sediments and smothering are shown below in **Table 17**.

Table 17: Habitat and Biotope Sensitivity to Increased SSC And Deposition Pressures

Habitat and Biotope	MarESA sensitivity	
	Smothering and siltation rate changes (light)	Changes in suspended solids (water clarity)
A3/4 Infralittoral / Circalittoral rock and other hard substrata	**Low**	
A4.232 *Polydora sp.* tubes on moderately exposed sublittoral soft rock	Not sensitive	Low
A4.1 Atlantic and Mediterranean high energy circalittoral rock	**Low**	
A4.134 *F. foliacea* and colonial ascidians on tide-swept moderately wave-exposed circalittoral rock	Not sensitive	Low
A4.2 Atlantic and Mediterranean moderate energy circalittoral rock	**Medium**	

Habitat and Biotope	MarESA sensitivity	
	Smothering and siltation rate changes (light)	Changes in suspended solids (water clarity)
A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay	Medium	Not sensitive
A5.1 Sublittoral coarse sediment	**Low**	
A5.133 ‘*Moerella spp.* with venerid bivalves in infralittoral gravelly sand’	Low	Low
A5.2 Sublittoral sand	**Low**	
A5.233 *Nephtys cirrosa* and *Bathyporeia spp*. in infralittoral sand	Low	Not sensitive
A5.4 Sublittoral mixed sediments	**Low**	
A5.431 *Crepidula fornicata* with ascidians and anemones on infralittoral coarse mixed sediment	Not sensitive	Low
A5.451 Polychaete-rich deep Venus community in offshore mixed sediments	Low	Low
A5.6 Sublittoral biogenic reefs	**Not sensitive**	
A5.611 *S. spinulosa* on stable circalittoral mixed sediment	Not sensitive	Not sensitive

161. A review of the sensitivities of the biotopes associated with the habitats present across SEP and DEP in relation to the pressures of increased SSCs and deposition indicates that all biotopes are either not sensitive or have a low sensitivity to these pressures (**Table 17**). One exception to this is biotope ‘A4.231 Piddocks with a sparse associated fauna in sublittoral very soft chalk or clay’, recorded at one location in the SEP wind farm site which has a sensitivity of medium. This biotope is not widespread in the SEP wind farm site and it is likely that construction activities will be a sufficient distance from this receptor such that the pathway for an effect is limited. However, as a worst-case scenario a sensitivity of medium has been determined in relation to temporary increases in SSC and deposition.

162. Activities associated with the offshore construction works at SEP and DEP will result in temporary increases in SSCs and subsequent deposition. Relevant construction activities are:

- Sea bed preparation;
- Wind turbine foundation installation;
- OSP foundation installation;
- Export cable installation, and

- Interlink (not required for SEP) and infield cable installation.

163. **Section 1.7.1** describes the expected movement of sediment suspended during the construction phase. Overall, increases in SSCs are expected to be localised at the point of discharge and short-term. Fine suspended sediment may then be transported by tidal currents, however due to the small quantities of fine-sediment released it is likely to be widely and rapidly dispersed. In most cases, the elevation of suspended sediment is expected to be lower than concentrations that would develop in the water column during storm conditions. The coarser sediment sand/gravel would be deposited near to the point of release up to thicknesses of approximately 3cm.

164. Given the localised and short-term increases in SSCs around the point of discharge, and negligible changes in sea bed level expected due to deposition, the magnitude of effect is considered to be negligible.

165. Based on the worst-case medium sensitivity of one biotope (A4.231) and the negligible magnitude of temporary increases in SSCs and deposition during the SEP and DEP construction phase, the impact is assessed as **minor adverse** significance.

1.7.3.2 Remobilisation of Contaminated Sediments

166. As described in **Section 1.7.2.2**, sediment disturbance could lead to the mobilisation of contaminants which may be lying dormant within sediment and which could be harmful to the benthos. Sediment contamination levels in the surveyed area are not considered to be of significant concern and are low risk in terms of potential impacts on the marine environment. Specifically, the organotin concentrations recorded were low and insufficient to affect the reproductive capability of sensitive gastropod species.

167. The MarESA pressure benchmark for ‘Pollution and other chemical changes’ is set at ‘compliance with all Annual Average Environmental Quality Standards (EQS), conformance with PELs, and OSPAR Environmental Assessment Criteria (EACs) or Effects Range Lows (ER-Ls’)’ and that compliance with ‘all relevant environmental protection’ is likely to result in no effects on the features (Tyler-Walters et al., 2018). Given contaminant levels are within environmental protection standards (i.e. no exceedance of Action Level 1 - see **Section 1.5.2**) marine species and habitats are not sensitive to changes that remain within these standards.

168. Due to there being no contaminated sediments above levels of concern within SEP and DEP, there is no pathway for effect on benthic receptors. Therefore, there is **no impact** for all scenarios.

1.7.3.3 Cumulative Impacts

169. Neither of the relevant potential impacts were screened into the benthic ecology cumulative assessment since increases in SSCs are expected to be localised at the point of discharge and short-term. The small quantities of fine-sediment present may be transported up to approximately 1km however these will be widely and rapidly dispersed. In most cases, the elevation of SSC is expected to be lower than concentrations that would develop in the water column during storm conditions.

170. Therefore, there is no pathway for cumulative effect with respect to sediment disposal.

1.8 Summary

171. As part of the DCO application for SEP and DEP, the Applicant is applying for a disposal licence for the areas identified in (**Figure 1**). SEP or DEP may be built in isolation, and it is currently unknown whether the DEP South array area and the interlink cable corridors originating from it will be required. However, in order to streamline the disposal site characterisation and licensing process, this document provides the necessary information for all areas to be licensed as disposal sites and included on the face of the DMLs. If any of these areas are not required following detailed design then the Applicant can agree with the MMO and Cefas that the licensed activities will not be undertaken in these areas.

172. Licensing of the proposed disposal sites would allow the Applicant to dispose of material arising from construction activities (including sea bed preparation (dredging) and drilling). Licensing of the proposed areas would allow the Applicant, as far as possible, to dispose of sediment in the vicinity of the locations from which it was extracted, ensuring sediment is disposed of within areas of similar sediment type and subject to the same sedimentary processes.

173. The sea bed sediments at the SEP and DEP wind farm sites are primarily medium sand. Maximum quantities of material which would need to be excavated for foundations are provided along with maximum quantities of material released from drilling should piled foundations be utilised.

174. Most of the material released from sea bed preparation, drilling and sand wave levelling would be deposited in the near vicinity of the point of release forming a mound (likely to be between tens of centimetres to a few metres high as a worst-case for foundation installation). The geometry of each of these mounds would vary across SEP and DEP, depending on the prevailing physical conditions, but in all cases the sediment within the mound would be similar (but not exactly the same as) the sea bed that it is deposited on and the surrounding sea bed.

175. Some of the finer sand fraction from this release and the very small proportion of mud that is present are likely to stay in suspension for longer and form a passive plume which would become advected by tidal currents. Due to the sediment sizes present, this is likely to exist as a measurable but modest concentration plume (tens of mg/l) for around half a tidal cycle (up to six hours). Sediment would eventually settle to the sea bed in proximity to its release (within a few hundred metres up to around a kilometre along the axis of tidal flow) within a short period of time (hours to days). Whilst lower SCCs would extend further from the dredged area, along the axis of predominant tidal flows, the magnitudes would be indistinguishable from background levels.

176. The disposal of dredged material has the potential to release sediment-bound contaminants, such as heavy metals and hydrocarbons into the water column. However, levels of contaminants throughout SEP and DEP are generally very low. Elevated levels of arsenic, which are typical of the region, have been recorded at some locations however regional information available indicates that these levels are below the range identified as being typical for the area and they are not at concentrations considered to pose an unacceptable risk to the marine environment.

177. Results of the benthic ecology assessment show that the majority of identified receptors for SEP and DEP are not sensitive to increased suspended sediments and smothering. Adverse impacts could occur within a few metres of the disposal locations where heavy smothering would be expected, but overall the impact from disposal site activities is predicted to result in no impact with the exception of temporary increases in SSC and deposition impacts which would be of minor adverse significance.

References

BERR (2008). Review of Cabling Techniques and Environmental Effects applicable to the Offshore Windfarm Industry.
CCME (2002) Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. Available online at: [redacted]
Cefas (2016). Suspended Sediment Climatologies around the UK. Report for the UK Department for Business, Energy and Industrial Strategy offshore energy Strategic Environmental Assessment Programme.
Cefas (2020) Review of Action Levels used for assessing dredging and disposal marine licences. Found at Defra, UK - Science Search
Cooper, N.J. and Brew, D.S. (2013). Impacts on the physical environment. In: R.C. Newell and T.A. Woodcock (Eds.). *Aggregate dredging and the marine environment: an overview of recent research and current industry practice*. The Crown Estate.
Dudgeon Offshore Wind Farm (DOW) (2009). Environmental Statement – Section 7: Physical Processes.
Environment Agency (2017) Clearing the Waters for All. Available online at: Water Framework Directive assessment: estuarine and coastal waters - GOV.UK (www.gov.uk)
Fugro (2020a). Dudgeon Extension Benthic Characterisation Report. Dudgeon Extension Project. Volume 4 Benthic Characterisation Report. Survey Period: 10 to 19 August 2020. 200270-R-00403. 23 December 2020.
Fugro (2020b). Sheringham Shoal Extension Benthic Characterisation Report Sheringham Extension Project. Volume 5 Benthic Characterisation Report. Survey Period: 10 to 19 August 2020. 200270-R-00502. 23 December 2020.
Hiscock, D.R. and Bell, S. (2004). Physical impacts of aggregate dredging on sea bed resources in coastal deposits. *Journal of Coastal Research*, 20 (10), 101-114.
HR Wallingford (2002). Southern North Sea Sediment Transport Study – Phase 2. HR Wallingford report EX4526.
John, S.A., Challinor, S.L., Simpson, M., Burt, T.N. and Spearman, J. (2000). *Scoping the assessment of sediment plumes from dredging*. CIRIA Publication.
MMO (2018). Marine Licensing: sediment analysis and sample plans. Guidance. Available online at: https://www.gov.uk/guidance/marine-licensing-sediment-analysis-and-sample-plans###Suitability%20of%20material
Newell, R.C., Seiderer, L.J., Robinson, J.E., Simpson, N.M., Pearce, B and Reeds, K.A. (2004). Impacts of overboard screening on sea bed and associated benthic biology community structure in relation to marine aggregate extraction. Technical

Report to the Office of the Deputy Prime Minister and Minerals Industry Research Organisation. Project No. SAMP 1.022, Marine Ecological Surveys Ltd, St. Ives, Cornwall.

Scira (2006). Sheringham Shoal Offshore Wind Farm Environmental Statement.

Tillin, H.M., Houghton, A.J., Saunders, J.E. Drabble, R. and Hull, S.C. (2011). Direct and indirect impacts of aggregate dredging. *Science Monograph Series No. 1*. MEPF 10/P144

Tyler-Walters, H., Tillin, H.M., d'Avack, E.A.S., Perry, F. & Stamp, T. (2018). Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide. Marine Life Information Network (MarLIN). Marine Biological Association of the United Kingdom, Plymouth, 91 pp

Whiteside, P.G.D., Ooms, K. and Postma, G.M. (1995). Generation and decay of sediment plumes from sand dredging overflow. *Proceedings of the 14th World Dredging Congress*. Amsterdam, The Netherlands. World Dredging Association, 877 – 892.

Annex 1

1. This annex and **Annex Table A 1** to **Annex Table A 4** provides coordinates to delineate the proposed disposal sites for SEP and DEP.

Annex Table A 1: Coordinates Delineating the Proposed SEP Wind Farm Site Disposal Site

Point	Latitude (Degree, minutes, seconds)	Longitude (Degrees, minutes, seconds)
1	53, 14, 44.160	1, 5, 29.656
2	53, 7, 19.880	1, 17, 7.609
3	53, 5, 7.814	1, 15, 39.928
4	53, 5, 47.202	1, 13, 1.714
5	53, 8, 58.858	1, 10, 56.766
6	53, 11, 4.11	1, 1, 59.253
7	53, 14, 44.16	1, 5, 29.655

Annex Table A 2: Coordinates Delineating the Proposed DEP North Array Area Disposal Site

Point	Latitude (Degree, minutes, seconds)	Longitude (Degrees, minutes, seconds)
1	53, 9, 9.223	1, 28, 22.706
2	53, 9, 18.54	1, 27, 23.004
3	53, 10, 5.912	1, 25, 33.290
4	53, 14, 5.406	1, 25, 52.575
5	53, 13, 44.763	1, 27, 26.146
6	53, 10, 38.870	1, 32, 6.381
7	53, 9, 9.223	1, 28, 22.706

Annex Table A 3: Coordinates Delineating the Proposed DEP South Array Area and Interlink Cable Corridor Disposal Site

Point	Latitude (Degree, minutes, seconds)	Longitude (Degrees, minutes, seconds)
DEP South Array Area Co-ordinates		
1	53, 20, 54.139	1, 24, 1.404
2	53, 20, 5.326	1, 24, 0.032
3	53, 19, 36.127	1, 24, 8.276
4	53, 19, 9.825	1, 24, 23.58
5	53, 18, 17.503	1, 25, 24.51
6	53, 18, 0.223	1, 25, 39.259
7	53, 17, 15.147	1, 26, 5.611
8	53, 18, 34.675	1, 23, 20.457
9	53, 18, 35.114	1, 22, 55.059
10	53, 18, 9.352	1, 22, 14.077
11	53, 18, 55.522	1, 20, 33.698
12	53, 18, 18.216	1, 19, 28.603
13	53, 18, 23.04	1, 19, 18.170

Point	Latitude (Degree, minutes, seconds)	Longitude (Degrees, minutes, seconds)
14	53, 16, 39.108	1, 19, 11.121
15	53, 18, 17.848	1, 17, 51.100
16	53, 19, 27.458	1, 17, 16.562
17	53, 20, 6.979	1, 16, 32.34
18	53, 20, 32.55	1, 15, 58.780
19	53, 19, 2.697	1, 12, 19.933
20	53, 21, 9.273	1, 10, 11.082
21	53, 21, 9.601	1, 17, 32.334
22	53, 20, 46.341	1, 18, 7.236
23	53, 20, 58.887	1, 18, 37.508
24	53, 21, 16.934	1, 18, 58.323
25	53, 21, 57.852	1, 23, 24.349
26	53, 20, 54.139	1, 24, 1.404
Interlink Cable Corridor Co-ordinates		
1	53, 10, 33.834	1, 13, 37.236
2	53, 9, 56.800	1, 14, 32.528
3	53, 12, 22.726	1, 25, 3.043
4	53, 13, 59.199	1, 21, 35.388
5	53, 14, 0.675	1, 21, 29.206
6	53, 15, 21.351	1, 18, 38.084
7	53, 15, 31.834	1, 18, 25.210
8	53, 15, 42.670	1, 18, 22.176
9	53, 17, 29.097	1, 18, 30.621
10	53, 16, 40.497	1, 19, 9.998
11	53, 15, 41.403	1, 19, 5.484
12	53, 12, 35.769	1, 25, 45.404
13	53, 12, 13.888	1, 25, 43.651
14	53, 9, 35.524	1, 14, 21.148

Annex Table A 4: Coordinates Delineating the Proposed SEP and DEP Offshore Export Cable Corridor Disposal Sites

Point	Latitude (Degree, minutes, seconds)	Longitude (Degrees, minutes, seconds)
1	53, 7, 12.187	1, 18, 5.637
2	53, 5, 3.998	1, 16, 47.438
3	53, 3, 39.214	1, 16, 5.714
4	53, 3, 4.284	1, 15, 45.010
5	53, 2, 18.679	1, 15, 22.982
6	53, 1, 50.538	1, 15, 6.847
7	53, 1, 22.101	1, 15, 8.812
8	53, 0, 37.630	1, 14, 15.36
9	53, 0, 4.888	1, 13, 45.462
10	52, 58, 31.515	1, 11, 41.755
11	52, 56, 53.419	1, 9, 25.988

Point	Latitude (Degree, minutes, seconds)	Longitude (Degrees, minutes, seconds)
12	52, 56, 58.815	1, 8, 11.965
13	52, 57, 8.132	1, 8, 22.146
14	52, 57, 14.356	1, 8, 25.825
15	52, 57, 40.111	1, 8, 33.187
16	52, 57, 42.426	1, 8, 35.383
17	52, 57, 52.102	1, 8, 56.637
18	52, 58, 16.244	1, 10, 2.679
19	53, 0, 17.064	1, 12, 49.788
20	53, 0, 57.553	1, 13, 25.222
21	53, 1, 43.741	1, 14, 26.066
22	53, 1, 54.321	1, 14, 36.758
23	53, 2, 14.456	1, 14, 49.563
24	53, 4, 23.25	1, 15, 46.785
25	53, 5, 0.996	1, 15, 11.113
26	53, 5, 20.508	1, 14, 48.411
27	53, 5, 20.706	1, 14, 48.181
28	53, 5, 47.202	1, 13, 1.718
29	53, 7, 50.026	1, 11, 41.715
30	53, 10, 14.682	1, 12, 33.699
31	53, 19, 29.532	1, 15, 27.997
32	53, 20, 0.214	1, 14, 40.660
33	53, 20, 32.384	1, 15, 59.072
34	53, 20, 6.813	1, 16, 32.631
35	53, 19, 41.797	1, 17, 0.628
36	53, 18, 56.530	1, 16, 15.33
37	53, 10, 33.834	1, 13, 37.236