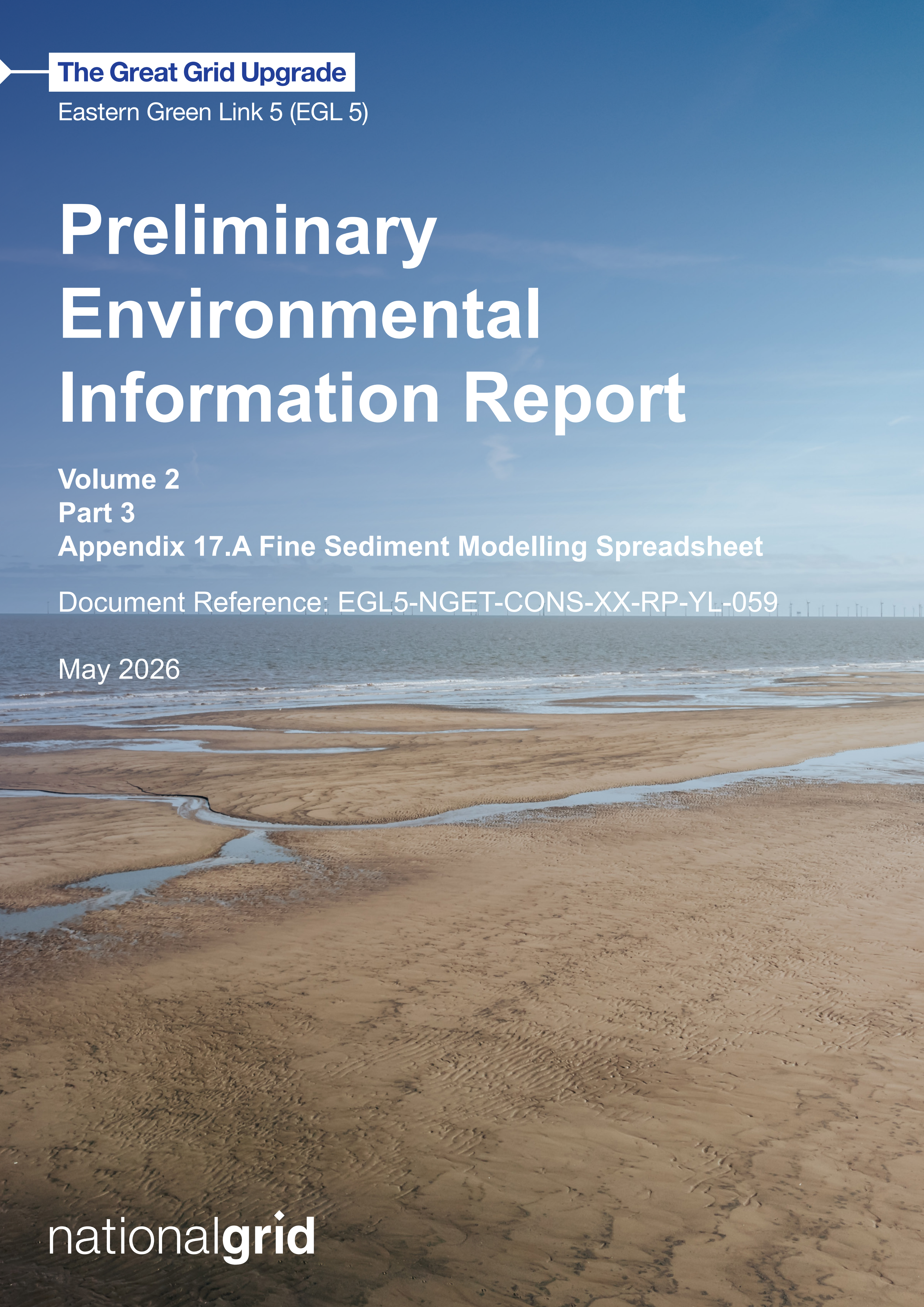


The Great Grid Upgrade

Eastern Green Link 5 (EGL 5)

Preliminary Environmental Information Report

Volume 2
Part 3
Appendix 17.A Fine Sediment Modelling Spreadsheet

Document Reference: EGL5-NGET-CONS-XX-RP-YL-059

May 2026

nationalgrid

Contents

Eastern Green Link (EGL) 5
Document control

Document Properties	
Organisation	Port and Coastal Solutions
Author	Rachel White
Approved by	Andy Symonds
Title	Appendix 17.A Fine Sediment Modelling Spreadsheet
Published Document Ref	EGL5-NGET-CONS-XX-RP-YL-059
Data Classification	Public

17.A. Fine Sediment Modelling Spreadsheet

17.A.1 Introduction

17.A.1.1 Eastern Green Link (EGL) 5 is a primarily offshore 2 Gigawatt (GW) High Voltage Direct Current (HVDC) electricity link, with associated onshore infrastructure, between Scotland and East Lindsey in England. EGL 5 comprises almost 600 kilometres (km) of subsea and underground HVDC cables between new converter stations at each end of the electricity transmission link, of which approximately 423 km is within the English Waters.

17.A.1.2 Sediment suspended during installation of the subsea cables could result in temporary increases in Suspended Sediment Concentrations (SSC) which could have an adverse effect on water quality. Subsequent deposition once material re-settles to the bed could also result in environmental impacts via smothering.

17.A.1.3 To inform the Preliminary Environmental Impact Report (PEIR) for the English Offshore Scheme, a spreadsheet-based model has been developed and applied to assess the potential adverse effects on water quality and smothering from construction related activities, including sandwave clearance, excavation of trenchless technology exit pits and cable trenching operations.

17.A.1.4 This technical note is structured as follows:

- Details on the baseline characteristics (including sediment properties and flow field) are provided in Section 2;
- Details on the applied methodology are provided in Section 3;
- Results are presented in Section 4; and
- A summary is provided in Section 5.

The Study Area

17.A.1.5 The Study Area includes the proposed subsea cable corridor for EGL 5 within English waters (seaward of Mean High Water Springs (MHWS)) plus the draft Order Limits (which are nominally 500 m wide, widening in areas where there are seabed features such as sandwaves, challenging seabed conditions or sensitive habitats to allow for micro-routing) and a 19.8 km buffer either side. This buffer is the area within which all impacts are expected to be constrained, and this is informed by the spring tide tidal excursion.

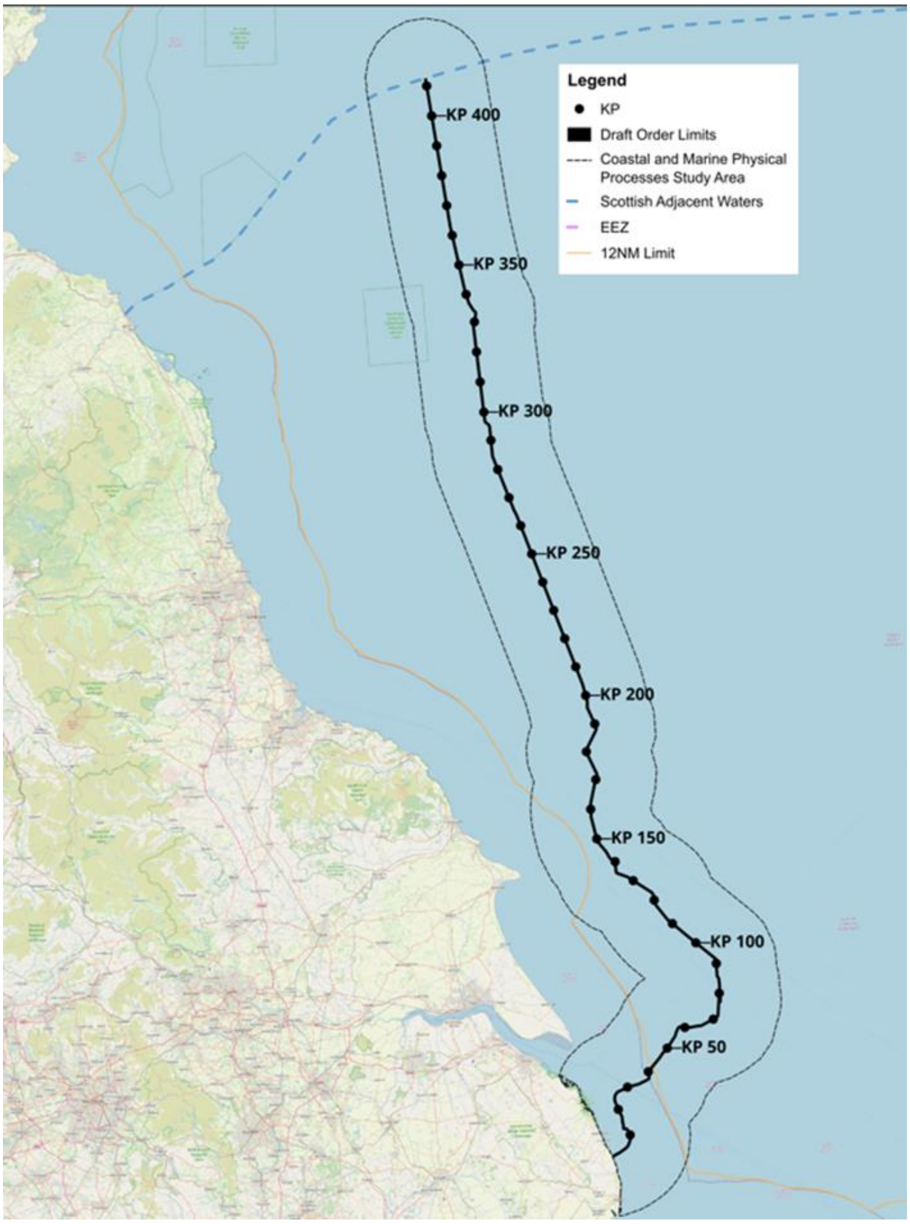
17.A.1.6 Kilometre Points (KPs) are used to provide context as to where within the Study Area a feature lies. The KPs are referenced as KP 0 to KP 412, with KP 0 defined at the Anderby Creek Landfall and KP 412 being at the English and Scottish adjacent waters.

17.A.1.7 Regional scale modelling tools (ABPmer, 2017) indicate the following tidal excursions along the route:

- Mean tide excursions of around 10 km (equivalent to 14 km on a mean spring tide) close to landfall (along the inner 40 km of the route);

- Mean tidal excursions of around 13 km (equivalent to 17 km on a mean spring tide) offshore of the Humber Estuary (KP 38 to KP 66), with longest mean tidal excursions of 15 km (equivalent to 19.8 km on a mean spring tide (KP 50 to KP 59); and
- Mean tide excursions of less than 5 km (equivalent to 7.5 km on a mean spring tide) offshore of KP 207 (approximately along half of the route).

Plate 17.A-1 The EGL 5 proposed subsea cable corridor and Study Area



17.A.2 Baseline Characterisation

17.A.2.1 A characterisation of the baseline conditions was undertaken to determine the sediment properties (Particle Size Distribution (PSD) and dry sediment density) and hydrodynamic flow conditions along the proposed subsea cable route. The percentage of fines along the proposed subsea cable route is shown in **Plate 17.A-2**. Locations of sandwaves are also shown for reference.

17.A.2.2 More detailed sediment properties are presented at a number of selected KPs in **Table 17.A-1**. KP 2 corresponds to the location of the HDD exit pit excavation, KP 117 corresponds to the location of sandwave clearance and all KPs in the table correspond to the location of trenching.

17.A.2.3 The PSD varies between samples, the samples were selected to include those with the highest percentages of fines (at KP 10, KP 17 and KP 283) to provide a conservative assessment of the potential area of impact. This is because fine sediment (e.g., silt and clay) will remain in suspension for longer and disperse to give a larger area of subsequent deposition on the seabed, while coarser grain fractions (e.g., sand) will settle to the bed close to the location of disturbance. Samples at KP 149, KP 199, KP 249 and KP 357 are more representative of the percentage of fines in the draft Order Limit (with an average of 8.8% of fines and a median of 6.7% of fines from a total of 173 surficial sediment samples along the full proposed subsea cable corridor). KP 46 is included as the sample with highest fines within the area of peak tidal flow where the tidal excursion distances will be longest. KP 199 is included to provide a worst-case assessment for sedimentation thickness on the bed as it has a relatively low percentage of fines (and relatively slow flow speeds).

17.A.2.4 The dry sediment density was derived from the percentage of fines based on the work of Allersma (1988) as presented in Van Rijn (1993). The density is highest when the fraction of fines is low (being 1,500 kg/m3 for 5% fines and reducing to 1,090 kg/m3 as the percentage of fines increases to 50%).

Plate 17.A-2 The percentage of fines from samples collected along the proposed subsea cable route.

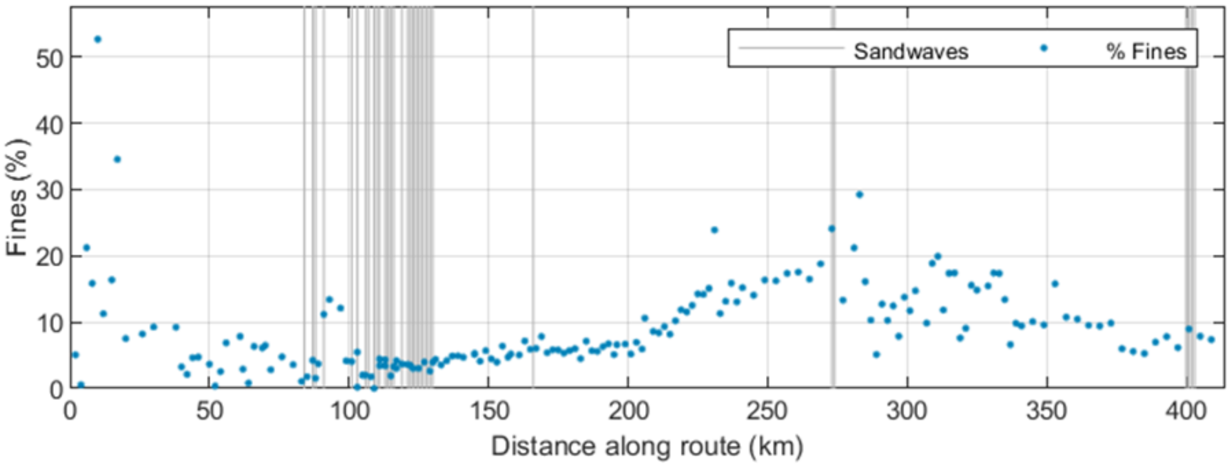


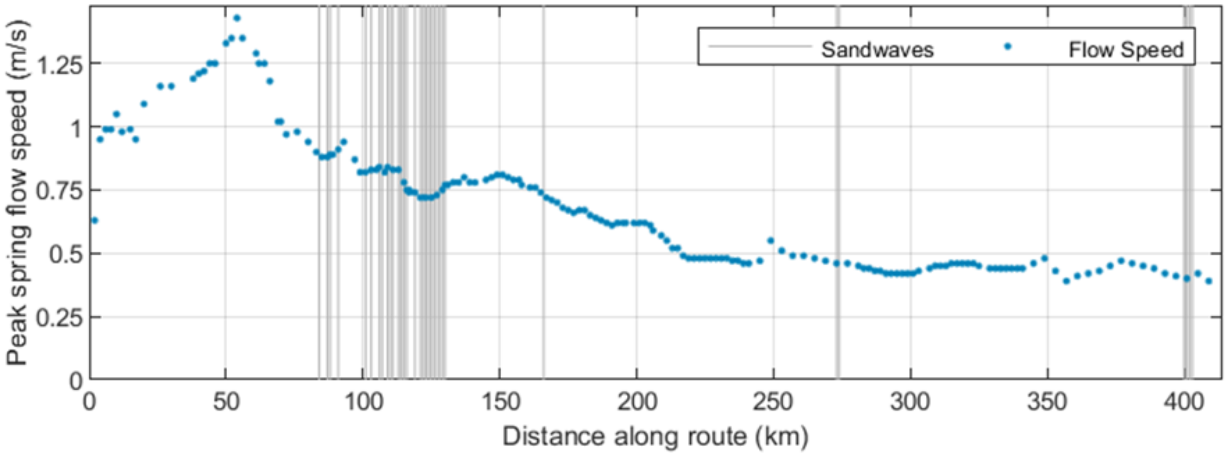
Table 17.A-1 PSD at locations along the proposed subsea cable corridor (percent).

Location	Clay to medium silt	Coarse silt	Very Fine Sand	Fine Sand	Medium Sand	Coarse sand and above	% age of fines
KP 2	3.7	1.3	0.1	4.9	18.1	71.9	5.1
KP 10	31.9	20.7	7.6	8.0	9.6	22.2	52.6
KP 17	24.9	9.7	7.0	19.2	18.5	20.8	34.5
KP 46	3.4	1.4	1.1	3.7	8.5	82.0	4.7
KP 117	2.6	1.5	8.9	50.3	31.7	4.8	4.2
KP 149	4.3	1.4	3.7	57.6	29.9	3.1	5.7
KP 199	4.5	2.2	9.3	56.0	26.8	1.1	6.7
KP 249	10.7	5.7	8.9	34.8	34.0	6.0	16.4
KP 283	18.9	10.3	3.9	24.9	36.7	5.3	29.2
KP 357	6.6	4.1	8.4	33.1	35.1	12.7	10.7
Mean*	5.7	3.1	8.1	34.7	27.4	21.0	8.8
Median*	4.4	2.2	4.9	37.1	29.6	7.5	6.7
Maximum*	32.3	20.7	38.6	67.9	68.4	93.4	53.0
* for all 173 samples collected along the proposed subsea cable route.							

17.A.2.5 Tidal currents in the Study Area are generally orientated southwards on the flood tide and northwards on the ebb tide. The currents close to the proposed landfall in the Study Area are bi-directional in nature, aligned with the coast, while currents become slightly more orbital in nature further offshore.

17.A.2.6 The peak spring flow speeds along the proposed subsea cable route (based on ABPmer (2017)) are shown in **Plate 17.A-3**, with tabulated values at the selected KPs provided in **Table 17.A-2**.

Plate 17.A-3 The spring tide peak flow speed along the proposed subsea cable route (based on ABPmer, 2017).



17.A.2.7 Fastest currents occur offshore of Spurn Head where peak spring tide current speeds are up to approximately 1.45 m/s. Current speeds reduce inshore and in a northward direction with spring tide current speeds of 1 m/s close to the proposed landfall and of 0.45 m/s at the northern end of the Study Area. Peak neap current speeds are approximately half the quoted peak spring tide current speeds.

17.A.2.8 There is a slight dominance in the southward flowing flood currents, particularly in the southern part of the Study Area. Superimposed on the regional scale flow pattern, local flow variations can be expected to occur in response to bathymetric features (for example to realign with channel features, or around banks).

17.A.2.9 The southern North Sea is particularly prone to surge-driven flows during winter months, when intense low-pressure systems, particularly from the North Atlantic, dominate the region. These systems can generate strong easterly and / or northerly winds and heightened sea levels, driving elevated surge flows into the southern North Sea which is relatively shallow compared to the deeper North Sea basins. Elevated surge flows can temporarily lead to an increase in sediment resuspension and transport, particularly in shallow regions and along coastlines (Spencer *et al*., 2015).

Table 17.A-2 Peak spring flow speeds at locations along the proposed subsea cable corridor (ABPmer, 2017).

Location	**Peak spring flow speed (m/s)**
KP 2	0.95
KP 10	1.05
KP 17	0.95
KP 46	1.43
KP 117	0.80
KP 149	0.80
KP 199	0.60

Location	Peak spring flow speed (m/s)
KP 249	0.55
KP 283	0.45
KP 357	0.40

* peak spring flow at KP 46 is 1.20 m/s, flows of 1.43 m/s occur at KP 54. However, the percentage of fines is slightly lower at KP 54 (2.6%) compared to KP 46 (4.7%) and the consideration of the fastest flow and highest percentage of fines is considered to provide a worst-case assessment.

Method

17.A.2.10 The spreadsheet model includes the following inputs:

- Sediment properties (% of fines and ratio of sediment within four fines subclasses (clay, very fine to fine silt, medium silt, coarse to very coarse silt) and sediment density (based on the % of fines);
- Sediment release height above the bed;
- Ambient flow speed (informed by peak spring flow speeds from the ABPmer Renewables Atlas, ABPmer, 2017); and
- Information on installation activity including installation speed and rate of sediment disturbance.

17.A.2.11 Details on the sediment properties and flow speeds in the Study Area were provided in Section 2. Details on the other model inputs are provided in Sections 3.3 to 3.4.

17.A.2.12 These model inputs were used to calculate the initial mass of sediment released in the model.

17.A.2.13 The spreadsheet model includes the following processes:

- Advection by tidal flow. The main difference between what would be included within a coupled hydrodynamic (HD)/sediment dispersion model is that the latter would include spatially and temporally varying flow speeds. The spreadsheet adopts a conservative approach with respect to plume extents by applying the peak spring tide flow speed throughout;
- Settling to the bed, calculated for each of the four sediment subclasses using Van Rijn (1984). This is akin to formulations within a coupled HD / sediment dispersion model but does not include the process of flocculation. Flocculation increases settling velocities and the omission of this process therefore maintains sediment in suspension for longer. The omission of flocculation therefore provides a conservative assessment of areas impacted by SSC and sedimentation, although may result in an underestimate of sedimentation thickness in areas close to release locations; and
- Spreading by dispersion, calculated using a constant rate of 0.2 m^2/s perpendicular to the direction of travel. Based on expert judgement and our experience of modelling effluent plumes in a range of environments, 0.2 m^2/s represents a relatively low dispersion (and therefore provides a conservative assessment of areas impacted by SSC and sedimentation, although may result in an underestimate of sedimentation thickness in areas close to release locations) with models often calibrating best against data when slightly higher values of up to around 0.4 m^2/s are adopted.

17.A.2.14 The model calculates the SSC at incremental distances from the release location by dividing the mass of sediment within a given area by the cell volume (in the same way coupled HD/sediment dispersion model does). The sediment is tracked until the SSC reaches 0 mg/l.

17.A.2.15 Estimates of sediment thickness of deposited material were calculated from the mass of sediment in suspension at the time at which the sediment settled to the bed (based on a single sediment release height and settling velocity per representative grain size) to determine a sediment mass and associated deposit thickness. This approach provides a conservative assessment of sediment thickness on the bed, since in reality sediment will be released at a range of heights and particles will therefore settle to the bed gradually over the settling period, spreading the sediment more thinly over a wider area. The sediment mass was converted to deposit thickness using a representative density and the plume area at the distance from the sediment release where settling is predicted to occur.

17.A.2.16 For sediment thickness calculations all sediment classes were considered (not just fines). For fines (<63 µm) the sediment mass was converted to deposit thickness using a density of 135 kg/m^3. This is a low density, representative of freshly deposited sediment with a high water content and overtime it is likely that sediment would settle and compact, increasing the density and reducing the thickness of the deposit. For sands and coarser sediment fractions a density of 1,250 kg/m^3 was applied to convert sediment mass to deposit thickness. This is because sandy sediment is non-cohesive and tends to hold less water than fines and will therefore have a much higher bed sediment density. The application of the faster peak spring tide flows and higher release heights were applied to provide an indication of the maximum distance from the sediment release location that impacts could occur, while application of slower neap tide flows and lower release heights were applied to provide an indication of the maximum thickness of deposits associated with each representative grain size. Sediment thicknesses are therefore quoted as a range.

17.A.3 Sediment Release Rates

17.A.3.1 At present there is some uncertainty in the exact construction methods which will be adopted and a project design envelope has been developed which captures the range of parameters from the potential options. Information in the project design envelope was reviewed to identify the worst-case construction methods (with respect to potential for sediment disturbance) for a range of activities including:

- Seabed preparation;
- Cable trenching;
- Trenchless technique exit pit excavation; and
- Trenchless technique punch out.

17.A.3.2 Additional details are provided for each activity in the following subsections along with estimated rates of sediment disturbance (used to define the sediment release rate in the model). The sediment release rates are calculated using information in the project design envelope and results from the environmental surveys (as detailed in the baseline characterisation).

Seabed Preparation

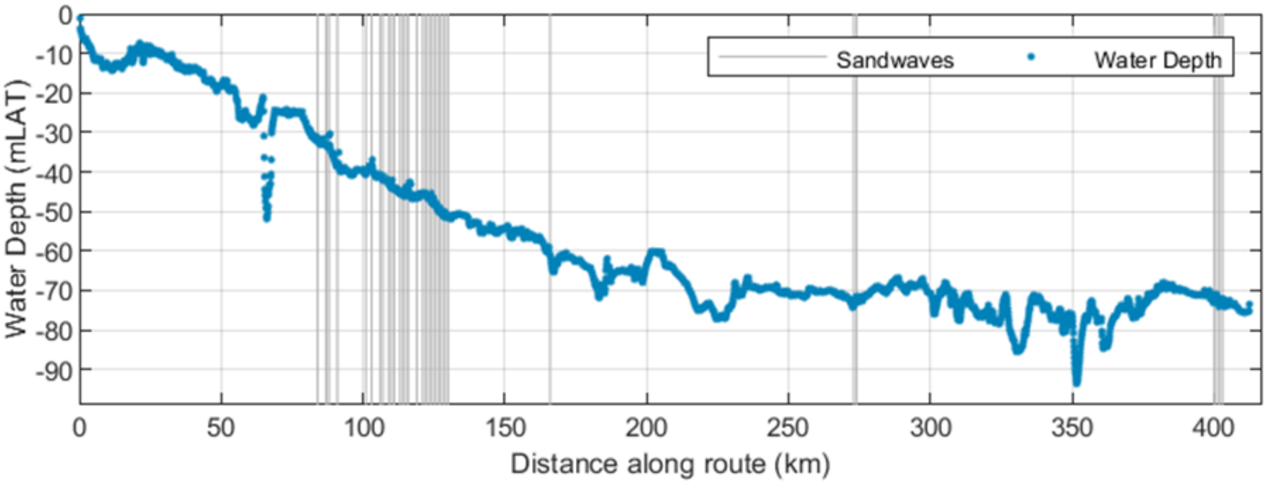
17.A.3.3 The following seabed preparation activities are expected:

- **Boulder clearance** – for areas with large stones and/or boulders, there may be a requirement to move these out of the way. A plough would be towed across the seabed, pushing the boulders to both sides creating a cleared swathe 25 m wide. Alternatively individual boulders could be moved using a grab deployed from a vessel;
- **Sandwave clearance** - to avoid potential future cable exposure in areas with mobile sediments, the cables need to be buried below the Non-Mobile Reference Level (NMRL), which is the depth below the sandwaves at which stable seabed is present. To achieve burial to the required level below NMRL and to ensure that the burial equipment can operate safely along the cable centreline (i.e. avoiding steep slopes) pre-sweeping could be required in areas where mega ripples and sandwaves are present;
- **Removal of seabed debris by Pre Lay Grapnel Run (PLGR)** - A vessel tows a wire with a string of specially designed hooks, or grapnels, along the centreline of the cable route snagging debris on the seabed and within the top 1.5 m of the seabed. Debris caught with the grapnel would be recovered to the vessel for appropriate licenced disposal ashore; and
- **Cutting Out of Service (OOS) Cables** – Permission will be sought from asset owners to cut OOS cables crossed by the Project. The OOS cable would be snagged using a grapnel and then cut, with approximately a 100 m section of cable being removed from the seabed. The cut ends would be tied to a weight and placed on to the seabed.

17.A.3.4 Most of the seabed preparation activities would disturb much less sediment than cable trenching and the consideration of the impact of cable trenching therefore provides a worst-case assessment of sediment plumes from construction activities along most of the route. The only exception to this is sandwave clearance. The preferred method for sandwave clearance is to use a Controlled Flow Excavator (CFE) and the sediment disturbance would therefore be similar to that for cable trenching with a CFE (see Cable Trenching Section). However, the technical feasibility of using a CFE has not yet been evaluated and it is possible that a Trailing Suction Hopper Dredger (TSHD) may be required for sandwave clearance, particularly for larger sandwave features (over 3 m high). It is assumed that if a TSHD is used, the dredge spoil would be deposited on the seabed in close proximity to where it was dredged from by sailing slowly whilst gradually opening the bottom doors of the hopper (Intertek Metoc, 2025). This is to ensure that the sediment is kept within the local mobile sediment transport system, aiding sandwave recovery, while minimising the potential for high concentration sediment plumes. Sandwave clearance by TSHD has been assessed as this presents the worst-case for sediment plume dispersion.

17.A.3.5 The water depths in the areas which could require sandwave clearance are mainly 30 to 50 m below Lowest Astronomical Tide (LAT), except for the northern section of the route where some isolated sandwaves were identified in depths of up to 74 m (Plate 17.A-4). Given the water depths, a relatively large dredger would be required. Boskalis' TSHD Fairway is capable of dredging in depths of up to 70 m, although this can be extended to 83 m by using a submergible dredge pump. The technical specifications of the TSHD Fairway were therefore used to calculate sediment release rates during dredging. The Fairway has a hopper capacity of 35,500 m^3 and a maximum draught of 13.5 m.

Plate 17.A-4 Water depths along the proposed subsea cable route.



17.A.3.6 Becker *et al*., (2015) summarises the reasonable ranges for sediment releases as source term fractions (i.e., a percentage of dredge production rate) based on results from field monitoring campaigns and practical experiences. Draghead releases are quoted to be in the range of 0 to 3%, overflow losses are in the range of 0 to 20% and losses from bottom-door placement are in the range 0 to 10%. Other studies have observed that TSHDs with a larger hopper (such as considered in this study) can be more efficient, in terms of the release of sediment into the passive plume during overflow, than smaller TSHDs and so applying lower source terms (5%) for the mass of sediment released into the passive plume from the overflow of sediment for the large TSHD is considered realistic (Kemps & Masini, 2017). The upper values of the ranges for sediment losses from draghead disturbance and placement have been adopted to provide a conservative assessment.

17.A.3.7 To derive applicable sediment releases for sediment disturbance from draghead disturbance, overflow and placement the following assumptions were made:

- Hopper when full (80% of capacity): 28,400 m³;
- Density of sediment in the hopper is 1,500 kg/m^3 (yielding a hopper load of 42,600 tonnes);
- Dredger speed during dredging and placement: 2 kts (yielding a travel distance of 1.8 km);
- Dredger fill time: four hours (yielding a production rate of 7,100 m^3/hr);
- Disposal duration: 30 mins;
- Sediment release from draghead disturbance: 3% of the production rate (Becker *et al*., 2015);
- Sediment release from overflow: 5% of the production rate (Becker *et al*., 2015, Kemps & Masini, 2017); and
- Sediment release from placement: 10% of hopper load (Becker, 2014).

17.A.3.8 Based on the applied source term fractions, the sediment releases for different components of dredging (based on an assumed sediment density of 1,500 kg/m^3) are:

- Draghead disturbance: 88.75 kg/s which would be released close to the seabed;

- Overflow: 147.9 kg/s which would be released near the sea surface at the draught of the vessel; and
- Placement: 2,367 kg/s which would be released throughout the water column (from the draught of the vessel to the seabed) as the dynamic plume descends to the bed.

17.A.3.9 Other than placement source terms, the sediment release rates from sandwave clearance with CFE would be higher than the values provided above (estimated to be 187.5 kg/s - see Cable Trenching Section for additional detail on CFE sediment source terms) and as such the assessment of the CFE provides a worst case assessment. Therefore, only fine sediment dispersion associated with the placement of sediment dredged using a TSHD has been assessed in the spreadsheet model.

Cable Trenching

17.A.3.10 For cable trenching a number of burial methods could be used, including:

- **Ploughing** – cable ploughs are used in non-cohesive soils such as loose coarse sand and fine dense sand, as well as cohesive soils such as clay. Displaced soil is typically pushed to either side of the trench, this soil may be simultaneously pushed by the plough back into the trench to cover the cable; pushed into the trench by a separate back-fill plough; or left in place to naturally back-fill the trench via natural seabed sediment movement;
- **Jet trenching and/or vertical injector** – jet trenchers are used in unconsolidated sediments (sand and silt). High pressure water is pushed through jetting swords into the seabed on either side of the cable, to fluidise the sediment. The pre-laid cables sink through the fluidised soil to the bottom of the trench. The seabed sediments naturally re-form and back-fill the trench covering the cables;
- **CFE** - CFE is a technique that uses high volumes of water under low pressure directed at the seabed to push sediment to either side of a trench and is suitable for use in sands and very soft clays; and
- **Mechanical cutting** - cutting is used on hard clay, cemented sand, sandstone and other types of rock. It would be used to either create a pre-cut trench into which the cables would be laid, or post-lay. Soil from the trench is ejected by the cutting action to either side of the trench. The open trench would be backfilled or left to refill naturally. The operation is slower than other burial methods and typically requires more frequent maintenance stops.

17.A.3.11 The choice of burial tool would be based on numerous factors including the seabed geology and mobility, the burial depth to be achieved, the installation contractor selected, proximity to existing infrastructure and environmental sensitivities and mitigation defined during the assessment process.

17.A.3.12 Source term fractions for mechanical cutting would be expected to be broadly similar to that from cutter suction dredgers, the reasonable range for which is quoted as being between 1 and 5% (Becker et al., 2015). In addition, installation speeds would be expected to be lower than other methods and the rate of fine sediment release would therefore be expected to be lower than for other cable installation methods.

17.A.3.13 Both jet trenching and CFE work by suspending sediment from the bed into the water column. Higher power jetting may be likely to introduce more sediment into suspension, compared with CFE (MarineSpace, 2019). Given, a lack of information on source terms for CFE in the literature, for conservatism, the source term fraction is assumed to be the same for CFE and jetting.

17.A.3.14 A summary of key parameters for cable installation by jet trenching / CFE and ploughing is provided in **Table 17.A-3**. The highest sediment releases are expected for installation by a jet trencher / CFE and the dispersion of sediment from this installation method has therefore been assessed along the proposed subsea cable route to ensure that flexibility in design is maintained, with impacts from other installation methods expected to be smaller.

17.A.3.15 The following assumptions were applied when calculating the sediment release rates:

- The cable installation speed is expected to be highly variable, with speeds ranging from 50 m/hour to 1,000 m/hour. The actual speed will depend on the sediment encountered (with lower speeds in sediments with a higher percentage of fines) and the type of plant used;
- The trench Cross Sectional Area (CSA) has been calculated using the maximum trench width (1.5 m) and depth (3.5 m) assuming a rectangular shaped trench (giving 5.25 m^2 CSA); and
- Achieving these trench dimensions at the expected installation speeds would require a production rate of 350 m^3/hour to 3500 m^3/hour. Values at the upper end of this range are unlikely to be achievable with a jet trencher or CFE, with maximum production rates expected to be around 1,000 m^3/hour. To provide a conservative assessment, a production rate of 1,500 m^3/hour has been assumed (equivalent to an installation rate of 286 m/hr for the given trench dimensions).

17.A.3.16 The sediment release rate is calculated as the sediment source term x productivity x density (for example yielding a sediment release rate of 187.5 kg/s for a density of 1,500 kg/m^3).

Table 17.A-3 Key parameters for cable installation.

Parameter	Jet trenching / CFE	Ploughing
Trench width (m)	1.5	5
Trench depth (m)	3.5	2
Trench CSA (m^2)	5.25 (rectangular)	5 (triangular)
Source term fraction	30 (Gooding et al, 2012)	1 (Intertek, 2017)
Total sediment released (m^2 per m of cable route)	1.575	0.1
Height of release above bed (m)	5	2

Exit Pit Excavation

17.A.3.17 For exit pit excavation, either a Backhoe Dredger (BHD) or a CFE could be used.

17.A.3.18 The major sources of sediment released by a BHD are noted by Becker *et al*. (2015) to typically be from hauling the dredged sediment from the bed to the water surface, with up to 4% of the fine-grained silt and clay present in the sediment (the ‘fine sediment’) having the potential to be suspended through the water column during the hauling. In addition, Becker *et al*. (2015) also note that for sediment dredged by a mechanical BHD up to 5% of the fine sediment has the potential to remain in suspension as a passive plume during placement through the bottom doors of a barge. For the exit pit excavation the sediment would not be loaded to a barge, but instead the sediment will be placed directly from the BHD bucket back to the adjacent seabed to ensure the sediment remains within the active sediment transport system. Therefore, it is expected that the passive plume from the dredging and placement activities will be lower than the maximum values quoted by Becker *et al*. (2015), with 9% therefore providing a conservative assessment of the sediment release term. The sediment release rate depends on the rate of dredging as well as the percentage of fines released. A production rate of 750 m^3/hr has been estimated for a BHD (based on a bucket size of 2.5 m^3 and a cycle time of 3 buckets per minute)[1]. This is lower than the assumed production rate for CFE (1,500 m^3/hr),further the sediment release rate from the BHD (up to 9% of 750 m^3/hr = 67.5 m^3/hr) is expected to be almost an order of magnitude less than the sediment release rate from the CFE (up to 30% of 1,500 m^3/hr = 450 m3/hr). Use of a CFE therefore provides a worst-case scenario for the assessment of fine sediment release from exit pit excavation.

Trenchless Technique Punch Out

17.A.3.19 In addition to exit pit excavation, other releases of fine sediment from the trenchless technique include small volumes of drilling fluid and fine sediment at punch out. The volume of drilling fluid discharged is estimated to be between 720 and 7,600 m^3 (for both ducts). The properties of the drilling fluids are not known at this time and a number of assumptions have been made to provide an estimate of the release of fine sediment at punch out, as follows:

- The dry density of bentonite is in the range of 2,200 to 2,800 kg/m^3;
- The percentage of bentonite in the drilling fluid is 4%;
- All particles are assumed to be clay sized; and
- The release during punch out occurs over a 12-hour period.

17.A.3.20 A volume of 7,600 m^3 of drilling fluid would therefore result in a release rate of 19.7 kg/s of fine sediment for 12 hours.

17.A.3.21 The sediment release rates applied in the spreadsheet model for the activities outlined in Seabed Preparation Section to Exit Pit Excavation Section are summarised in **Table 14.A-4**.

Table 14.A-4 Estimated rate of fine sediment release associated with different activities.

Location	Percentage Fines (%)	Dry sediment density (kg/m^3)	Release rate (kg/s)
Activity: Placement of sediment following sandwave clearance by TSHD			
KP 117	4.2	1,500	99.4

---

[1] In reality the production rate would be lower than this since a bucket would not be full to capacity. The production rate is typically calculated by application of a modification factor which accounts for the fullness of the bucket load. The modification factor varies with soil type being in the range of 0.72 (for wet sticky clay) to 0.9 (sand and gravel) (Bray et al., 1997). Cycle times of the bucket depends on the dredging depth and soil type, but are in the order between 20 and 40 second (TUDelft, 2016).

Location	Percentage Fines (%)	Dry sediment density (kg/m^3)	Release rate (kg/s)
Activity Trenchless technique exit pit excavation by CFE			
KP 2	5.1	1,500	9.6
Activity Trenchless technique punch out			
KP 2	4	2800	19.7
Activity: Trenching by jet trencher / CFE			
KP 10	52.6	1,090	71.7
KP17	34.5	1,236	53.3
KP 46	4.7	1,500	8.8
KP 117	4.2	1,500	7.9
KP 149	5.7	1,500	10.7
KP 199	6.7	1,470	12.3
KP 249	16.4	1,400	28.6
KP 283	29.2	1,282	46.8
KP 357	10.7	1,436	19.2

17.A.4 Sediment Release Height

17.A.4.1 The height of release of sediment disturbed was assumed to be 5 m above the bed for cable trenching with a CFE. In reality, the actual height of sediment release for trenching by CFE will be at a range of heights above the bed (from anywhere just above the seabed to several metres above the bed), so the adoption of 5 m provides a conservative assessment for assessing the potential extent of sediment plumes.

17.A.4.2 The release of drilling fluid at the trenchless technique punch-out would be from the seabed but momentum would result in the release of fine sediment at a small height above the bed, assumed to be 2 m above the bed for the purposes of modelling.

17.A.4.3 For disposal of dredge spoil during sandwave clearance using a TSHD, the height of release of sediment disturbed was assumed to be at 50 m above the bed (at the water surface in the region where sandwaves are present). The actual release height will be slightly lower in the water column than this (since release would be via the hopper doors which are in the bottom of the hull) and would vary depending on the draught (which will vary with vessel type and load). In addition, the high sediment concentrations will result in the formation of a dynamic plume which will settle rapidly to the bed with sediment being lost from the plume edges as water is entrained into the plume during it descent to the bed (so that releases will actually occur throughout the water column).

17.A.4.4 The surface release adopted therefore provides a conservative assessment with respect to the plume extent. When calculating the SSC, it was assumed that the plume was constrained to the water column below the vessel draught (rather than across the full depth).

17.A.5 Sediment Fall Velocity

17.A.5.1 The spreadsheet model calculates the settling times and distances for different grain sizes based on grain size settling velocities of individual grains using the equation from Van Rijn (1984) and a water temperature of 10 Celsius[2]. The settling distances are calculated by applying the peak flow speed over the settling time. To account for variations in flow speed which would occur over the tide during the period during which fine sediment settles back to the bed, a maximum distance equal to the tidal excursion was applied. The tidal excursion was estimated assuming a sinusoidal flow distribution with a 6-hour cycle (representative of a flood or ebb phase).

17.A.5.2 Non tidal flow (wind driven and surge driven flow) could result in faster flow speeds and/or the persistence of flows in the same direction for longer than a 6-hour period. However, due to operability constraints, construction would be unlikely to occur during such conditions. In addition, the results (Section 4.2) show that plume concentrations are unlikely to have an impact on water quality at distances of more than approximately half of the spring tidal excursion and therefore the inclusion of non-tidal flows would not be expected to change the results presented.

17.A.5.3 Typically, it is accepted that the settling velocities are applicable to grains larger than 63 µm. At grain sizes smaller than this, the particles tend to have a more plate-like rather than spherical shape and this affects the settling velocity. In addition, cohesive processes (particularly in the marine environment) result in the formation of flocs (aggregates of smaller particles), further altering the settling velocity. In general, flocs will increase the settling velocity of fine grained sediment and the use of the settling velocity for individual grains will therefore tend to provide a conservative assessment of settling times.

17.A.5.4 The settling time to the bed for releases at 5 m and 50 m above the bed are provided in **Table 17.A-5**, along with the indicative travel distance for a range of peak spring flow speeds and representative grain sizes. For finer sediment fractions, where settling takes more than half a semidiurnal tidal period (the time over which sediment will be travelling in the same direction), the peak flow speed is converted to an average flow speed assuming a sinusoidal flow over time. For coarser fractions, where settling occurs on much shorter periods of around 1 hour, the peak flow speed was applied to calculate settling distance.

17.A.5.5 The calculated settling distances indicate that only fine sands and silts will disperse beyond the draft Order Limits. Silt sized material will remain in suspension for much longer durations and could disperse away from the site of sediment release. The maximum dispersion distance is set to be the maximum spring tide tidal excursion associated with the peak flow speed. Typically, fine sediment particles will not travel in suspension beyond this maximum distance. However, for particles which remain in suspension for a long period of time and where there is either a notable tidal or non-tidal (surge) residual, sediment in suspension could travel beyond the maximum distances quoted. Given that dispersion processes will also act to dilute the concentration of silt carried in suspension, elevated SSC levels at such large distances would be greatly reduced compared to those in close proximity to the site of sediment release and would be immeasurable in practice.

---

[2] This is the average of the summer and winter water temperature off the east coast of England (Met Office, 2016). Grains settle slightly slower in colder water and slightly quicker in warmer water.

Table 17.A-5 Settling times and distances along the proposed subsea cable corridor.

Peak flow (m/s)	Fines (<63 µm)		Very fine sand (125 µm)		Fine sand (250 µm)		Medium sand (500 µm)	
	Settling time (hours)	Settling distance (km)	Settling time (hours)	Settling distance (km)	Settling time (hours)	Settling distance (km)	Settling time (hours)	Settling distance (km)
Release at 5 m above the bed								
1.43	0.7 to 407	3.8 to 19.8	0.5	2.4	0.1	0.7	0.03	0.1
1.2		3.1 to 16.6		2.0		0.6		0.1
0.8		0.7 to 11.1		1.3		0.4		0.1
0.4		1.1 to 5.5		0.7		0.2		0.04
Release at 50 m above the bed								
1.43	5 to 4,070	19.8	1.4	7.2	0.3	1.4	0.1	0.4
1.2		16.6		6.0		1.2		0.3
0.8		11.1		4.0		0.8		0.2
0.4		5.5		2.0		0.4		0.1

17.A.6 Results

17.A.6.1 Results of the predicted spread of sediment in suspension and the thickness of sediment on the bed are presented in Section 4.2 and Section 4.3, respectively.

SSC

17.A.6.2 Results of the predicted SSC from the spreadsheet model are plotted in **Plate 17.A-5** to **Plate 17.A-8**, for cabling, trenchless technique exit pit excavation, trenchless technique punch-out and placement following sandwave clearance. Based on the background SSC and natural temporal variability in SSC in the Study Area, increases in SSC of less than 1 mg/l are not expected to be detectable.

17.A.6.3 In the near-field (within 5 to 10 m of the activity) sediment disturbed by construction activities will result in very high SSC (several orders of magnitude higher than shown in the plots). These very high SSC will only last while the activity resulting in the sediment disturbance is occurring. A large proportion of this sediment will settle back onto the seabed within the draft Order Limits (or where sediment is released in the case of placement of sediment following dredging by TSHD), with the actual amount depending on the grain size characteristics and the flow conditions (see Section 4.3 for additional information on sedimentation).

17.A.6.4 The plots show the gradual reduction in SSC with distance from the sediment release location associated with the spreading of the plume from dispersion and the more rapid reduction in SSC at incremental distances associated with the distances at which the representative grain sizes drop out of suspension (not apparent for trenchless technique punch-out due to the assumption of 100% fines, nor for sandwave clearance due to the high release height so that no modelled fractions reach the bed within a tidal period). These more rapid reductions are an artefact of the applied method (with all grains being released at the same height above the bed and with all grains within each representative grain size settling at the same rate). In reality, the SSC will decrease gradually with distance from the sediment release location due to variations in release heights and settling velocities.

17.A.6.5 The distances at which elevated SSC is predicted to reduce to less than 10 and 0 mg/l are summarised in **Table 17.A-6**. The greatest plume extent (above 0 mg/l) is associated with trenching in the area of fastest flow speeds (at KP 46), where increased SSC occurs up to 19.8 km from the point of release. Any increases in SSC will be of short duration (order of hours or less) beyond the draft Order Limits, due to the variable nature of the flow field and the relatively fast installation speeds. The plume extent for trenching at KP 357 is notably shorter, being 5.6 km due to the slower flows in the offshore half of the draft Order Limits.

17.A.6.6 The plume extent from trenchless technique exit pit excavation is up to 13.2 km from the release location, although plume concentrations are less than 10 mg/l above background within 2.7 km of the release location. Given high nearshore natural SSC it is therefore unlikely that any plume from exit pit excavation would be detectable at distances of more than 2.7 km from the release location. Sediment plumes from the trenchless technique punch-out exceed 10 mg/l at greater distances than exit pit excavation, extending up to 8.5 km from the release location. This is due to both the higher release rate of fine sediment and the assumption of 100% clay sized particles.

Table 17.A-6 Maximum distance where SSC is greater than 10 mg/l and 0 mg/l

Location	Maximum distance where SSC>10 mg/l (km)	Maximum distance where SSC>0 mg/l (km)
Activity: Trenching		
KP 10	8.8	16.8
KP 17	7.5	13.2
KP 46	3.8	19.8
KP 117	2.2	11.1
KP 149	2.5	11.1
KP 199	1.9	8.3
KP 249	2.8	7.7
KP 283	3.1	6.3
KP 357	1.6	5.6
Activity: Trenchless technique exit pit excavation		
KP 2	2.7	13.2

Location	Maximum distance where SSC>10 mg/l (km)	Maximum distance where SSC>0 mg/l (km)
Activity: Sandwave clearance		
KP 117 Placement	2.8	11.1
Activity: Trenchless technique punch out		
KP 2	8.5	13.2

17.A.6.7 The plume extent for placement from sandwave clearance is up to 11.1 km from the release location. This is the same extent as associated with trenching at this location (since the distance will be dictated by tidal excursion distance). Plume concentrations reduce to less than 10 mg/l at 2.8 km from the release location for sandwave clearance which further than the distance affected by concentrations of more than 10 mg/l distance from trenching at the same location (which reduce below 10 mg/l at 2.2 km from the release location). The higher plume concentrations close to the release location for sandwave clearance is due to the greater sediment release rate from placement than occurs during trenching.

17.A.6.8 Based on the plume extents, cable trenching, exit pit excavation and trenchless technique punch-out have the potential to increase SSC at a number of bathing waters including Huttoft and Marsh Yard (with the proposed cable route passing directly through this bathing water, although construction activities will only occur offshore with the trenchless technique passing underneath the bathing water), Anderby (750 m south of the cable route), Chapel St Leonards (5 km south of the cable route) and Sutton-on-Sea (5 km north of the cable route). However, tidal flows in the nearshore region are predominantly aligned with the coast and given that the excavation of the exit pit, the trenchless technique punch-out and the cable trenching will be constrained to water depths of more than 3 m below LAT, any sediment plume will most likely remain offshore of the bathing water sites with the plume predominantly being transported parallel with the coastline. The plume extent associated with trenchless technique punch-out will be over-predicted with the very fine sediment particles expected to flocculate in the marine environment, increasing the settling velocity and reducing the time over which sediment can be transported away from the release location.

17.A.6.9 The Environment Agency undertake regular beach renourishment along the entire coast between Mablethorpe and Skegness. This activity involves pumping large volumes of sediment and water into the intertidal region. Relative to the renourishment activity any sediment disturbance due to exit pit excavation and cable installation is smaller in scale both spatially and temporally.

17.A.6.10 The plume extent associated with placement activities from sandwave clearance will be sensitive to the assumptions made on the time to empty the hopper, the sailing speed of the dredger during emptying and the depth of the water column over which the plume is assumed to be spread. However, impacts are not expected to be worse than assessed based on the assumptions applied.

17.A.6.11 KP 357 was selected as an area with a high percentage of fines in closest proximity to the North East of Farnes Deep Highly Protected Marine Area (HPMA). The plume extent in this section of the route was calculated to be less than 6 km, while at its closest point, the HMPA is more than 13 km from the proposed subsea cable route. Further, the tidal renewables atlas (ABPmer, 2017) shows flows to be orientated north-south in this region so that sediment plumes would be advected along the cable route, rather than towards the HPMA and therefore no sediment plumes are expected to impinge on the HPMA.

Plate 17.A-5 Fine sediment SSC with distance from release during trenching.

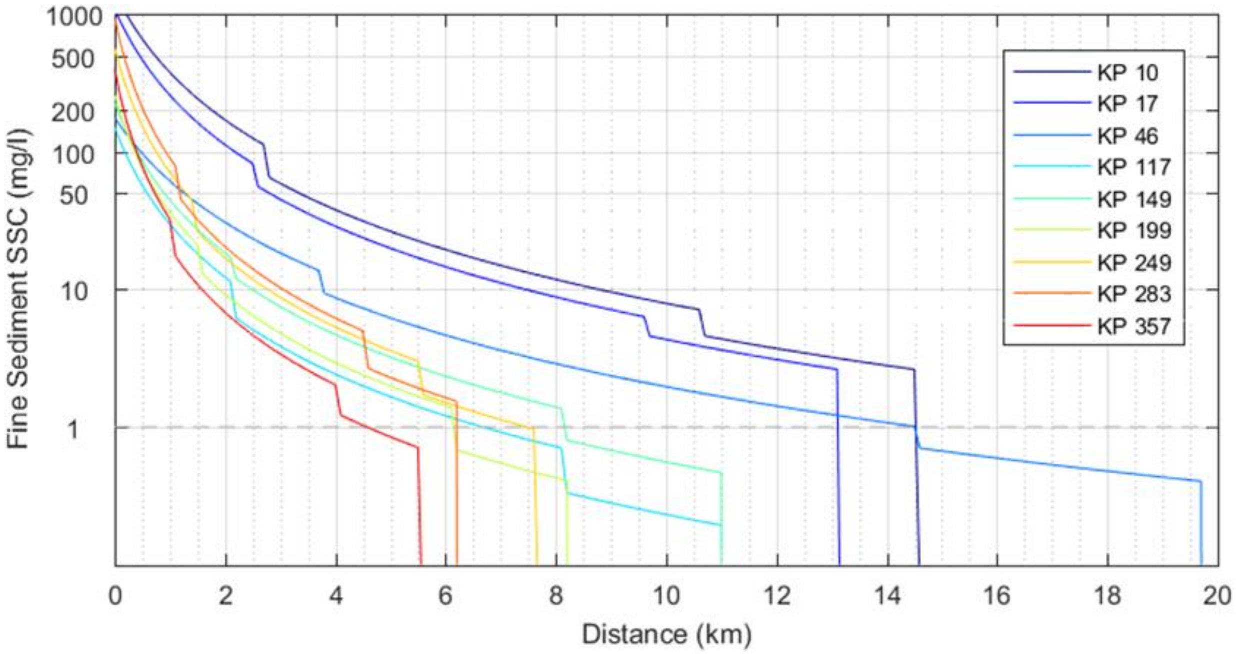


Plate 17.A-6 Fine sediment SSC with distance from release during HDD exit pit excavation.

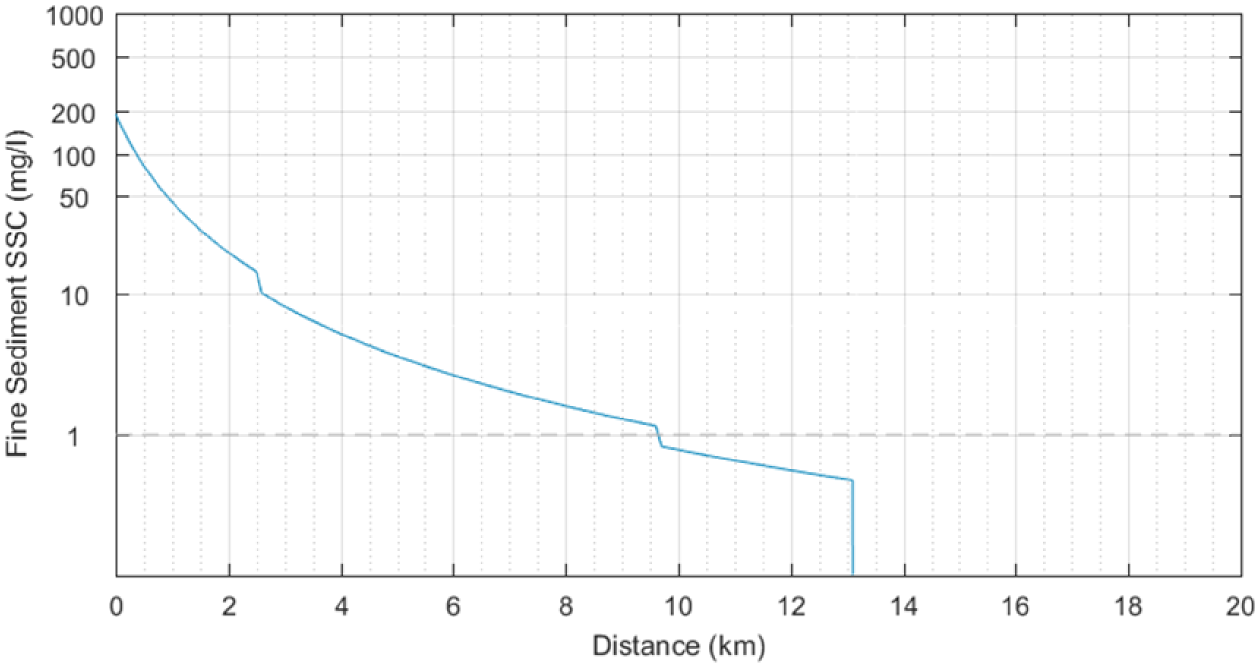


Plate 17.A-7 Fine sediment SSC with distance from release during HDD punch-out.

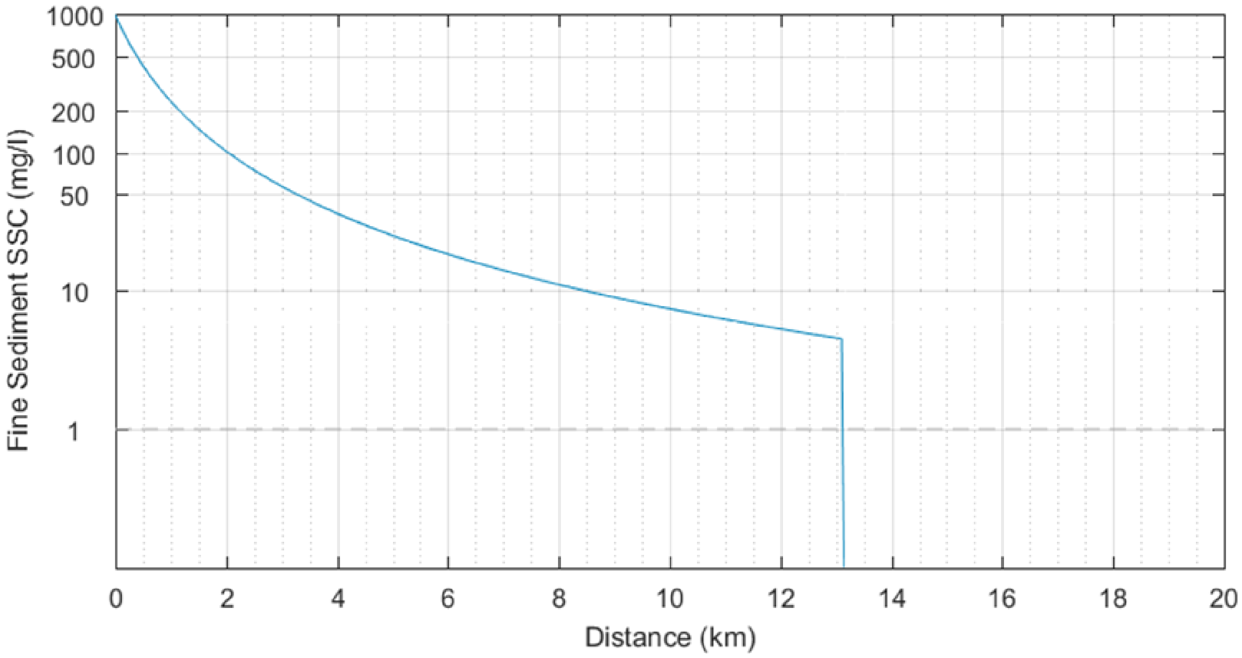
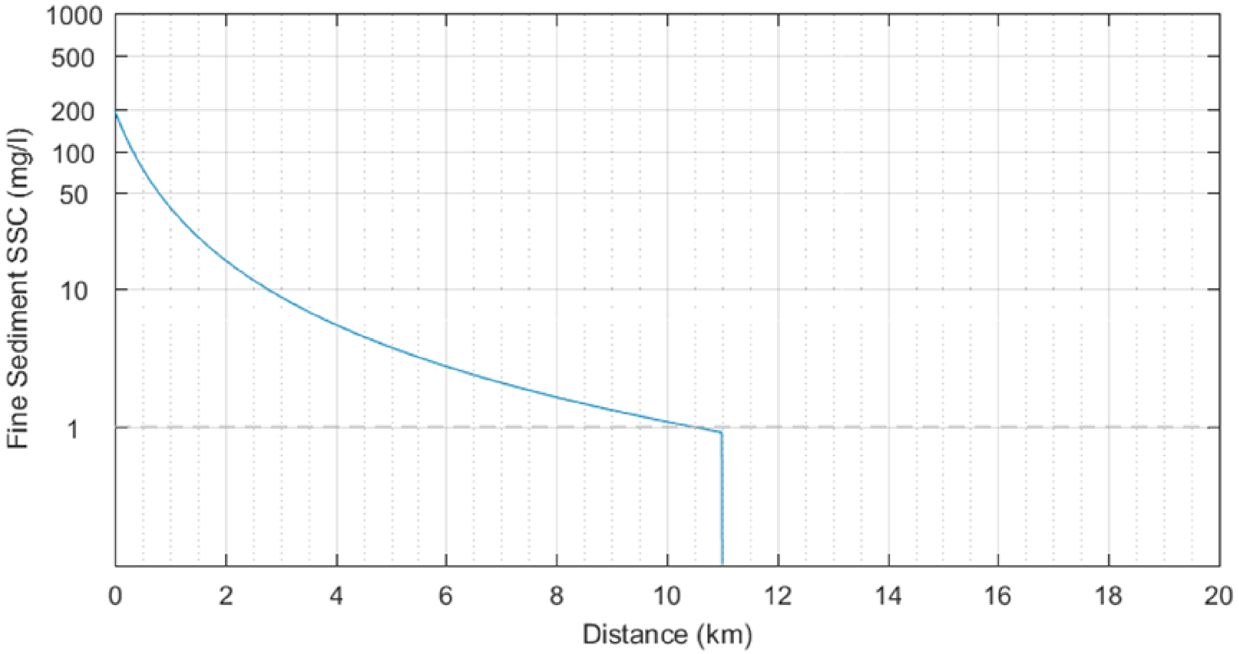


Plate 17.A-8 Fine sediment SSC with distance from release during sandwave clearance.



Sedimentation

17.A.6.12 Estimates of sediment thickness on the bed for different sediment fractions are provided for trenching at KP 10 in **Table 17.A-7** and at KP 199 in **Table 17.A-8**. Results are given for KP 10 which has a high percentage of fines and fast flow speed (to give an indication of the upper distance of impact) and for KP 199 which has a lower percentage of fines and slower flow speeds (to give an indication of the upper thickness). To provide a range of impact distances and sediment thickness, at both locations estimates of distance of impact and thickness of deposit were made for:

- Spring tide flow speeds with a release at 5 m above the bed; and
- Neap tide flow speeds with a release at 2 m above the bed.

17.A.6.13 The higher release height is associated with the lower range of sediment thickness and the lower release height is associated with the upper range of sediment thickness.

17.A.6.14 In the near-field (within 5 to 10 m of the activity) sediment thicknesses on the bed will result in higher values than quoted, since the values are based on averaging over a 100 m x 100 m area. Results show that within 0.1 km (i.e., within the draft Order Limits) the sediment thickness can be several tens of millimetres (i.e., centimetres) thick but that beyond the draft Order Limits the sediment thickness is of the order of millimetres or less.

17.A.6.15 It is important to note that the results only consider the 30% of sediment predicted to be ejected out of the trench. The other 70% will either fall back into the trench or be deposited within a couple of metres either side of the trench (as berms), resulting in much thicker deposits in these regions (in the order of centimetres to metres). Depending where along the route trenching is occurring, the sediment deposited on the bed may or may not subsequently be transported from the bed by natural processes.

17.A.6.16 Results are not provided for the trenchless technique exit pit excavation but would be expected to be similar in magnitude to trenching (i.e., order of millimetres or less outside of the draft Order Limits). Sediment thickness for sediment released from the trenchless technique at punch-out would depend on the formation and settling of flocs. The spreadsheet model does not include flocculation. Based on the mass of sediment released, if all sediment was deposited within one hour after release the thickness of deposits would be around 2 mm assuming a uniform spread over an area of 7 km by 0.4 m (with the area informed by travel distance over a one hour period and lateral spread based on a dispersion of 0.2 m^2/s).

17.A.6.17 Estimates of sediment thickness for different sediment fractions are provided for sandwave clearance in **Table 17.A-9**.

17.A.6.18 Estimates of distance of impact and thickness of deposit were made for spring tide flow speeds with a release at 35 m above the bed and for neap tide flow speeds with a release at 15 m above the bed to provide a range of impact distances and sediment thicknesses. The higher release height is associated with the lower range of sediment thickness and the lower release height is associated with the upper range of sediment thickness.

17.A.6.19 Note that the reported sediment thickness only accounts for the passive plume (taken to be 10% of the sediment pumped from dredging for sandwave clearance). Accounting for the other 90% from the dynamic plume which settles straight to the bed could result in local deposits of the order of more than a metre in thickness (in addition to the 10 to 25 mm of medium to coarse sand) close to the release location.

Table 17.A-7 Estimated sediment thickness from trenching activity at KP 10.

Fraction	Distance from release (km)	Max thickness (mm)
Medium silt to clay	0.6 to 13.6	0.20 to 1.14
Coarse silt	0.4 to 1.8	0.84 to 4.48
Very fine sand	0.1 to 0.5	0.29 to 1.16
Fine sand	<0.1 to 0.1	2.73 to 5.57

Fraction	Distance from release (km)	Max thickness (mm)
Medium Sand	<0.1	8.24 to 10.8
Coarse Sand and above	<0.1	26.8 to 28.9

Table 17.A-8 Estimated sediment thickness from trenching activity at KP 199

Fraction	Distance from release (km)	Max thickness (mm)
Medium silt to clay	0.3 to 7.8	0.07 to 0.39
Coarse silt	0.2 to 1.0	0.13 to 0.72
Very fine sand	0.1 to 0.3	0.75 to 3.02
Fine sand	<0.1 to 0.1	28.6 to 58.4
Medium Sand	<0.1	16.8 to 22.0
Coarse Sand and above	<0.1	0.53 to 0.58

17.A.6.20 The dredger may make multiple placements for dredging of all sandwaves and if so, the numbers quoted for the coarser sediment would need multiplying up by the number of passes. For the fines this is not likely to be an issue as the tidal flow will determine where the plume will disperse and settle and it is very unlikely that multiple passes would impact the same location (since the tidal state would vary for repeat passes). The total sandwave clearance is estimated to be 629,965 m^3 (Intertek, 2025), which is equivalent to 22.5 dredger loads.

17.A.6.21 Most of the sediment with any notable thickness on the bed is predicted to settle close to the area of release which is in an area of sandwaves where the bed is mobile and any deposited sediment will therefore be moved either as bedload or in suspension along with the existing sand present on the bed.

Table 17.A-9 Estimated sediment thickness from sandwave clearance.

Fraction	Distance from release (km)	Max thickness (mm)
Medium silt to clay	5.2 to 10.4	0
Coarse silt	2.0 to 9.3	<0.01
Very fine sand	0.6 to 2.8	<0.01 to 0.06
Fine sand	0.1 to 0.6	1.44 to 5.76
Medium Sand	<0.1 to 0.1	7.09 to 18.0
Coarse Sand and above	<0.1	4.09 to 6.11

17.A.7 Summary

17.A.7.1 The greatest plume extent is predicted to be associated with trenching in the area of fastest flows, where SSC above zero extended up to 19.8 km from the release location.

In the offshore half of the proposed route, plume extents are typically around half of this distance due to the slower flow speeds. In the nearshore areas, background SSC is seasonally variable and increases in SSC of more than 10 mg/l are unlikely to be detectable. The plume extent at concentrations of more than 10 mg/l are constrained to a much smaller area than increases above 0 mg/l, extending up to 8.8 km from the release location in the area of highest percentage of fines. Any exceedances of more than 10 mg/l are predicted to be of short duration (order of hours or less) beyond the draft Order Limits due to the relatively fast installation speeds.

17.A.7.2 A large proportion of sediment dispersed by construction activities are predicted to settle back onto the seabed within the draft Order Limits (or where sediment is released in the case of placement following dredging), with the actual amount depending on the grain size characteristics and the flow conditions. Beyond the draft Order Limits, sediment deposits are predicted to be very thin (millimetres or less).

Bibliography

ABPmer (2017). UK Renewables Atlas (online). Available from https://www.renewables-atlas.info/explore-the-atlas/ (April 2025).

Allersma, E. (1988). Composition and density of sediments (in Dutch). Report Z71.03, Delft Hydraulics, Delft, The Netherlands.

Bray, R.N, A.D. Bates and J.M. Land (1997). Dredging: A handbook for engineers, Wiley 1997, 434 pages.

Becker, J., van Eekelen, E., van Wiechen, J., de Lange, W., Damsma, T., Smolders, T., & van Koningsveld, M. (2015). Estimating source terms for far field dredge plume modelling. Journal of environmental management, 149, 282–293. https://doi.org/10.1016/j.jenvman.2014.10.022

Gooding, S., Black, K., Boyde, P. and Boyes, S. (2012). Environmental Impacts of Subsea Trenching Operations. Offshore Site Investigation and Geotechnics: Integrated Technologies – Present and Future, 12-14 September, London, UK.

Intertek Metoc (2025). Sandwave pre-sweeping technical note for National Grid. EGL 5 – Memorandum to support pre-sweeping of sandwaves. P2783_AJOCT14_Rev0.

Kemps, H. and Masini, R., 2017. Estimating dredge source terms – a review of contemporary practice in the context of Environmental Impact assessment in Western Australia. WAMSI Dredging Science Node Report, Theme 2, Project 2.2, August 2017.

MarineSpace (2019), Caithness-Moray HVDC link – controlled flow excavation/rock placement environmental appraisal.

Met Office (2016). Eastern England: Climate. [Online]. Available at https://www.metoffice.gov.uk/binaries/content/assets/metofficegovuk/pdf/weather/learnabout/weather/regional-climates/eastern-england_-climate-met-office.pdf (Accessed January 2026).

Spencer, T., Brooks, S.M., Evans, B.R., Tempest, J.A. and Möller, I. (2015) Southern North Sea storm surge event of 5 December 2013: Water levels, waves and coastal impacts, Earth-Science Reviews, 146, pp. 120–145. doi: 10.1016/j.earscirev.2015.04.002.

TUDelft (2016). Design of dredging equipment, lecture notes 8: The backhoe or dipper dredger. Available at: https://ocw.tudelft.nl/course-readings/lecture-notes-8-backhoe-dipper-dredger/ (accessed January 2026).

Van Rijn, L. C. (1984). Sediment transport: part I: bed load transport; part II: suspended load transport; part III: bed forms and alluvial roughness. J.Hydraul. Div., Proc. ASCE, 110 (HY10), 1431-56; (HY11), 1613-41; (HY12), 1733-54.

Van Rijn , L. C. (1993). Principles of sediment transport in rivers, estuaries and coastal seas, Part 1: Edition 1993. Aqua Publications

National Grid plc
National Grid House,
Warwick Technology Park,
Gallows Hill, Warwick.
CV34 6DA United

Registered in England and Wales
No. 4031152
nationalgrid.com