The Great Grid Upgrade

Sea Link

Sea Link

Volume 9: Examination Submissions

Document 9.144: Additional Sediment Dispersion Modelling - Technical Note

Planning Inspectorate Reference: EN020026

Version: A
April 2026

nationalgrid

Page intentionally blank

Contents

Table of Tables

Table of Plates

1. Introduction

1.1 Background

1.1.1 This technical note has been prepared to address three issues of concern raised during the examination process which relate specifically to hydrodynamic and sediment dispersion processes.

1.1.2 **Landfall Approaches:** Sediment dispersion modelling previously undertaken to estimate the effect of elevated suspended sediment concentrations (SSC) as a result of cable installation activities for subtidal sections of the cable route. Additional information was requested in written questions submitted by Natural England and the Environment Agency at Deadline 1 to better understand potential impacts at both the Suffolk and Kent landfalls. Additional modelling has therefore been undertaken to address the specific queries raised.

1.1.3 **Pegwell Bay:** Whilst previous modelling of sediment dispersion processes covered offshore areas along the cable route, the assessment of similar processes within Pegwell Bay relied on the interpretation of local tidal conditions. A more detailed modelling exercise has therefore been undertaken to quantify potential increases in suspended sediment concentration within the bay as a result of construction activities. This covers the potential re-mobilisation of sediments disturbed following cable burial and/or the fate of sediment disturbed as a result of scouring around the perimeter of a temporary cofferdam.

1.1.4 **Cofferdam Blockage:** Results from a simplified modelling approach have been used to assess changes in tidal flow conditions around the cofferdam due to the blockage effect of the cofferdam. A particular concern in this instance would be the potential for an increase in current speeds leading to erosion of the saltmarsh edge.

2. Sediment Dispersion Modelling

2.1 Landfall Approaches

Background

2.1.1 Additional modelling of sediment dispersion during cable installation has been undertaken for both the Suffolk and Kent landfall approaches to address comments received during the examination stage.

2.1.2 Results are presented alongside those from the previous sediment dispersion modelling so that any differences due to tidal conditions or sediment characteristics close to the shoreline are identified. In particular, this focuses on the definition of a Zone of Influence (ZoI) for the landfall approaches.

2.1.3 The same modelling approach used previously was applied involving the use of an established tidal model of the North Sea. Details of the model calibration are provided in the original sediment modelling report (AECOM, 2024).

New Sediment Release Locations

2.1.4 The new sediment release locations representing the landfall approaches are labelled ‘0’ and ‘7’ (Plate 2.1) which are adjacent to the Suffolk and Kent landfalls, respectively.

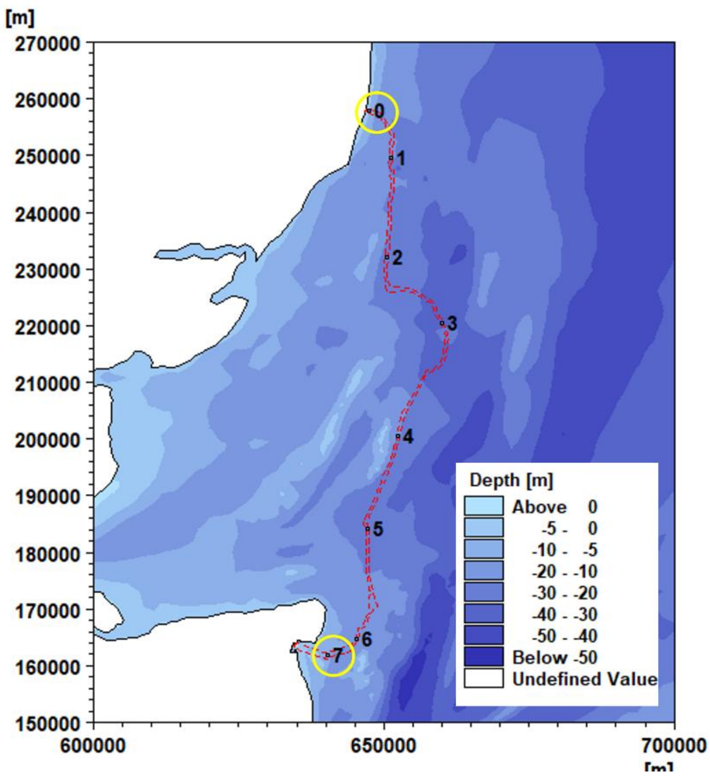

Plate 2.1 New sediment release locations at landfall approaches (circled in yellow)

2.1.5 Sediment characteristics at each location were taken from the nearest sampling points from the same geotechnical survey report, as used previously (MMT, 2022). Details of the particle size distribution at the two additional release locations are provided in Table 2.1.

Table 2.1 Particle size distribution for landfall approach samples

Sample ID	Release Location	**mud %** <0.063mm	**sand %** 0.063mm-2mm	**gravel %** >2mm
S033	0	44	56	0
S037	7	0	76	24

2.1.6 The sediment dispersion modelling was carried out for two sediment fractions described in the model set-up as 'Fine Sand' and 'Mud' (i.e. silt and clay fractions). Release rates are defined in the model to simulate the amount of sediment brought into suspension during the burial process. A worst-case scenario was modelled which assumes that the cable will be installed by jetting methods which gives a higher release rate compared to ploughing.

2.1.7 The release rates applied in the modelling are summarised in Table 2.2 below. These are based on an installation rate of 4 km/day which is less than the 7 km/day rate previously considered for offshore section of the cable route and was considered appropriate due to the vessel approaching land and operating in shallower water depths.

Table 2.2. Sediment release rates

Location	**Release Rate (kg/s)**	
	Fine Sand	Mud[1]
Suffolk Landfall	19.4	26.8
Kent Landfall	26.4	-

Note 1. No silt/clay present in Kent landfall sediment sample.

A.1.1 The model considers a 24-hour period of cable installation on spring tides with the sediment dispersion model simulating a 14-day period, thus allowing maximum concentrations to be calculated over a full spring-neap tidal cycle. Plots showing modelled suspended sediment concentrations at peak flood and ebb during the first tide following commencement of cable installation are provided in Appendix A.

2.1.8 Plots showing the maximum suspended sediment concentrations (SSC) are provided in Plate 2.2 and Plate 2.3 for the Fine Sand and Mud fractions, respectively. The plots have been used to estimate ZoI distances for concentration levels of 30 and 100 mg/l, as given in Table 2.3.

2.1.9 Given that the ZoI distances are either less than the corresponding distances calculated for the nearest offshore points (Release Location 1 for Suffolk and Release Location 6 for Kent) or within a ±1 km error margin, any subsequent analysis made using the figures provided for Release Location 1 and Release Location 6 is considered to be within acceptable limits.

Table 2.3. Modelled SSC ZoI for sand/mud fractions with installation by jetting

Release Location	Approximate distance (km) from cable trench	
	Fine Sand [30 mg/l / 100 mg/l]	Mud[1] [30 mg/l / 100 mg/l]
0 (Suffolk landfall approach)	6 / 4	5 / 4
1	12 / 4	6 / 3
6	14 / 11	9 / 0
7 (Kent landfall approach)	12 / 10	-

Note 1. No silt/clay present in Kent landfall sediment sample (S037).

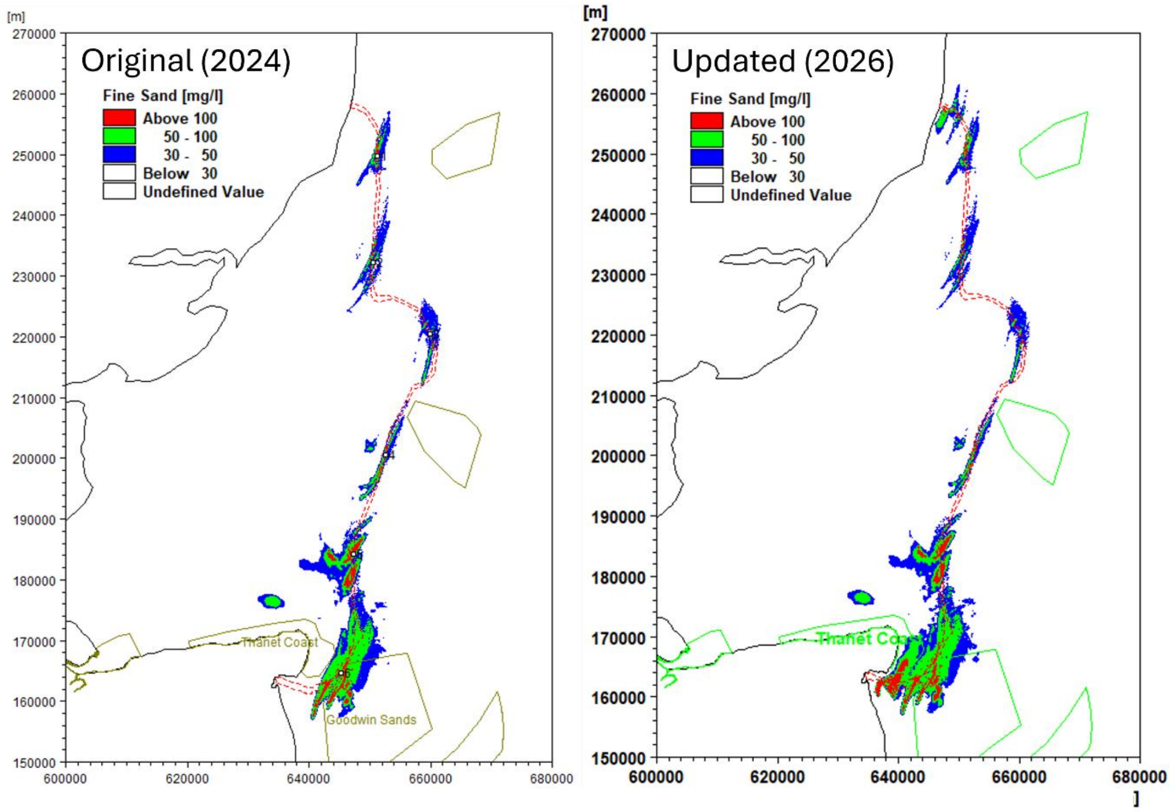

Plate 2.2 Maximum sand SSC over 14-day period

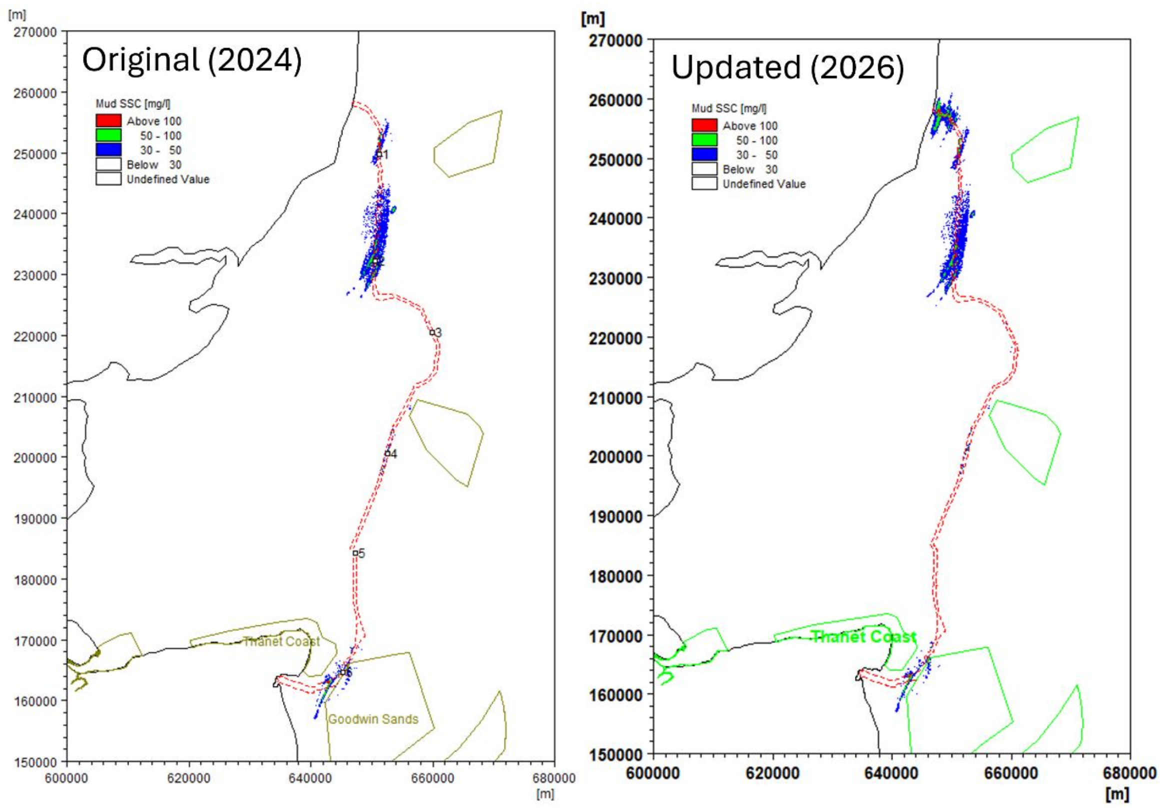

Plate 2.3. Maximum mud SSC over 14-day period

2.2 Pegwell Bay

2.2.1 Sediment dispersion processes within Pegwell Bay have been investigated in more detail using a tidal model of part of the Southern North Sea. The model, as shown in Plate 2.4, provides enhanced resolution within Pegwell Bay and includes the full extent of the River Stour, upstream to the tidal limit. Calibration of the tidal model was undertaken using established criteria (FWR, 1993) and the model was originally approved for use by the Environment Agency (AECOM, 2010).

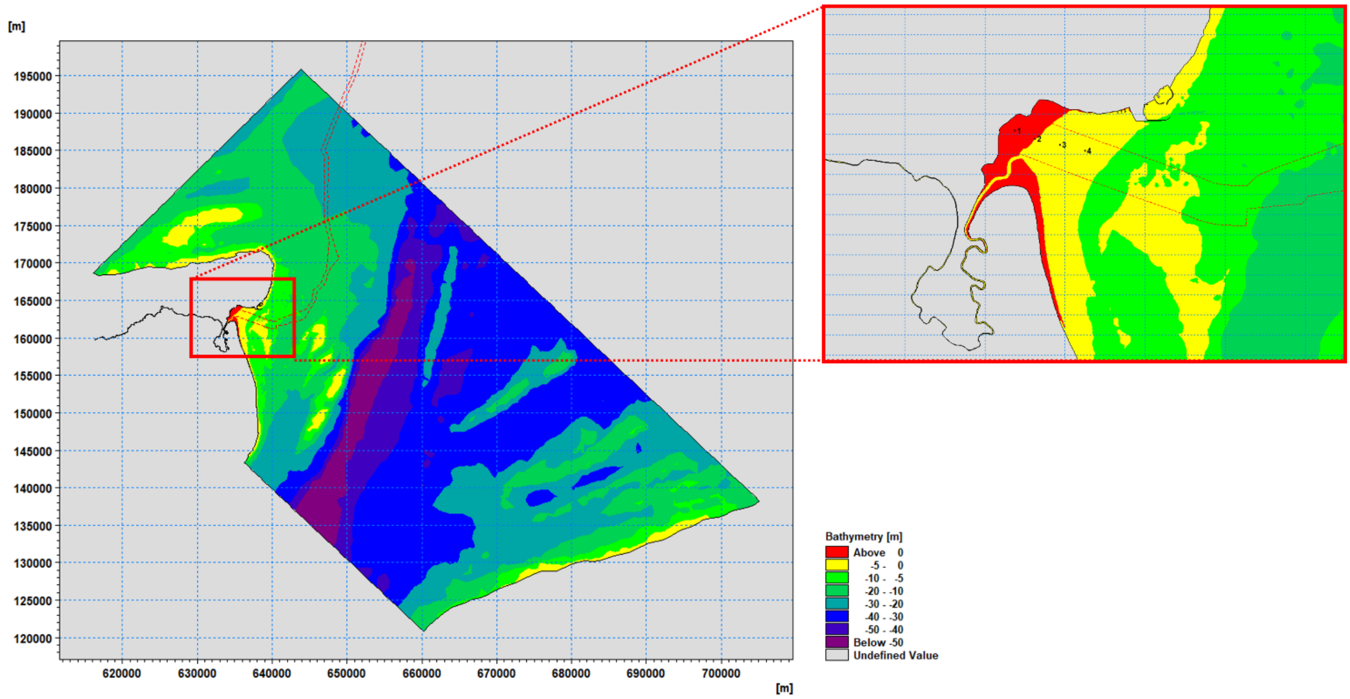

Plate 2.4. Extent of tidal model with enlarged view of Pegwell Bay and intertidal locations

2.2.2 Four discrete release points across the intertidal, labelled as 1 to 4, are shown on Plate 2.4. Results from the simulation of sediment releases from these points are used to assess the extent of suspended sediment plumes and corresponding deposition to show how sediments behave due to some form of seabed disturbance.

2.2.3 The cofferdam is assumed to have negligible impact on tidal current patterns and is not therefore represented in the model. This is a reasonable assumption given that the magnitude of peak current speeds are very low, of the order 0.1 m/s. Also, the effect of cofferdam blockage on local currents is considered separately.

2.2.4 A constant sediment release rate of 1 kg/s was applied in the model during a 7-day simulation period. The start time was chosen to include a sequence of tides with increasing range and the peak spring tide occurring mid-way through the model run. The model results therefore represent conditions around a peak spring tide which is the worst-case scenario due to the depths of inundation being greatest over this period

2.2.5 The released sediment mass was distributed between the two sediment fractions based on information obtained from grab sampling of intertidal sediments (APEM, 2024).

2.2.6 There is no direct pathway for sediment to be released into the water column during cable burial between the HDD exit and low water since this activity will be undertaken around the time of low water when the intertidal area is fully exposed. However, the backfilled material is likely to be less consolidated and may therefore be more susceptible to erosion.

2.2.7 Sediment from the intertidal release points can be used to understand the potential spread of material in the event that it is mobilised from this location. The SSC concentrations, as presented in Plate 2.5, provide an indication of elevated levels above background which, in reality, will depend on the in-situ density of the backfilled material.

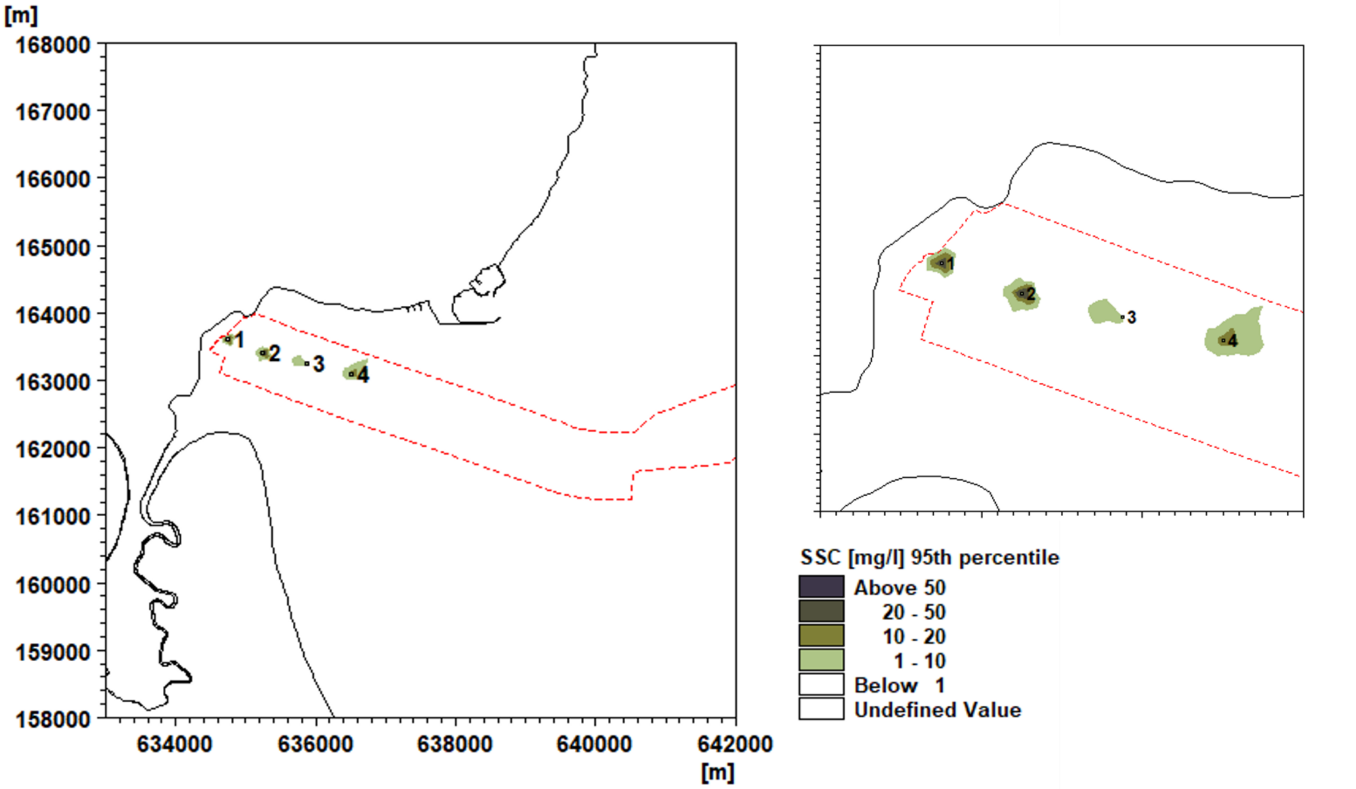

Plate 2.5 Distribution of 95th percentile SSC over 7-day simulation period

2.2.8 A key point to note is that the SSC contours are confined to the area surrounding the release point, partly due to the very weak tidal currents but also due to the limited inundation period with each of the four points located on the intertidal sandflats. The lowest position (Point 4) shows a wider spreading of suspended sediment which is not so evident at Point 3 where SSC levels cover a smaller area at a lower concentration.

2.2.9 The apparent anomaly at Point 3 described above was investigated further and the reason for this was found to be the non-uniform distribution of peak currents during the flood phase of the tide. The peak current speeds shown in Plate 2.6 are higher at Point 3 than at the other points and exceed the erosion threshold for fine sand (approx.0.34 m/s). The currents are shown to be weaker at Point 4, which although located in slightly deeper water, is not subject to the erosion of fine sand.

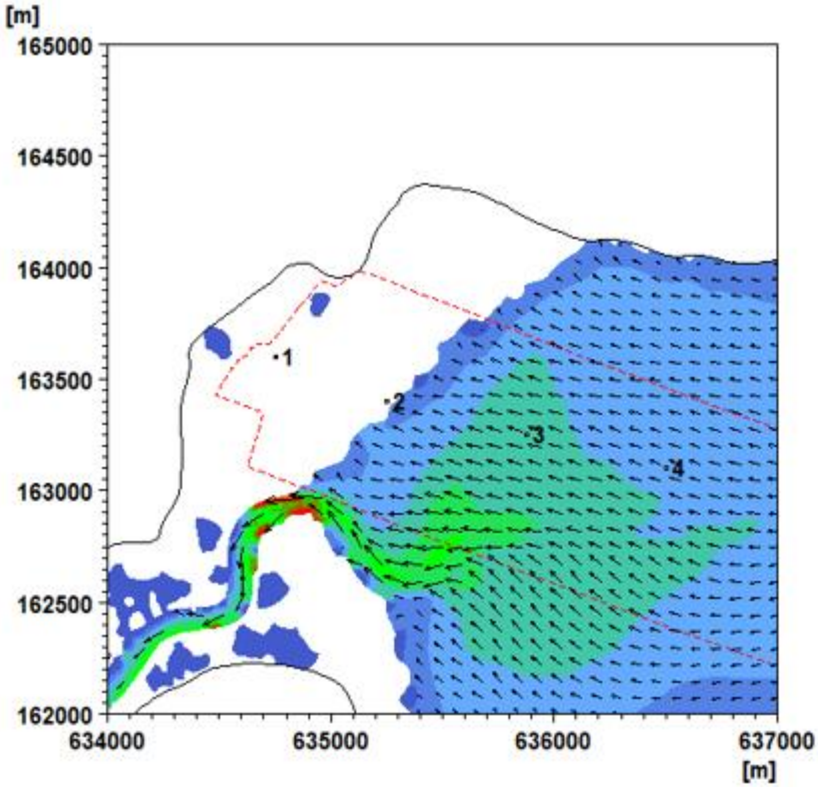

Plate 2.6 Peak flood currents exceeding erosion threshold at Point 3

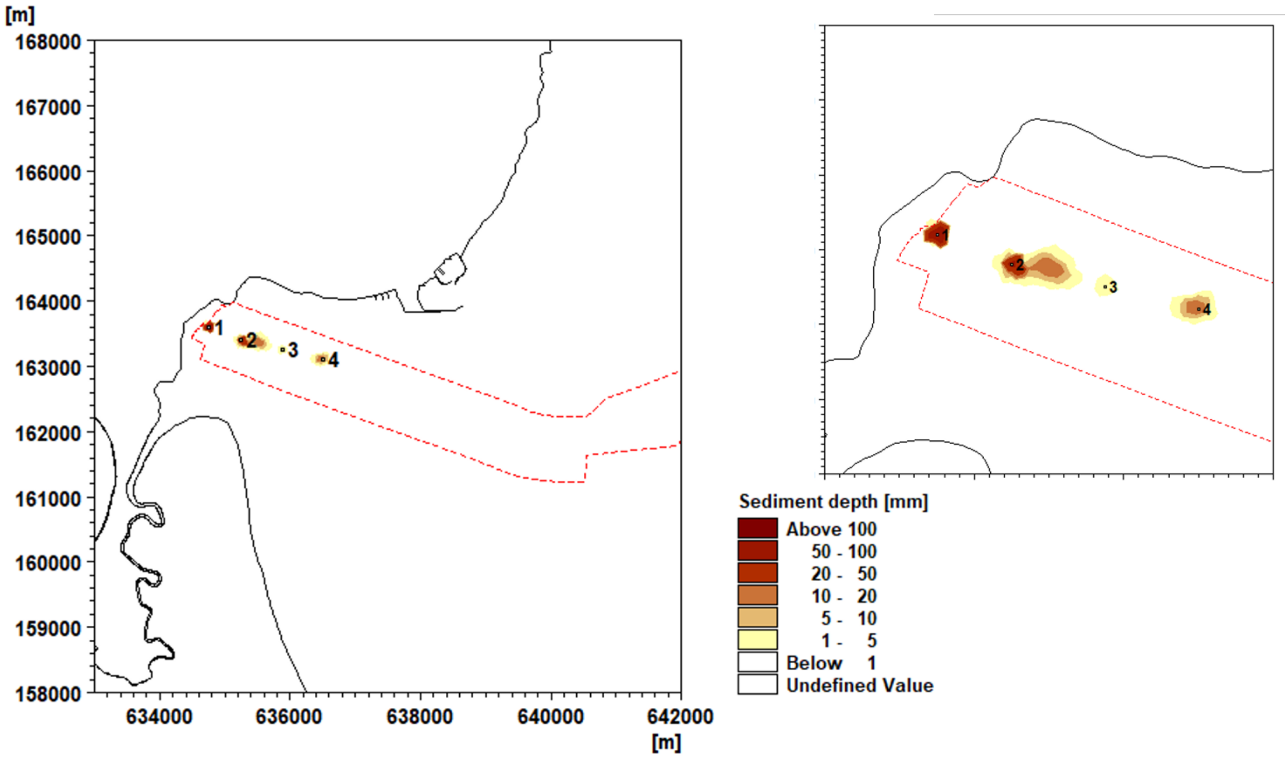

Plate 2.7 Model results for deposition over 7-day period

2.2.10 Similar patterns are found for depths of sediment deposited on the sandflats, as shown in Plate 2.7. The largest depth of deposition is shown to occur on the upper intertidal, reducing with distance from the shoreline, excluding the anomaly at Point 3 for the reasons explained above.

2.2.11 Further insight into the behaviour of intertidal sediments within Pegwell Bay is gained from the presentation of key parameters as time-series throughout the 7-day simulation period, as shown in Plate 2.8. The plots show that peak SSC levels are of very short duration, occurring at each point as it is inundated. The sediment mass introduced into the shallow water depth, as determined by the constant 1 kg/s release rate, results in a short duration 'spike' in SSC due to the relatively small volume of water. The concentration subsequently reduces as the water depth increases.

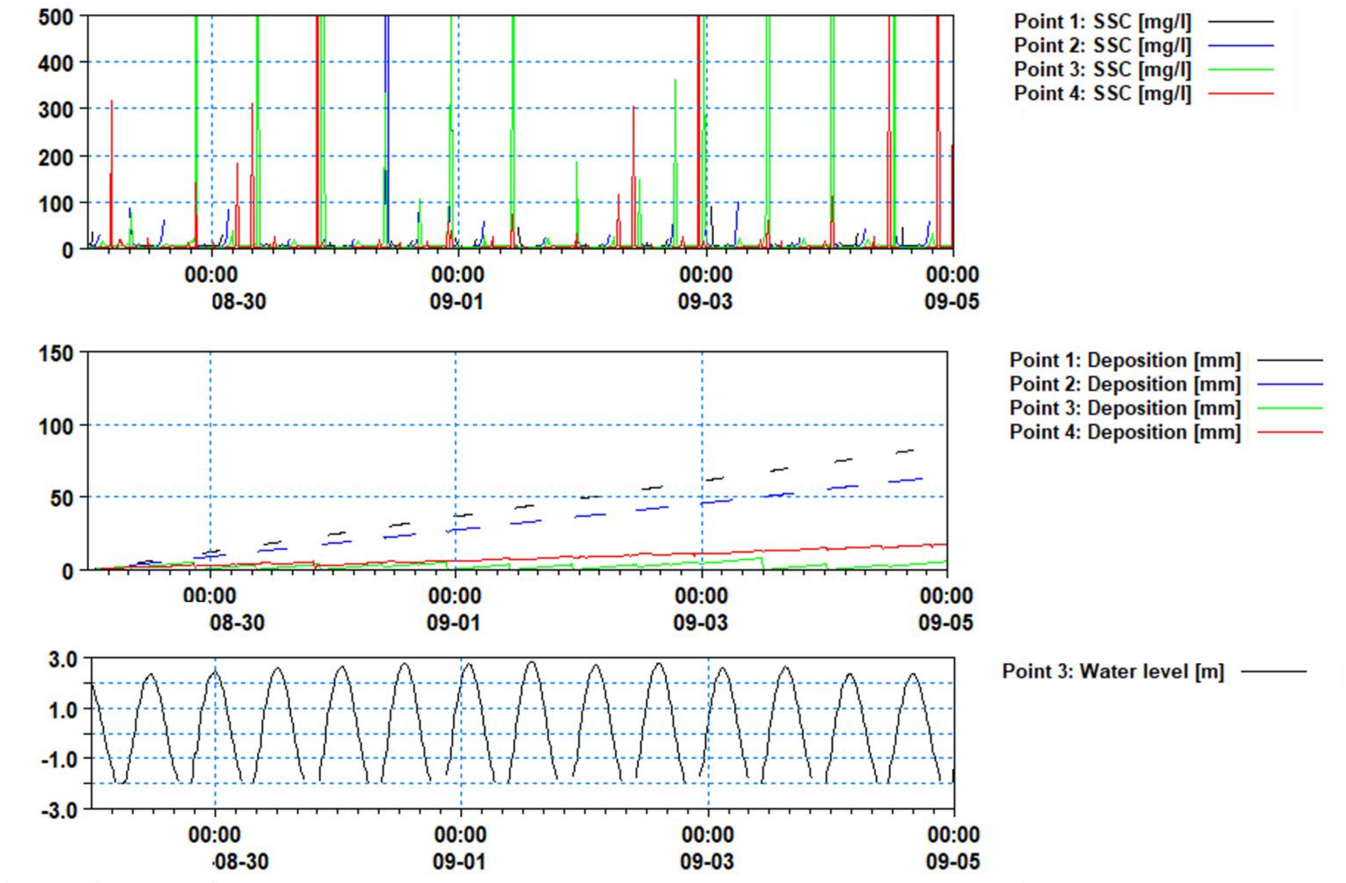

Plate 2.8 Time-series of sediment parameters and water levels over 7-day period

2.2.12 At points 1, 2 and 4 there is shown to be a continuous trend of increasing deposition over the 7-day period. However, this is not the case at Point 3 which shows an accumulation of sediment that is followed by rapid erosion on the rising flood tide. This explains why instantaneous peak SSC levels are higher at Point 3, as shown in Plate 2.8, due to the sediment being brought into suspension soon after becoming inundated. Due to the short duration of the peaks in SSC, they are not apparent in Plate 2.5 which uses the 95th percentile statistical value. Once mobilised by erosion processes, the sediment is dispersed within the bay at relatively low concentration levels (i.e. less than 1 mg/l).

2.3 Cofferdam Blockage

2.3.1 Regional tidal models can typically provide a maximum mesh resolution of 5-10 m covering areas of interest decreasing to around 100-500 m at the location of the model boundaries. Increasing the mesh resolution by a factor or 2 would require the calculation time-step to be reduced by the same factor in order to maintain numerical stability. Reducing the linear mesh resolution by a factor of 2 translates to a factor of 4 when considering the area of a mesh element with the corresponding computational effort therefore increased by a factor of 8.

2.3.2 Due to the explanation provided above, it is not a practical option to provide a resolution of 1 m within a regional tidal model and for this reason, an alternative approach has therefore been used to investigate the interaction between tidal flows and a cofferdam structure on the upper intertidal within Pegwell Bay. An alternative approach has therefore been adopted by representing a section of intertidal area surrounding a 5 m wide and 30 m long cofferdam using square grid cells with a dimension of 1 m.

2.3.3 The model set-up has been simplified to represent a worst-case scenario with a flat bed set to an elevation of 0 mODN and a constant water level at +2.64 mODN which is equivalent to Mean High Water Springs (MHWS). A constant current is applied along the right-hand side open boundary with a constant water level applied along the left and lower boundaries. The upper boundary of the model represents the saltmarsh edge operates as a 'free-slip', no-flow boundary. This simplified model set-up has been used to determine the maximum instantaneous increase in current speed at the saltmarsh edge due to the presence of a cofferdam, as shown in Plate 2.9.

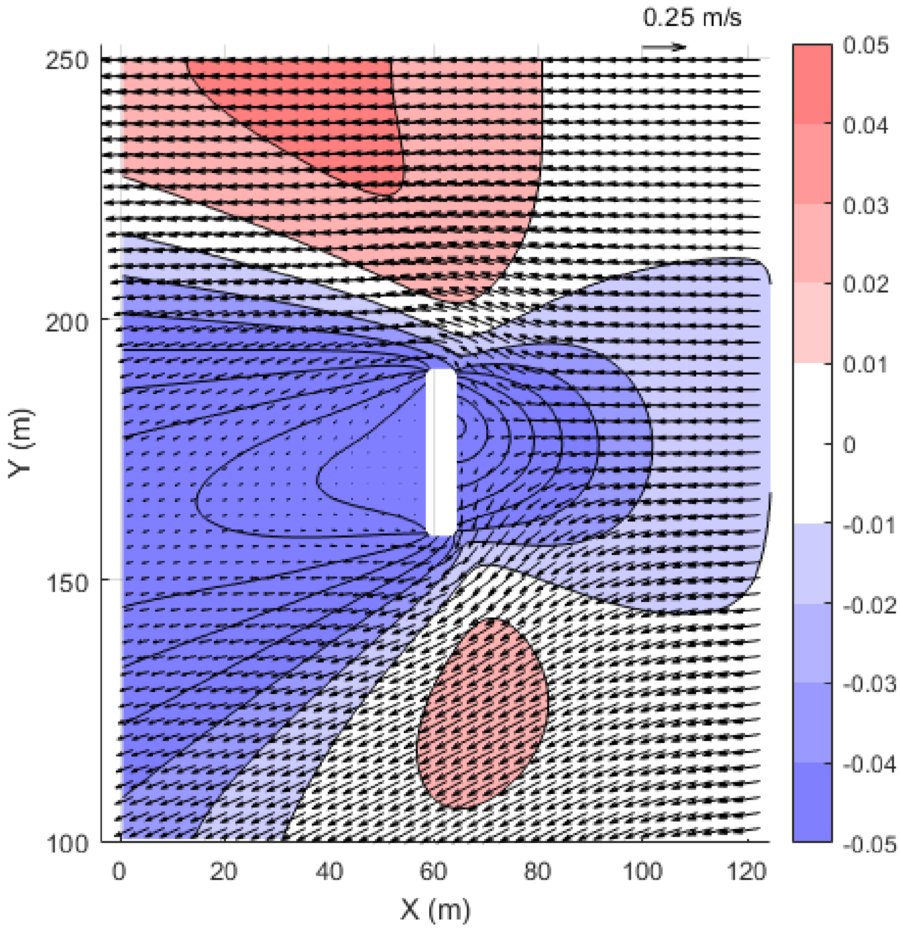

Plate 2.9 Changes in current speed around cofferdam

2.3.4 The model results presented in Plate 2.9 shows how current vectors respond to the presence of the cofferdam with shaded contours representing the difference in current speed magnitude relative to a uniform flow field with no cofferdam present.

2.3.5 A constant, uniform current is applied to the model which flows from right to left. The main blockage effect is a reduction in current speed immediately upstream and downstream of the cofferdam which diminishes with distance, as indicated by the blue shaded contours. Localised increases in current speed are indicated by the pink/red shading, with a maximum increase of approx. 0.04 m/s along the upper boundary of the model, indicative of conditions along the saltmarsh edge.

2.3.6 It should be noted that the changes predicted by the steady-state model will in reality be of a short duration (i.e. a few minutes) and lower in magnitude due to the saltmarsh being a greater distance from the cofferdam. Another factor that will further reduce the predicted change in current speed is bed friction which would have a greater influence in shallower water depths at the saltmarsh edge if a sloping rather than flat bed was applied in the model.

3. Summary of Results

3.1 Landfall Approaches

The following conclusions are based on the results from sediment dispersion modelling for the landfall approaches:

3.1.1 **Suffolk Landfall:**

- Maximum SSC levels near Suffolk landfall used to define ZoI distances are similar to those for nearest offshore release location (1).
- Initial mud SSC levels near the Suffolk landfall are lower than SSC at nearest release location (1).
- Initial sand SSC levels near Suffolk landfall are either less than or similar to SSC at nearest release location (1).

3.1.2 **Kent Landfall:**

- Maximum sand SSC levels near Kent landfall used to define ZoI distances are less than those for the nearest offshore release location (6).
- No mud fractions (clay/silt) were present in sediment sample S037.
- Initial sand SSC levels near Kent landfall either less than or similar to SSC levels at nearest release location (6).

3.1.3 **General:**

- Results from original sediment dispersion modelling remain valid.
- No justification for revising ZoI distances as previously defined in the ES chapter

3.2 Pegwell Bay

The following conclusions are based on the results from sediment dispersion modelling within Pegwell Bay:

- A progressive increase in deposition was found at Points 1, 2 and 4.
- The highest rate of accumulation occurs at Point 1 (upper intertidal).
- Accumulated sediment at Point 3 erodes on subsequent spring flood tides.
- Erosion at Point 3 is due to the peak velocity exceeding the erosion threshold.
- Short-term peaks in SSC are due to sediment release into shallow water depths.
- SSC reduces to zero as each point dries.
- At mid to upper intertidal levels (Points 1 & 2), elevated SSC and depths of deposition are highly localised.
- A reduced rate of sediment accumulation is found at lower intertidal levels.
- Wider sediment dispersion occurs at levels below 1 mg/l.

3.3 Cofferdam Blockage

The following conclusions are based on the results from modelling of the blockage effect of a cofferdam in Pegwell Bay:

- A high-resolution model has been used to assess potential increases in current speed based on a worst-case scenario.
- The dominant effect is a reduction in current speed on either side of the cofferdam.
- Current speeds near the saltmarsh edge can be expected to increase by less than 0.04 m/s for a limited period around the time of peak flood or peak ebb.
- The predicted increase in current speeds is less than natural variability due to local wind and wave effects.
- The increase in current speed is not sufficient to cause erosion of saltmarsh sediments.

4. References

AECOM. (2010). *Pegwell Bay model build & calibration.*
AECOM. (2024). *Sediment Dispersion Modelling - Technical Note.*
APEM. (2024). *Intertidal Environmental Survey Report.*
FWR. (1993). *A framework for marine and estuarine model specification in the UK.*
MMT. (2022). *Geophysical & Environmental Survey.*

Appendix A Sediment Dispersion Model Results

Description of Model Results

A.1.1 Plate A.1 and Plate A.2 show modelled suspended sediment concentrations for fine sand at peak flood and ebb, respectively, during the first tide following commencement of installation by jetting.

A.1.2 Plate A.3 and Plate A.4 show modelled suspended sediment concentrations for mud at peak flood and ebb, respectively, during the first tide following commencement of installation by jetting.

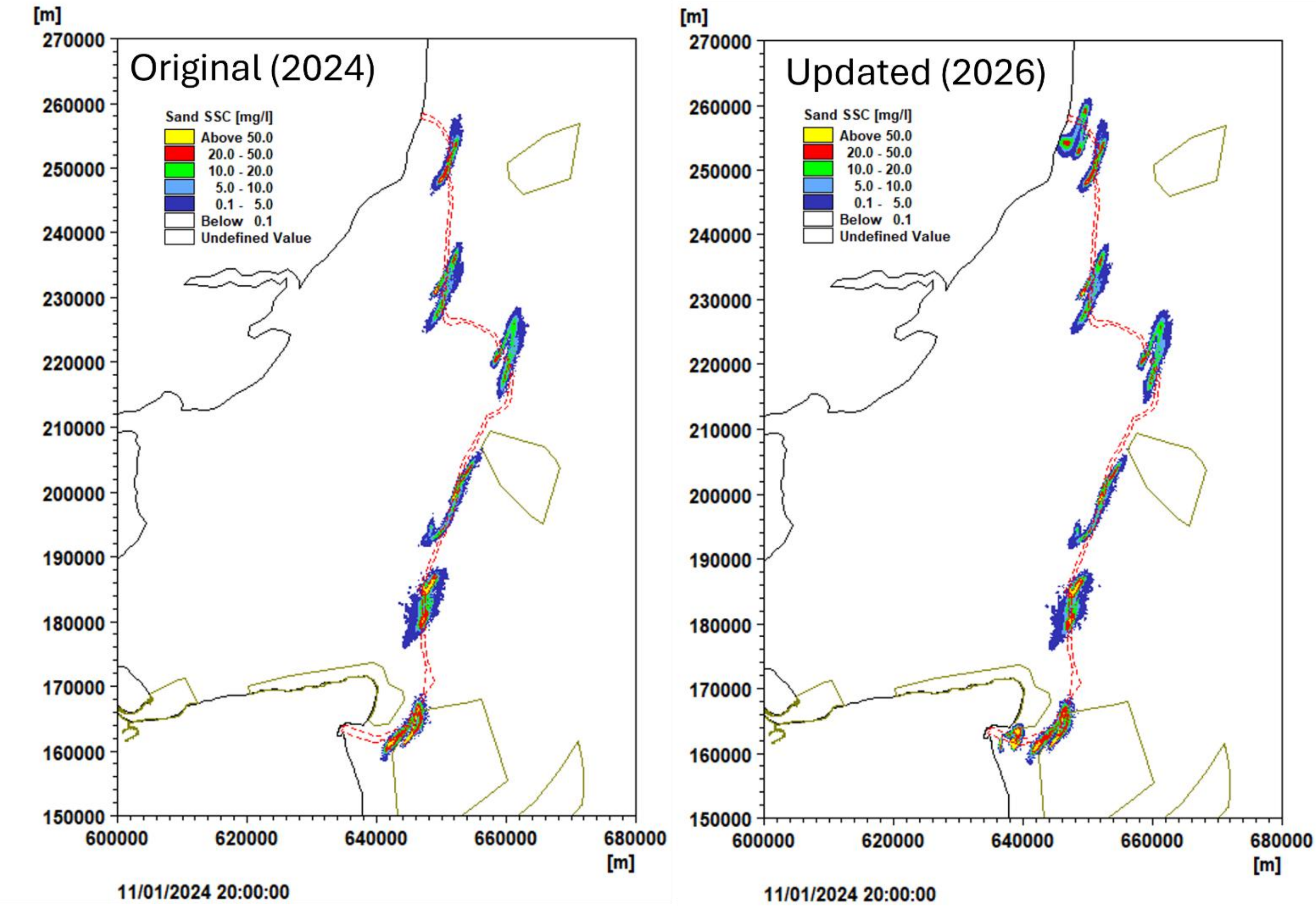

Plate A.1 Sand SSC with installation by jetting during flood tide

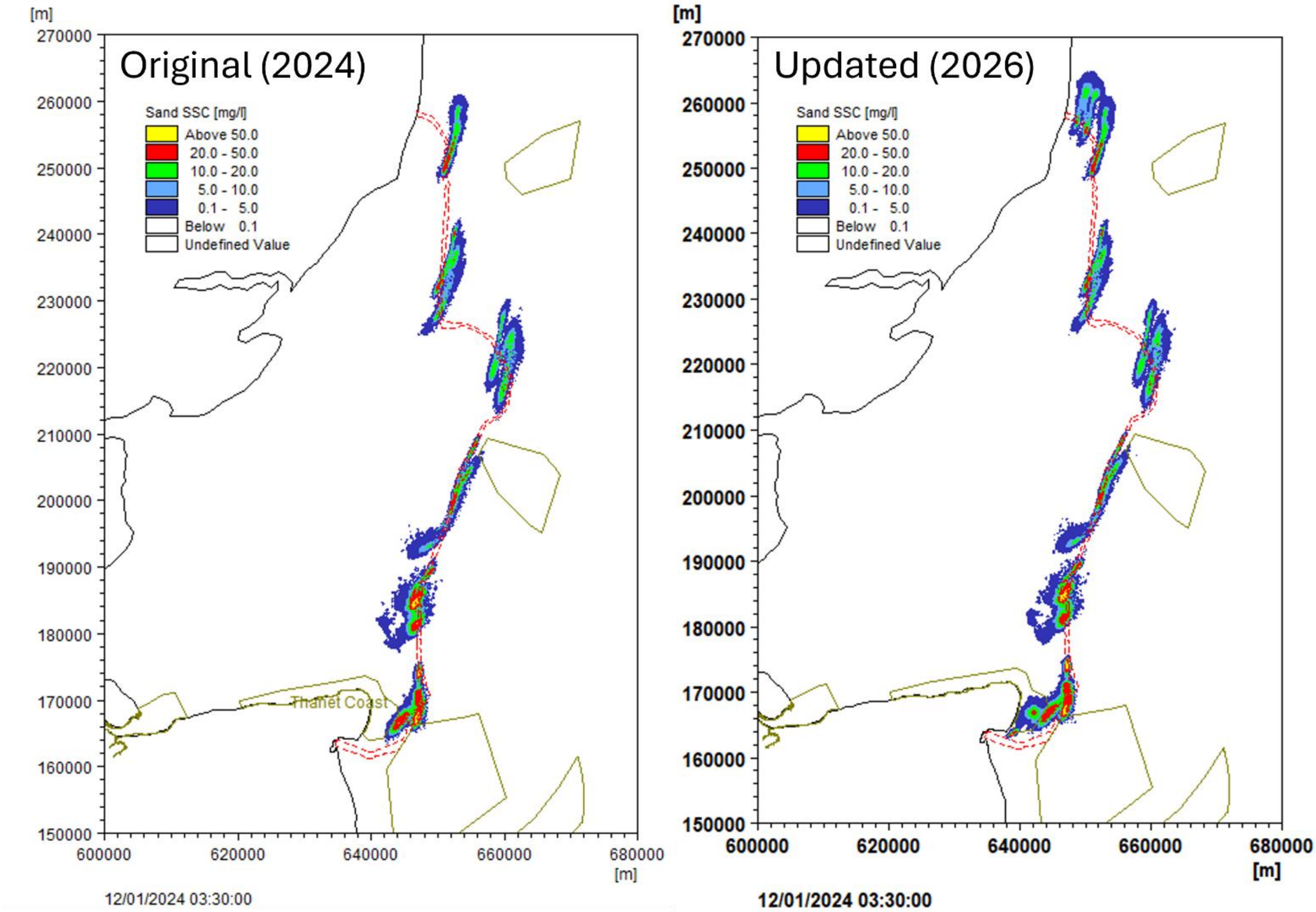

Plate A.2 Sand SSC with installation by jetting on ebb tide

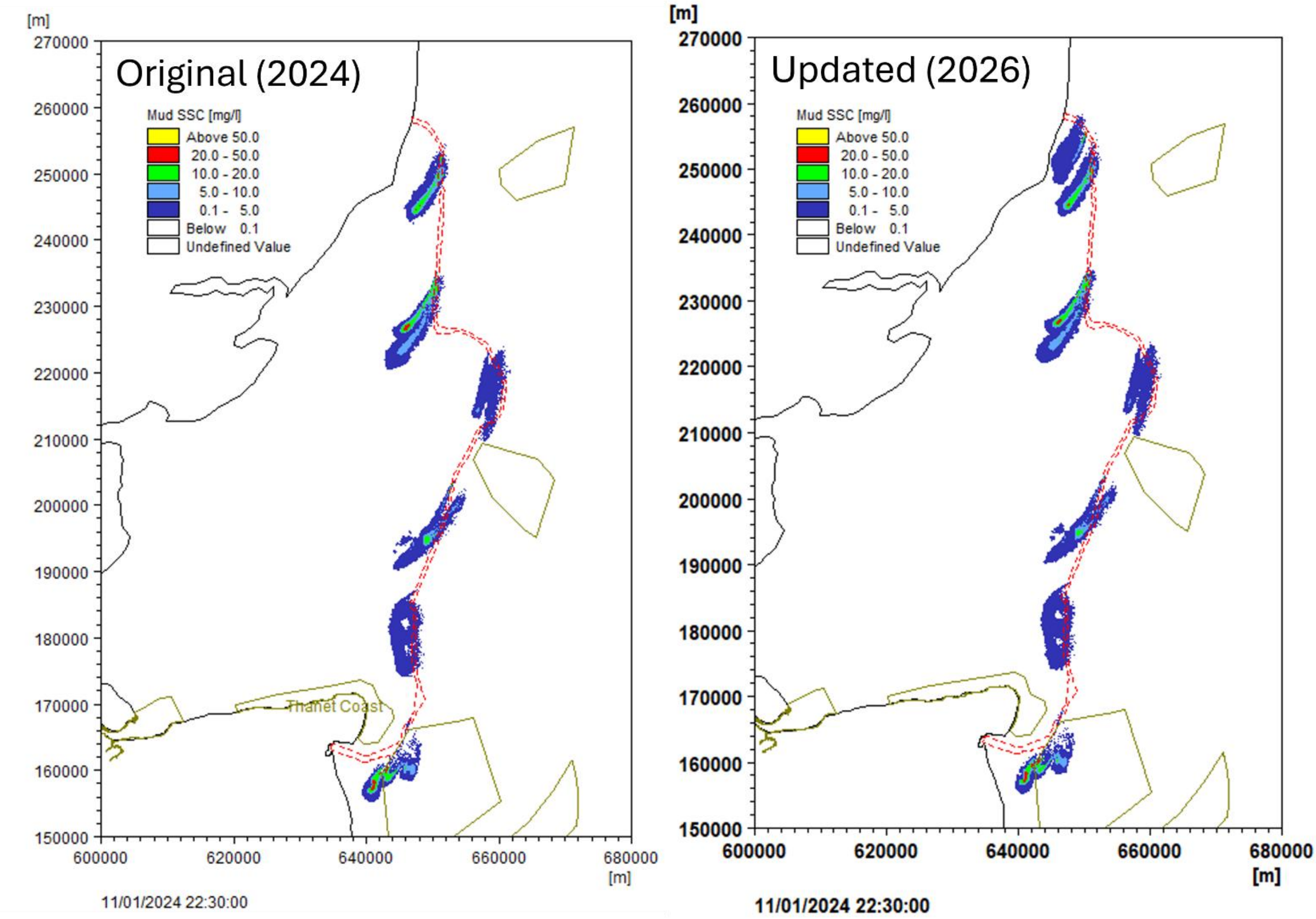

Plate A.3 Mud SSC with installation by jetting on flood tide

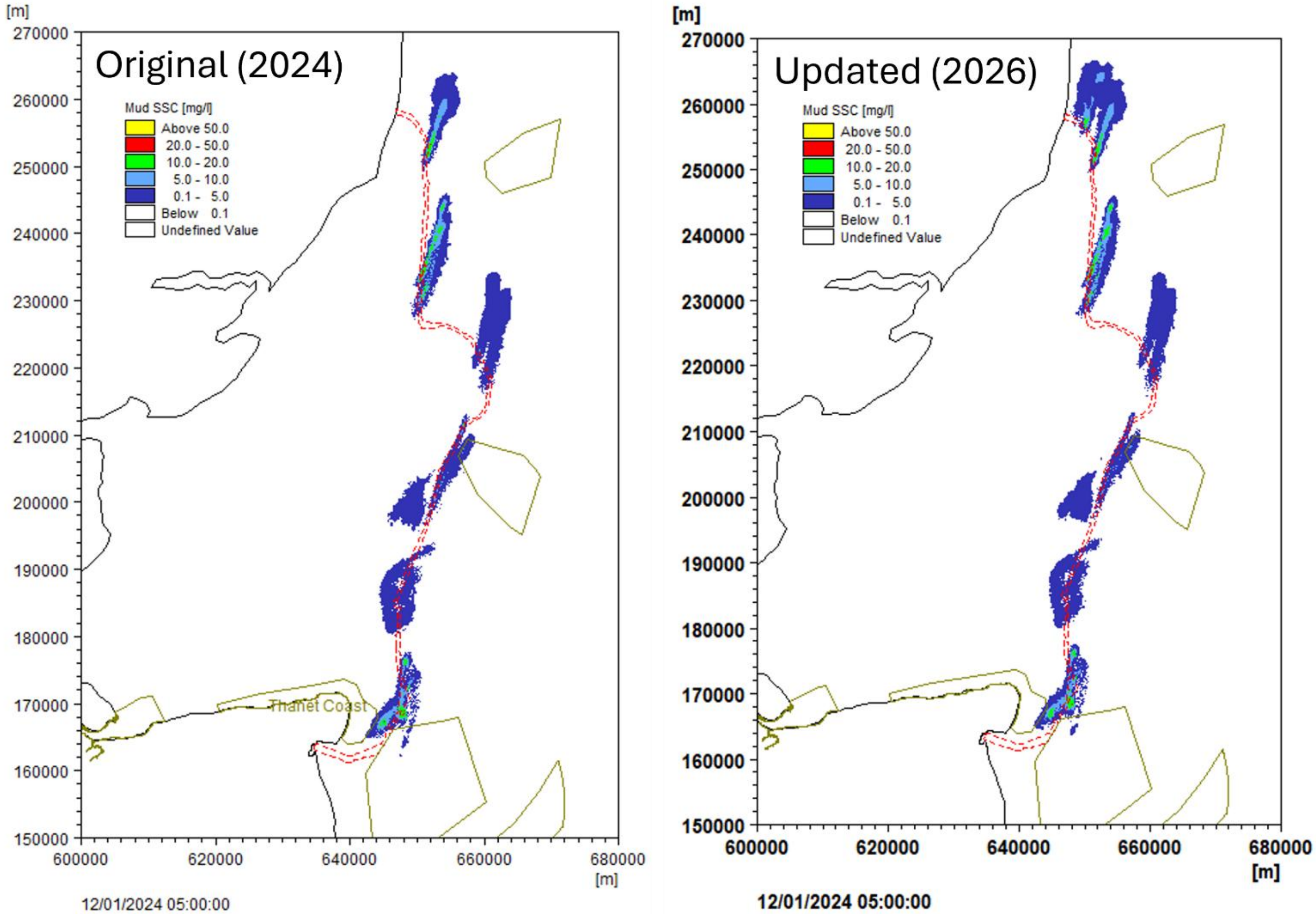

Plate A.4 Mud SSC with installation by jetting on ebb tide

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

Registered in England and Wales
No. 4031152
nationalgrid.com