FIVE ESTUARIES OFFSHORE WIND FARM

10.20.1 TECHNICAL NOTE: METHODOLOGY FOR DETERMINING MDS (OFFSHORE) (CLEAN)

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In preparation of this document Five Estuaries Wind Farm Ltd has made reasonable efforts to ensure that the content is accurate, up to date and complete for purpose.

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
A	Oct-24	Deadline 2	VEOWF	VEOWF	VEOWF
B	Dec-24	Deadline 4	VEOWF	VEOWF	VEOWF

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FIGURES

DEFINITION OF ACRONYMS

Term	Definition
VE	Five Estuaries Offshore Wind Farm
ExA	Examining Authority
TCE Guide	Guide to an offshore wind farm; The Crown Estate (TCE) 2019
WTG	Wind Trubine
OoS	Out of Service. *This is the term used for cables left in the seabed that are no longer of use. Many are from the 1970s telecoms industry.*
MDS	Maximum Design Scenario
OWF	Offshore Wind Farm

For ease a list of the relevant documents from the DCO library is provided below:

AS-041	6.3.1 Onshore Project Description
APP-069	6.2.1 Offshore Project Description
APP-070	6.2.1.1 Detailed Offshore Project Design Envelope
APP-229	8.1 Cable Statement
Jan Riezebos, 2023	Hendrik Jan Riezebos; Lasse Hybel &Andreas Roulund; "Field performance of cable crossings rock berms in the North Sea." proceedings of the 11th International Conference on Scour and Erosion; 2023

1. INTRODUCTION

1.1.1 To aid the understanding of the offshore cable installation works the ExA has requested a Technical Note providing further description of how some of the values in the MDS have been calculated. This note was asked to be updated in response to Examiner's Question (ExQ) ME.2.05 at Deadline 4.

1.1.2 ExQ ME.2.05 requested the following updates:

ExQ ME.2.05	Applicant response
a) Paragraph 1.1.12 states that some information is not provided as the Applicant considers it to be confidential or propriety information that is sensitive. The ExA requests confirmation as to whether this information could be submitted on a confidential basis or in part. If not, the Applicant is requested to explain the level of confidence the ExA can have in the MDS used in the absence of full information.	This statement was to cover, for example, the rates of progress for specific cable tools in specific ground conditions based on previous projects. Instead the Applicant provides assumed values of progress rates that are an amalgamation of previous project experience. The Applicant does not consider that providing project or contractor specific information would add value to the information provided in the note as the MDS is inherently considering a high-level of data to provide an envelope for assessment.
b) Paragraph 2.1.3 restates that the maximum number of cable crossings has been set at 56. The Applicant must present a detailed explanation of how this parameter has been established, including any assumptions made.	Further details are provided in Section 2.1.
c) Paragraph 2.2.2 refers to the potential for a very small volume of sediment being trapped within rock voids and/or accumulating on the updrift side of berms of the cable protection, if required. The Applicant is requested to quantify the volume or provide an estimate of the maximum expected volume of such sediment.	An estimate of the volume of trapped sediment has been provided in Section 2.2. Context for this volume is provided in relation to the tip of the Margate and Long Sands (MLS SAC) sand bank which intersects the Export Cable Corridor (ECC). The relative volumes of potential trapped sediment and the tiny proportion of the nearby sandbank demonstrate that the potential effect of the project is not material.
d) Paragraph 2.2.4 states that monitoring and observation of operational offshore wind farms shows that large scale morphological features are not affected by the presence of assets (cable protection) and that scour	Covered in section 2.2.92.2.12.

impacts would be very small. The Applicant is requested to ExQ2 Responses by Deadline 4 (3 December 2024) Page 13 of 29 Question to: Question submit evidence in support of this	
e) Paragraph 2.4.2 states that a 50% assumption has been applied to sediment disturbed from fluidised material dispersed during cable trenching. This information seems to contradict the Applicant's response at Deadline 1 [REP1-051] that an assumption of 100% of material is fluidised and displaced. The Applicant is requested to clarify what has been considered in the assessment. The ExA notes that Table 2.8 in [APP-071] states that a sensitivity check on 100% of material ejected in local areas was undertaken. The Applicant is requested to confirm where this is presented in the Application documentation.	Further explanation is provided in Section 2.5.
f) A full response to the matters raised by Natural England in items B13 [PD2-004] and E6 and E7 in [PD2-006] should be provided in terms of how seabed disturbance from operational cable repairs and replacement has been calculated drawing on experience (including analysis from operational offshore wind farms) and ground type information.	The matters raised by Natural England (noting at E6 and E7 are in [PD2-007]) relate to the quantification of cable repairs and associated impacts. This is responded to in Section 4.

2. CLARIFICATION OF MDS VALUES

2.1 CABLES CROSSINGS

2.1.1 Table 1.25 Maximum design envelope for cable crossings is repeated below.

Parameter	Design envelope for export cables	Design envelope of inter-array cables	Total
Total number of crossings required	30	26	56
Length of crossings (m)	300	300	N/A
Total length of cable crossings (m)	9,000	7,800	16,800
Width of crossing (m)	13	13	N/A
Height of rock berm (m)	1.4	1.4	N/A
Cross sectional area of trapezoid (m^2)	12.2	12.2	N/A
Total area of seabed covered by cable crossings (m^2)[5]	119,300	103,400	222,700
Total volume of cable protection required (m^3)	111,400	96,500	207,900

2.1.2 Total number of crossings is comprised of the export cable and inter array cables. These are maximum values. The project has identified in use and out of service (OoS) cables that cross the export cable corridor and array area. The project has also identified cables that are likely to be installed before the VE project. Some of these will need to be crossed. Some OoS cables may be removed instead, and not crossed.

2.1.3 As is common for companies operating in the offshore cable industry, the project is in active discussion regarding crossing agreements for the active assets, and in discussion with the owners regarding removal of OoS cables. Because of this potential for removal of cables, and uncertainty regarding the WTG layout and number of array cables, the project cannot determine the exact number of crossings pre DCO. To allow for the Rochdale envelop approach it has been determined that the number of crossings will be less than 56. 56 has hence been assessed in the environmental assessments.

2.1.4 Figure 1 has been extracted from the Offshore Project Description APP-069. It can be seen that there are a number of planned, active, inactive / out of service cables in the Export and Array area. This has been further summarized in Table 2.

2.1.5 The project has allowance for 56 cable crossings. At least 14 of these are anticipated to be for the export cables in the Export Cable Corridor (ECC). This leaves 42 for the array areas. It is not possible to identify the number of crossings in the array area until the final layout and array routing has occurred, and this will not be done until after DCO award. Similarly there are a number of OoS cables where though it is assumed the preference is to but remove these, however this is not confirmed yet. This is why the project cannot confirm the total number of crossings and instead has to make an allowance based on a range of possible scenarios.

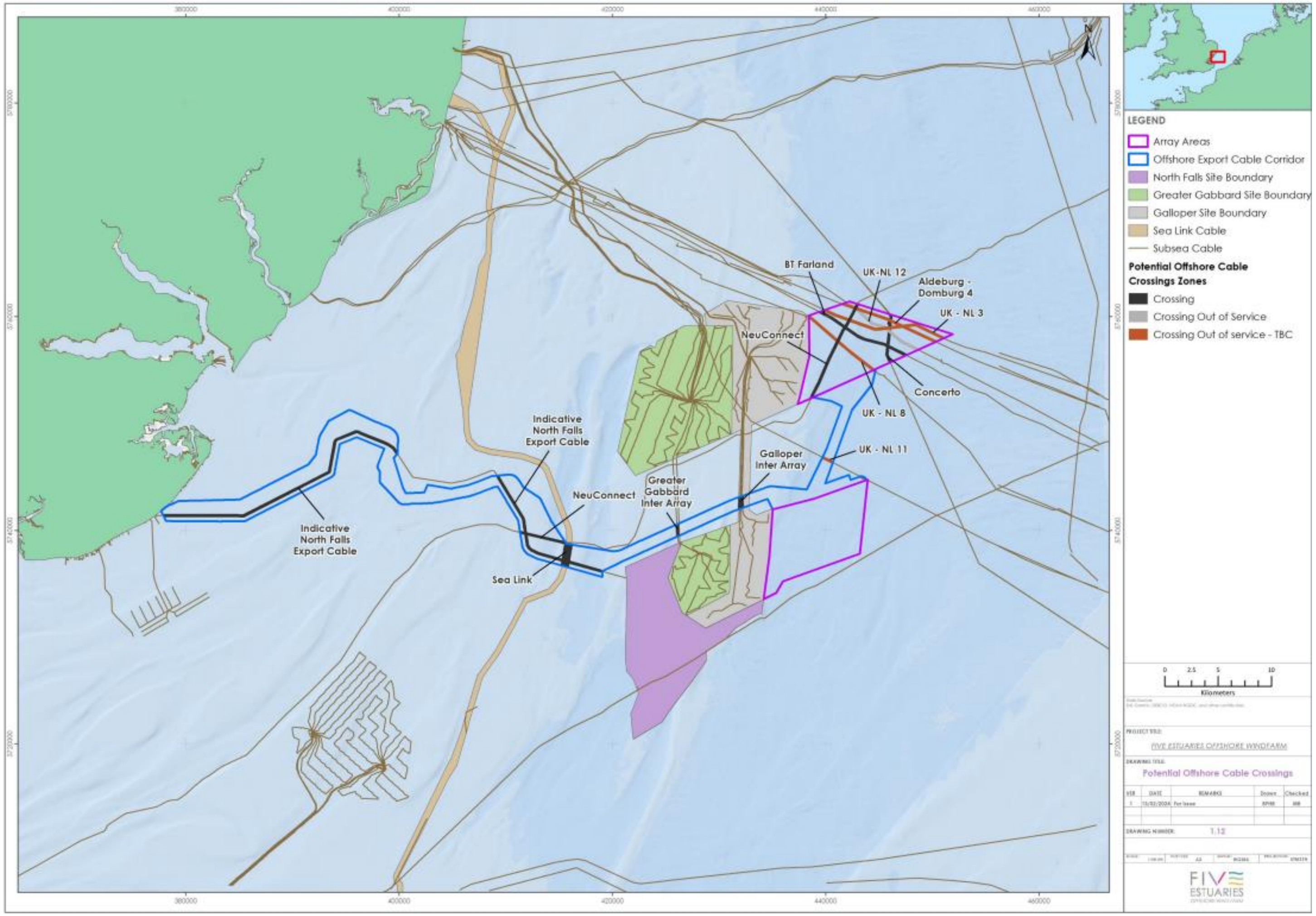

Figure 1 Offshore cable crossings

Table 1 Tabular summary of anticipated cables

CABLE	AREA	STATUS	ANTICIPATED NUMBER OF CABLES	ANTICIPATED NUMBER OF CROSSINGS
Sealink	ECC	Planned	2 (bundled)	2 crossings
North Falls	ECC	Planned	2	4 crossings
Neu Connect	ECC & Array	In construction	2 (bundled)	2 crossings in ECC, TBD Array
EXA Concerto	Array	Active	1	TBD
BT Farland	Array	Active	1	TBD
Galloper	ECC	Active	1	2 crossings
Gabbard	ECC	Active	3	6 crossings
Aldeburg - Domburg 4”	Array	Out of Service	1	TBD / Removal
UK NL 3	Array	OoS	1	TBD / Removal
UK NL 8	Array	OoS	1	TBD / Removal
UK NL 11	Array	OoS	1	TBD / Removal
UK NL 12	Array	OoS	1	TBD / Removal

2.1.6 Cables crossings and external protection are described in section 3.7.5 of 8.1 Cable Statement [APP-229]. To aid in the understanding of the terms used, Figure 2 is provided. Please note that the cover layer is the same as the “secondary layer”. For clarity a typical concrete mattress is shown in Figure 3 For crossings, multiple concrete mattresses may be used to provide the necessary separation and cover. Figure 4 provides a guide to help understand the values quoted in the MDS.

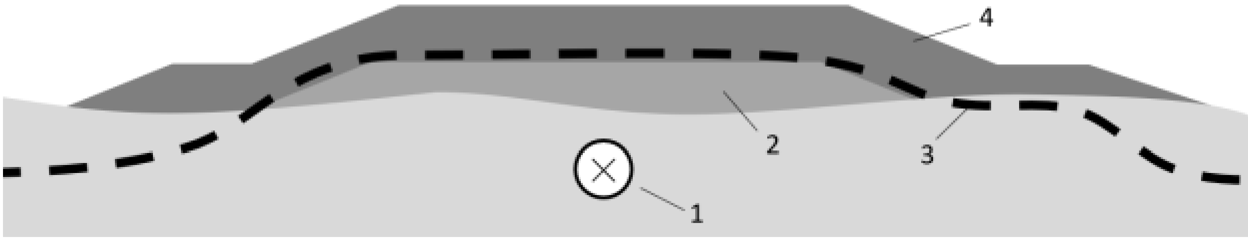

Figure 2. Definition of typical cable crossing rock berm elements.
1: Crossed asset. 2: Separation layer. 3: Crossing asset. 4: Cover layer.

Figure 2 Indicative cable crossing (Jan Riezebos, 2023).

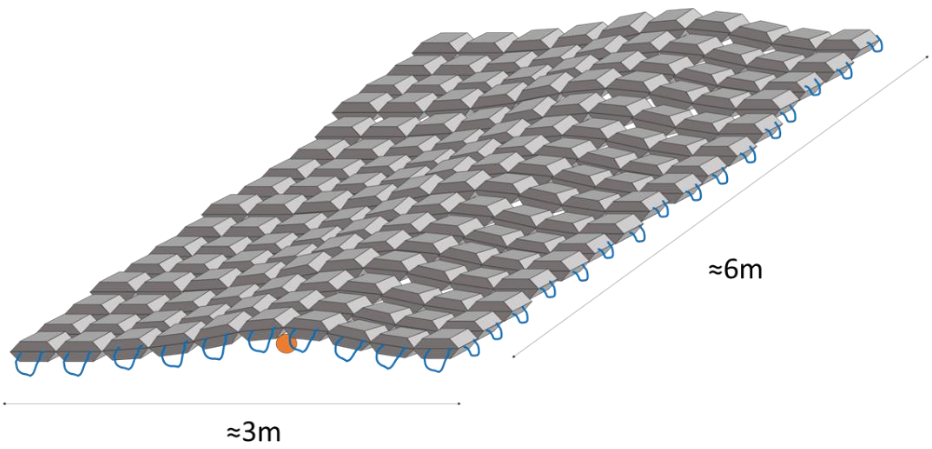

Figure 3 Single concrete mattress (note single mattresses are typically combined to make a crossing)

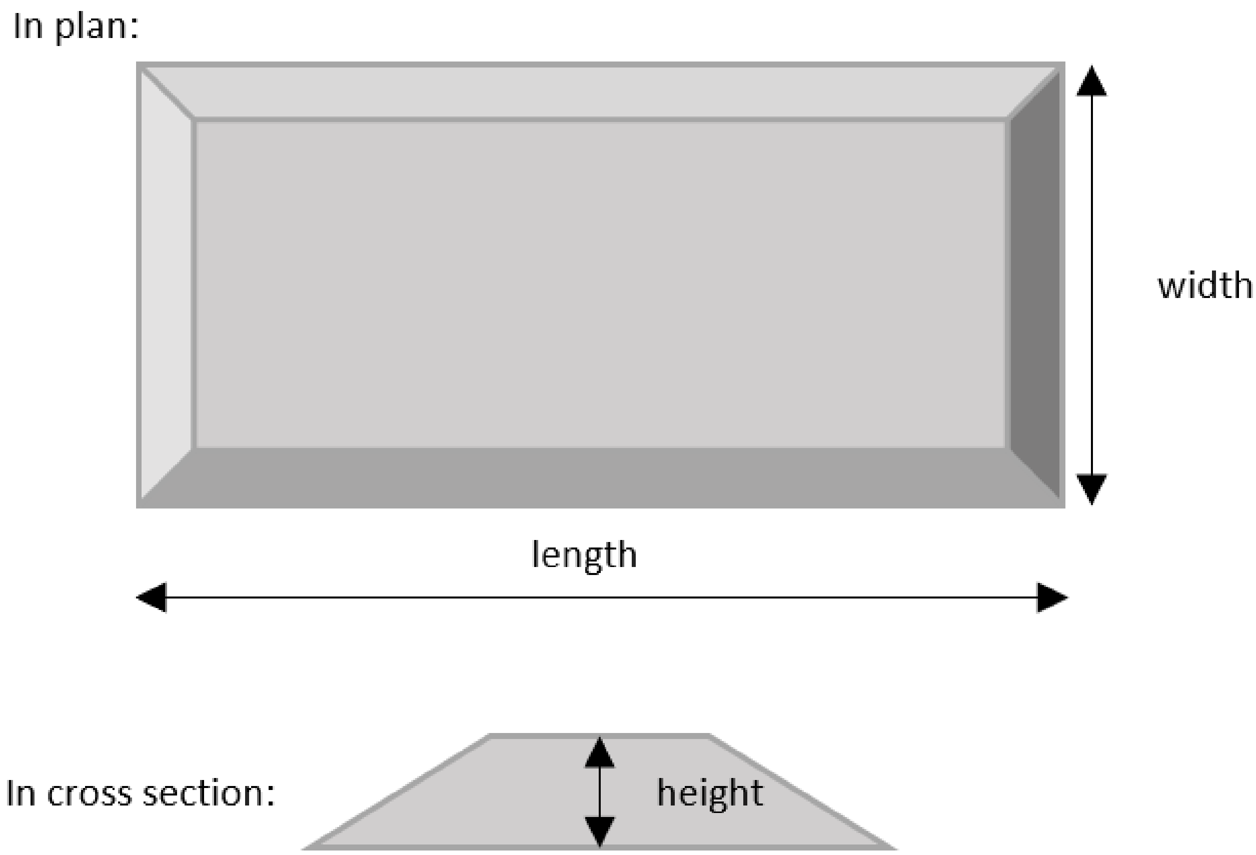

Figure 4 Crossing dimensions

2.1.7 The values assumed in the MDS, particularly for the array area, are typical values from offshore wind experience and are not based on project specific design at this stage. The total number of crossings in the array will in large part be determined by the WTG layout and the associated layout of the inter-array cables. Where cable crossings are required, either rock berms or mattresses will be chosen and detailed design will be conducted to confirm the hydrodynamic, mechanical and electromagnetic suitability of the crossing method. The Applicant notes that the conditions at site are within normal ranges (in terms of water depth and seabed conditions) for the design of crossings.

2.2 CABLE PROTECTION – TRAPPED SEDIMENT VOLUME

2.2.1 Within ExQ2 ME.2.05 the ExA has requested the Applicant to quantify the volume or provide an estimate of the maximum expected volume of the very small volume of sediment that may be trapped within rock voids and/or accumulated on the updrift side of berms of the cable protection (if required).

2.2.2 To provide both a calculation and context for the 'very small' volume of sediment the Applicant has referred to, the parameters from Table 1.24 in the Offshore Project Description APP-070 are used.

Table 1.24 MDS for cable protection

Parameter	Design envelope for export cables	Design envelope of inter-array cables	Total
Length of cable requiring cable protection (excluding cable ends protection) (%)	10	20	N/A
Length of cable requiring cable protection (minus cable crossings but including cable ends protection) (km)	18.5	54	72.2
Width of cable protection on seabed (m)	9.7	6	N/A
Height of cable protection berm (m)	1.1	1	N/A
Total area of seabed covered by cable protection (m^2)	178,304	321,600	499,904
Total volume of cable protection (m^3)	129,691	187,600	317,291

2.2.3 To calculate the volume of cable protection, the cross sectional area based on the above parameters is calculated, using the equation for the area of a trapezium:

$$A = \frac{a+b}{2}h$$

where A= Area in (m^2), a = smaller width (top) (m), b = wider width (bottom) (m), h=height (m)

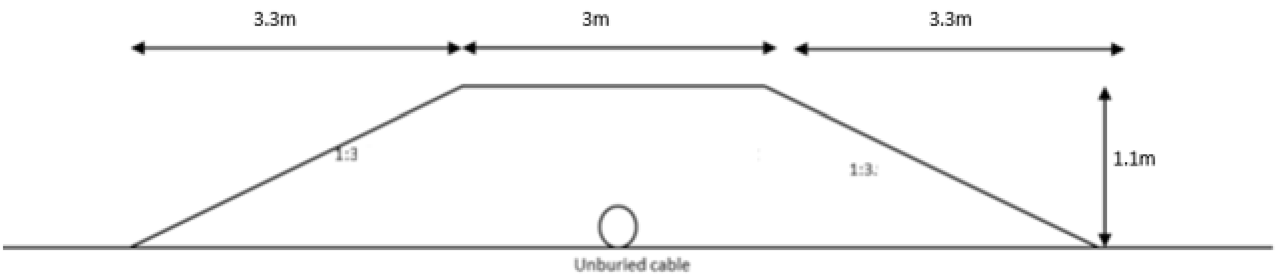

Figure 5 Assumed external protection trapezium. Please note that bottom width is stated as 9.7m as it has been rounded to 1 decimal place

$$6.99 = \frac{3+9.7}{2}1.1$$

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2.2.4 The area for the trapezium is therefore calculated as 7m^2 which can then be multiplied by the length of cable protection to provide the volume.

2.2.5 The volume of material that could be trapped in the rock berm is then a function of the length of the berm. This would be dependent on the length of exposed cable (noting that this is a very unlikely scenario and burial with no external protection is the most likely scenario).

2.2.6 To estimate the potential volume of sand that could be trapped the porosity of the rock berm must be estimated. This porosity is the ratio of voids (gaps between the rocks) to the rocks. A conservative value for this calculation is a high value, and 0.45 is assumed. Typically a value of 0.2-0.35would be more typical. Table 2 contains an upper bound estimate of the volume of material that could conceivably be "trapped".

Table 2 Estimation of the volume for material for different size rock berms

LENGTH OF BERM (M)	**POTENTIAL "TRAPPED" SAND (m3)**	% of the volume of the Northen tip of the sand bank
5	15.75	0.000066%
10	31.5	0.000131%
20	63	0.000263%
18.5km[1] (export cable allowance)	58,361	0.24%
72.2km[2] (total export can array allowance)	142,781	0.59%

[1,2] 18.5km is the maximum length of cable protection minus cable crossings but including cable ends protection across the export cables (Table 1.24 in APP-070). This is a combined value that represents a total length of individual berms that would be spaced along the export route. It should be noted that these will only be used as a last resort as the primary protection is burial.

2.2.7 To put this in context of the size and proximity to the Margate and Long Sands sand bank a transect is shown below in Figure 6 and Figure 7. Transects at 1:20 and 1:50 scale are provided in Annex A: Transects at 1:20 and 1:50 V:H scale (printed at A3)

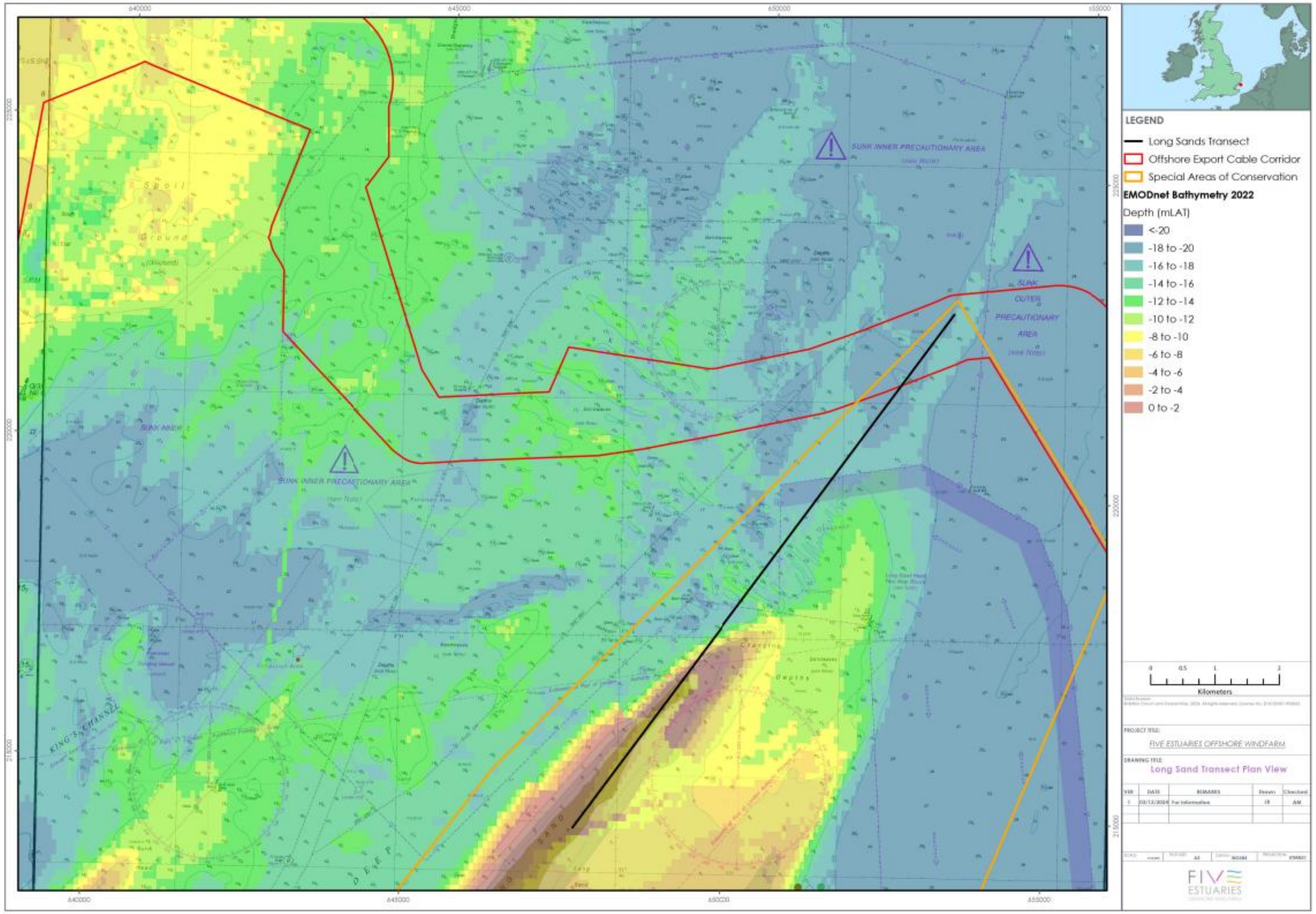


Figure 6 Location of transect from the export cable route to the M&LS northern edge

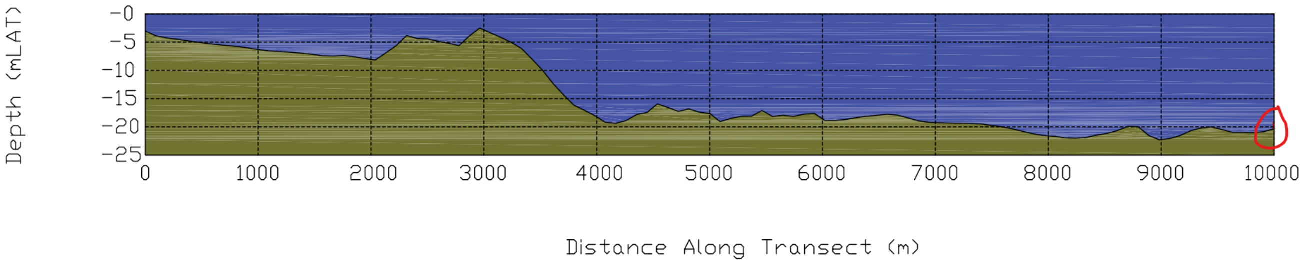


Figure 7 Transect at exaggerated 1:50 Vertical:Horizontal scale with rock berm circled (please see Annex A).

2.2.8 The Applicant cannot find a reported value for the volume of material in the Margate and Long Sands Sand bank, hence a conservative estimate is made below:

Assuming the northern edge of the sand bank in the transect alone and ignoring the rest of the sand bank:

$$A = \frac{a+b}{2}h$$

where A= Area in (m^2), a = smaller width (top) (200m), b = wider width (bottom) (600m), h=height (15m). Please note these values only consider the area circled in the figure and conservatively disregard the sand bank outside this area.

$$A = \frac{200+600}{2}15$$

A= 6000m.

For the 4000m shown in the figure **which is circa 10% of the total length** from the northern tip to the southern this equates to 24 million m^3 of sand.

2.2.9 The Applicant notes that there is no specific studies investigating the impact of cable protection on large scale sand banks such as the M&LS. Studies that have been conducted investigating the impact of offshore wind farms on smaller scale morphological features such as sand waves and concluded that “the direct impact of OWFs on sand waves is expected to be local near offshore wind turbine foundations and not to be significant at a larger scale”[1]. As shown above the scale of the M&LS sand bank (and the wider sediment transport regime of the outer Thames estuary) are many orders of magnitude larger than any potential cable protection.

2.2.10 To support the assertion that the sand bank is controlled by processes that are orders of magnitude larger than the maximum impact of the project, the Applicant refers to the historic movement of the sand bank shown in Figure 8 below.

2.2.11 The volume involved in this movement are in the order of magnitude of hundreds of millions of m^3 of sand each decade.

2.2.12 The Applicant maintains the worst case installation of cable protection in the ECC and array areas combined are many orders of magnitude too small to impact either the M&LS sand bank or the wider sediment transport processes in the area.

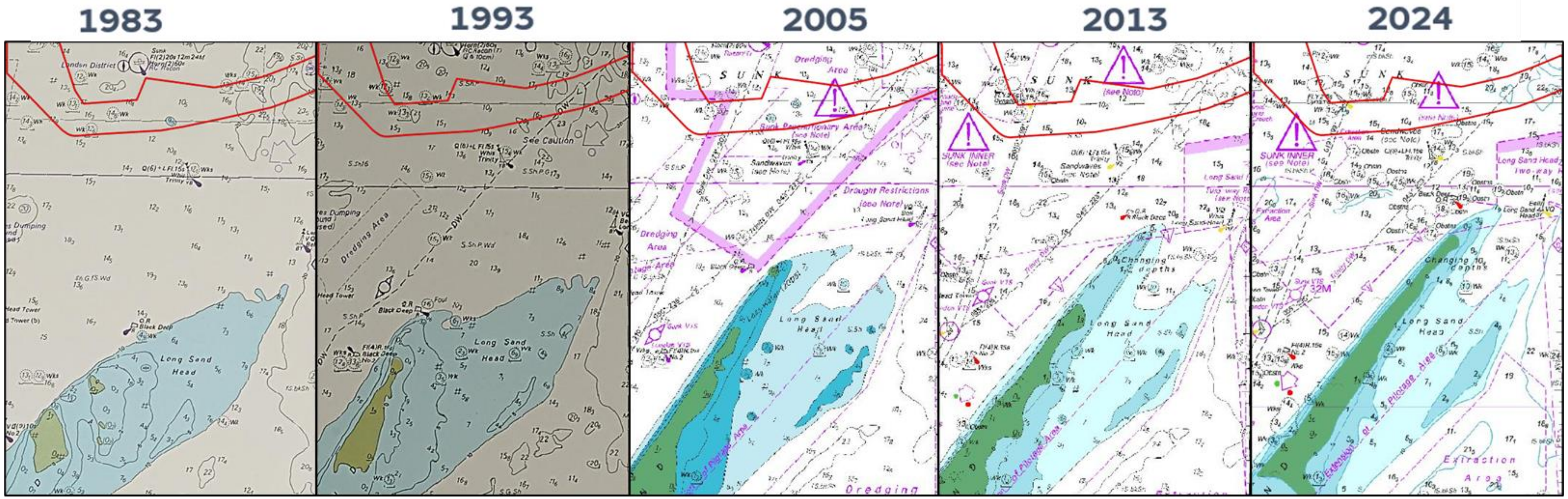


Figure 8 Historic bathymetry of the M&LS shown on marine charts

2.3 CONSTRUCTION IMPACTS ON SEABED MORPHOLOGY

2.3.1 The Applicant has undertaken a detailed assessment of the potential for cable protection measures to interrupt sediment transport pathways within and nearby to MLS SAC, but also within the wider ECC and Array Areas. This is underpinned by a robust understanding of baseline sediment transport processes, developed through analysis of high-resolution geophysical datasets and complemented by numerical modelling of sediment transport pathways.

2.3.2 The Applicant acknowledges that the presence of cable protection could lead to a very small volume of sediment being trapped within the rock voids, whilst a similarly small volume of material could also accumulate on the updrift side of the berms, before the slope reaches an equilibrium position defined by the angle of repose of the accumulated material. However, thereafter sediment can reasonably be expected to be transported at the same rate (and in the same direction) as under baseline conditions. Any indirect changes to sediment transport arising from modification of tidal currents and waves as they interact with the berms will be highly spatially restricted - order of 10's of metres (maximum) from the feature. Given that only very minor changes are expected to the sediment transport regime, any associated morphological impacts are also expected to be very limited. This is reflected in both 6.2.5 Benthic and Intertidal Ecology chapter [APP-074] and the 5.4 Report to Inform Appropriate Assessment [APP-040].

2.3.3 Furthermore, cable crossings, scour protection at foundations (which are at least 830m apart) and foundations are very spatially distant, small and construction occurs in a very short timescale. As a result, there will be no meaningful impact on large scale seabed morphology / morphological features.

2.3.4 This is confirmed by the monitoring and observations of operational wind farms whereby large scale morphological features are not affected by the presence of the assets and only very small scale impacts occur in the form of scour (in the order of magnitude of meters rather than 100s of meters or kms).

2.4 BOULDER CLEARANCE & PRE LAY GRAPNEL RUN

2.4.1 Table 1.3 MDS for Boulder clearance from 6.2.1.1 Detailed Offshore Project Design Envelope [APP-070] is repeated below.

Parameter	Design envelope for export cables	Design envelope of inter-array cables	Total
Length of cable route requiring boulder clearance	25%	25%	N/A
Length of cable route requiring boulder clearance (km)	48.875	50	98.875
Width of boulder plough/ clearance tool (m)	18	18	N/A
Total area of seabed disturbed by boulder plough/ clearance (m^2)	879,750	900,000	1,779,750
Total area of seabed disturbed by boulder clearance (km^2)	0.88	0.90	1.78
Additional isolated boulders in remainder of route which may need cleared with grab type tool	100	200	300

2.4.2 To estimate the length of the cable route requiring boulder clearance (%) and the length of cable route requiring clearance (km) a study has been conducted on the project obtained geophysical data to estimate the number of boulders over the cable route that would have to be relocated to allow cable installation tools to progress unimpeded. The value estimated is an upper bound, and additional more refined survey and detailed routing is likely to reduce this number.

2.4.3 The maximum width of the clearance area is based on the boulder clearance plough width. The final tool however, will be selected after detailed design.

2.4.4 The total area of seabed disturbed by boulder plough/ clearance is the maximum length of cable route requiring clearance multiplied by the width of the boulder plough/ clearance tool.

2.4.5 In the case where there are boulders that can't be moved by a plough because they are sitting too low in the seabed, or are too large but cannot be avoided, then they can be removed by a grab tool.

2.6 FLUIDIZED MATERIAL (50% ASSUMPTION)

2.6.1 Table 1.6 MDS for trial trenching from 6.2.1.1 Detailed Offshore Project Design Envelope [APP-070] is repeated below.

Parameter	Design Envelope		
	Export cables	Inter-array cables	Total
Total length of trial trenching (km)	5	5	10
Maximum burial depth (m)	3.5	3.5	N/A
Maximum installation tool seabed disturbance width (jetting) (m)	18	18	N/A
Total area of seabed disturbed by cable installation (m^2)	90,000	90,000	180,000
Total area of seabed disturbed by cable installation (km^2)	0.09	0.09	0.18
Total volume of sediment disturbed by cable installation[1] (m^3)	78,750	78,750	157,500

2.6.2 The values in this table are estimated with a 50% assumption, regarding the amount of sediment disturbed. This value is used because during the trenching not 100% of the material is dispersed into the water column. An example of this for jetting is shown in the sketch in Figure . Some of the sand is fluidized into the water column and may disperse, however some backfills over the cable. The values in the table for the maximum volume are calculated from a typical average burial depth of 1.75 m, the maximum value of 3.5 m is a maximum indicative value. The actual burial depth will be below the average, hence this value has been used to assess the impact of sediment dispersal on sensitive receptors in the marine environment.

2.6.3

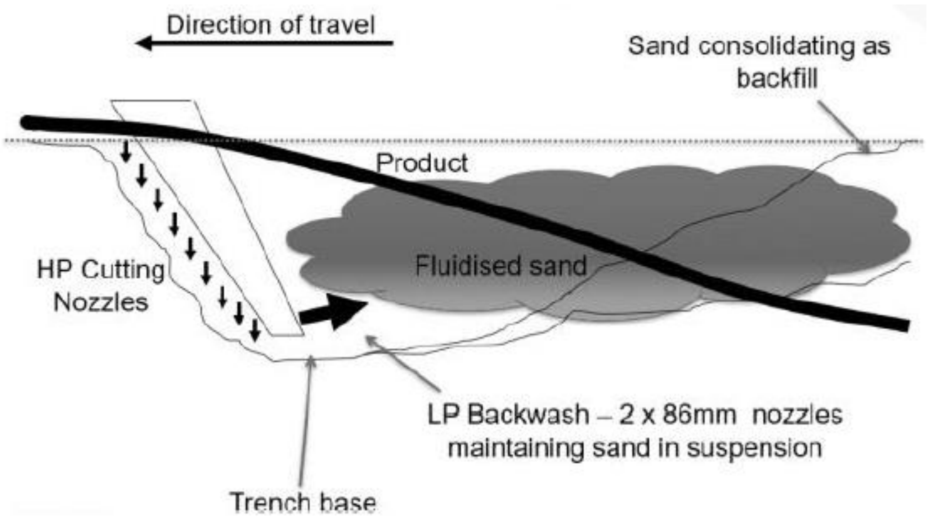


Figure 9 Sediment dispersal during jetting (IMCA Code of Practice for Offshore Cable Laying in the Renewable Energy Industry M264 Rev. 0.1 – November 2023)

2.6.4 The initial calculations in the Environmental Assessment were more realistically based on the assumption of 50% ejected material as provided in the engineering estimate. The summary results (summarised in Paragraph 2.10.7 et seq. in [APP-071]) include any and all activities causing sediment disturbance, some of which are greater than the impact for trenching alone, i.e. cable installation (trenching) with the assumption of 50% ejected material was not the MDS for all potential causes of sediment dispersal and deposition. Following Section 42 consultation, additional internal sensitivity checks were undertaken to confirm that this still applied if an assumption of 100% ejection is also considered. Following this check, the Applicant was satisfied that even using the unrealistic assumption of 100% material ejected during trenching, cable installation would not result in greater sediment disturbance than the assessed MDS.

2.6.5

2.6.6 This position (that cable trenching is not the MDS) has subsequently been reconfirmed following the additional plume modelling contained in [REP1-057] which was undertaken using the assumption of 100% ejected material. The results of the modelling were consistent with those already assessed using other methods in the ES, and therefore the ExA can have confidence that the ES has considered the worst case impacts for sediment disturbance irrespective of the percentage of sediment ejected during trenching.

3. QUESTIONS RELATING TO MARGATE & LONG SANDS SPA [ME.1.07 FROM EXQ1]

3.1 HOW HAS MAXIMUM LENGTH OF CABLE PROTECTION REQUIRED WITHIN MARGATE AND LONG SANDS (MLS) SPECIAL AREA OF CONSERVATION (SAC) BEEN DETERMINED?

3.1.1 Theoretical max single cable length is estimated at circa 2.5 km as shown in Figure below. It can also be seen that the Long Sand Head sand bank feature is 4-5km from the cable corridor and separated by the Long Sand Head two way route (Shipping Lane) used by vessels transiting to the ports.

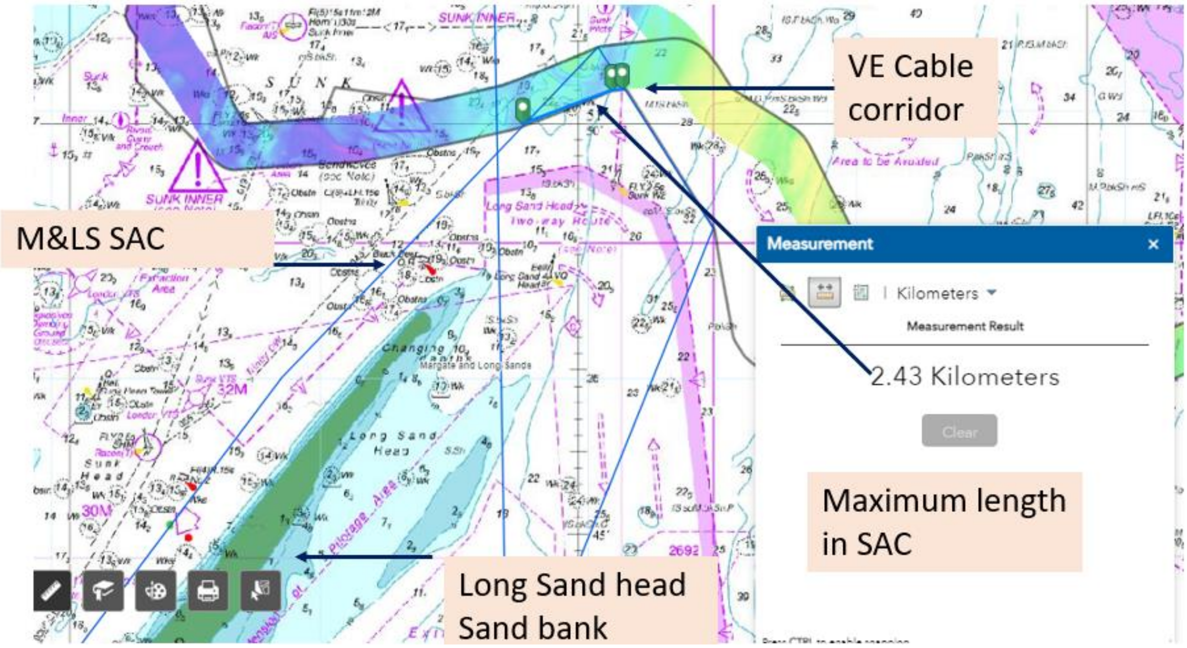


Figure 10 Maximum length of cable in SAC

3.1.2 This would be hugging the southern corridor edge. The project cannot conduct the final routing until post DCO, however the Applicant has committed to the following *"Final cable routing will seek to take the shortest route through the M&LS SAC where possible*" (9.13 Margate and Long Sands SAC Benthic Mitigation Plan [APP-243 Table 9.1]).

3.1.3 In practice this means this will mean that during detailed routing weighting is applied to minimising the length of the cable routes in the SAC. This is then balanced against other constraints such as minimising the time in the vicinity of the sunk pilot diamond to the north to avoid shipping & navigation impacts for the ports, physical constraints on the seabed such as UXO or archaeological features, targeting preferred geology for cable burial, avoiding sand waves etc.

3.1.4 Based on the preliminary work conducted to date this is resulting in indicative routes with between 0.4-1.5km within the SAC.

3.1.5 A highly conservative assumption of 50% of the cable would require protection has then been applied to an assumed routing of 900 m per cable in the SAC. This has been combined with an assumed mattress width of 6m to result in the 5,400 m^2. This value is considered highly conservative by the Applicant and the most likely scenario is that no external cable protection will be used.

3.2 WHAT EFFECTS WOULD THE PRESENCE OF CABLE PROTECTION WITHIN AND OUTSIDE OF THE MLS SAC HAVE IN RELATION TO SEDIMENT TRANSPORT PROCESSES, WITH PARTICULAR REGARD TO ANNEX I SANDBANKS.

3.2.1 The Applicant has undertaken a detailed assessment of the potential for cable protection measures to interrupt sediment transport pathways within and nearby to MLS SAC. This is underpinned by a robust understanding of baseline sediment transport processes, developed through analysis of high-resolution geophysical datasets and complemented by numerical modelling of sediment transport pathways.

3.2.2 The Applicant acknowledges that the presence of cable protection could lead to a very small volume of sediment being trapped within the rock voids, whilst a similarly small volume of material could also accumulate on the updrift side of the berms, before the slope reaches an equilibrium position defined by the angle of repose of the accumulated material. However, thereafter sediment can reasonably be expected to be transported at the same rate (and in the same direction) as under baseline conditions. Any indirect changes to sediment transport arising from modification of tidal currents and waves as they interact with the berms will be highly spatially restricted - order of 10's of metres (maximum) from the feature. Given that only very minor changes are expected to the sediment transport regime, any associated morphological impacts are also expected to be very limited. This is reflected in both 6.2.5 Benthic and Intertidal Ecology chapter [APP-074] and the 5.4 Report to Inform Appropriate Assessment [APP-040].

3.3 HAS THE POTENTIAL FOR THE ADDITION OF FURTHER SCOUR/CABLE PROTECTION, INCLUDING ANY REQUIRED AS A RESULT OF CABLE REPAIR AND REPLACEMENT OR CABLE EXPOSURE DURING OPERATION, BEEN INCLUDED WITHIN THE CALCULATIONS FOR THE WORST-CASE SCENARIO FOR CABLE PROTECTION WITHIN THE MLS SAC? IF SO, WHAT ASSUMPTIONS HAVE BEEN MADE FOR WORST-CASE ASSESSMENTS CONCERNING CABLE PROTECTION EXPOSURE?

3.3.1 The word additional in the context around cable protection as stated in the 5.4 Report to Inform Appropriate Assessment [APP-040] and the 9.13 Margate and Long Sands SAC Benthic Mitigation Plan [APP-243] was with reference to the addition of ‘any’ volume of cable protection should cable burial without any protection not be feasible. For clarity within the context of the assessments, the word additional has been removed from all relevant documents which will be submitted at a future deadline.

3.3.2 The Applicant considers the requirements for cable protection within the SAC has been considered and is covered within the MDS of 5,400 m^2. Available data indicates burial within M&LS SAC is likely to be successful, and as such the 5,400 m^2 of cable protection is highly precautionary.

3.4 WHAT IS PROPOSED IN TERMS OF ANY CABLE PROTECTION AT THE DECOMMISSIONING STAGE FOR THE PROPOSED DEVELOPMENT? HOW HAS THIS BEEN CONSIDERED IN THE ASSESSMENTS?

3.4.1 There is a commitment to remove the cable protection (such as mattresses) from within MLS SAC should any ultimately be required at the point of decommissioning.

3.4.2 The removal of cable protection has been considered as part of the assessment, as decommissioning impacts were assessed as being of a similar size/scale as that of construction (installation of concrete mattresses involves lifting them to the seafloor, while removing is lifting them back up). Whereby there would be a degree of temporary disturbance during the removal of cable protection.

4. RESPONSE TO ME.2.05(F) RELATING TO CABLE REPAIR AND REPLACEMENT [

4.1.1 The Examining Authority has asked the Applicant in examiner's question ME.2.05 [PD-014] to provide 'A full response to the matters raised by Natural England in items B13 [PD2-004] and E6 and E7 in [PD2-006] … in terms of how seabed disturbance from operational cable repairs and replacement has been calculated drawing on experience (including analysis from operational offshore wind farms) and ground type information.'

4.1.2 References B13, E6 and E7 (noting that E6 and E7 relate to [PD2-00**7**]) and the Applicant's updated response is provided below.

NE relevant representation reference	NE statement	VE response
B13	Natural England queries whether the number of array and export cable repairs/replacements over the project lifetime are realistic, as well as how the total impact amounts in Table 1.31 were determined.	Set out below from paragraph 4.1.4, in addition to the response provided in REP1-051 (10.4.1 Applicant's response to Natural England's Relevant Representation)
E6	Natural England advises that there is insufficient detail in particular on proposed Operation and Maintenance relating to the potential placement of scour prevention/cable protection over the lifetime of the project. There is currently no 'workings out' as to how total seabed disturbance has been calculated from cable repairs and replacement e.g. what is the max. length of any one cable repair noting that the total number of repairs is 9 and the total length is 5,000m. And how a figure of 20% for cable/sour replacement has been determined and assessed.	The calculation of total seabed disturbance was set out in response to Natural England's relevant representation at Deadline 1. As stated in this response, cable protection must laid within 10 years of the granting of the order. Replenishment is assumed. The value of 20% is based on a worst case assumption from operational experience. The Base case for engineering is that designs are intended to be "maintenance free were possible".

		The 20% replacement of cable or scour protection is within the assessed MDS for total habitat loss, i.e. would occupy the same area is not additional to it. See Impact 5 in the 6.2.5 Benthic and Intertidal Ecology ES chapter [APP-074].
E7	It is not clear to Natural England what information has been used to determine the maximum length of cable protection required within MLS SAC (i.e. 900 m). It is also not clear whether the potential for the addition of further cable protection has been considered and included within the calculations for MDS/WCS for scour protection within the SAC.	This has been addressed in Section 3 of this document.

4.1.3 Table 1.31 from the Detailed Offshore Project Description APP-070 is shown below. This contains the repair and replacement estimation of seabed disturbance.

Array cables	
Number of array cable repairs/ replacements over project lifetime	8
Seabed disturbance per array cable repair/replacement event (including vessel anchors) (m^2)	34,582
Seabed disturbance volume per array cable repair/replacement event (including vessel anchors) (m^3)	53,762

4.1.4 The Applicant has experience developing and operating offshore wind farms which is drawn on to form assumptions such as the number of array cable replacements over the project lifetime. The value of 8 has been established based on a failure rate of 0.0016 failures / km / year and assuming the maximum 200km of array cables. It is also assumed that the whole cable is replaced rather than being jointed (as is typical for array cables).

4.1.5 This value is higher than the values presented in industry standards such as CIGRÉ (0.000705 failure/ km / year) and DNV (0.0004 failure/km/year). This is intentional because operational data has demonstrated that on average there are significantly more array cables failures than are predicted by these values. This assertion is supported by recent research from the University of Strathclyde 2019 Failure Rates of Offshore Wind Transmission Systems[2]. It should be noted though that the variability is very with a large number of projects having no failures, while some projects have systematic issues and hence many failures.

4.1.6 The uncertainty in these values should be understood and the Applicant makes reference to DNV RP 0360 3.2.4.4 that indicates these values should be considered "order-of-magnitude comparisons". This means that due to the level of certainty it is important to understand the context of these values and assumptions rather than focus on the specific value.

4.1.7 To help the Examination Authority in understanding the reasonableness of this assumption reference is made to Rampion 2 assumed value of 6 for 250 km of cables which is assuming fewer repairs, however research from the University of Strathclyde in 2019 indicates and average value of 0.003 failure/km/year.

4.1.8 In response to Natural England's suggestion to use the operational data from Galloper, the Applicant considers it not appropriate. The industry, technology and installation methods have matured and changed since the Galloper was installed hence the situation is not directly comparable. An example of this is the well documented issue relating to systematic Cable Protection System (CPS) failure due to abrasion on scour protection that led to multiple array cable replacements at numerous wind farms after installation. This was then a recognised issue and addressed by the industry; typically by stabilizing the array cable / CPS systems with rock bags or rock berms; and hence future wind farms will not be affected in the same way. This is an example of a systematic issue that significantly affected some wind farms, while others have 0 failures. This further justifies not using a single wind farm as the basis for the assessment.

4.1.9 The maximum seabed disturbance value in m^3 is calculated as the sum of the value for the anchor penetration for the cable repair vessel (9,382m^2) and the volume per repair needed for the new cable (calculated i.e. 18m wide corridor, the length of an assumed array cable (2.52km) with V-shaped trench 3.5m deep, 50% suspended, and 50% fluidised. The value is an average estimate that is multiplied by the number of assumed replacements. This overcomes the uncertainties with the length of the array cables (as the WTG layouts are not known).

4.1.11 A summary is provided below:

Additional seabed disturbance area to be considered for array cable repairs carried out by vessel utilising anchors (m2) per repair	9382
Indicative anchor penetration depth [m]	1.5
Volume for anchors (m^3)	14,073
Cable installation volume is calculated the same way as for the main installation works, (i.e. 18m wide corridor, with V-shaped trench 3.5m deep, 50% suspended, and 50% fluidised. For a 2520m array cable	39,690
Additional seabed disturbance volume to be considered for array cable repairs carried out by vessel utilising anchors (m3) per repair	53,763 (please not this is 53,762 in Table 1.31 due to rounding in the MDS).

4.1.12 The values of disturbance and number of repairs for the export cables are shown below:

Offshore export cables	
Number of offshore export cable repairs over project lifetime	9
Seabed disturbance per export cable repair event (including vessel anchors) (m^2)	16,205

Seabed disturbance volume per offshore export cable repair event (including vessel anchors) (m3)	25,057

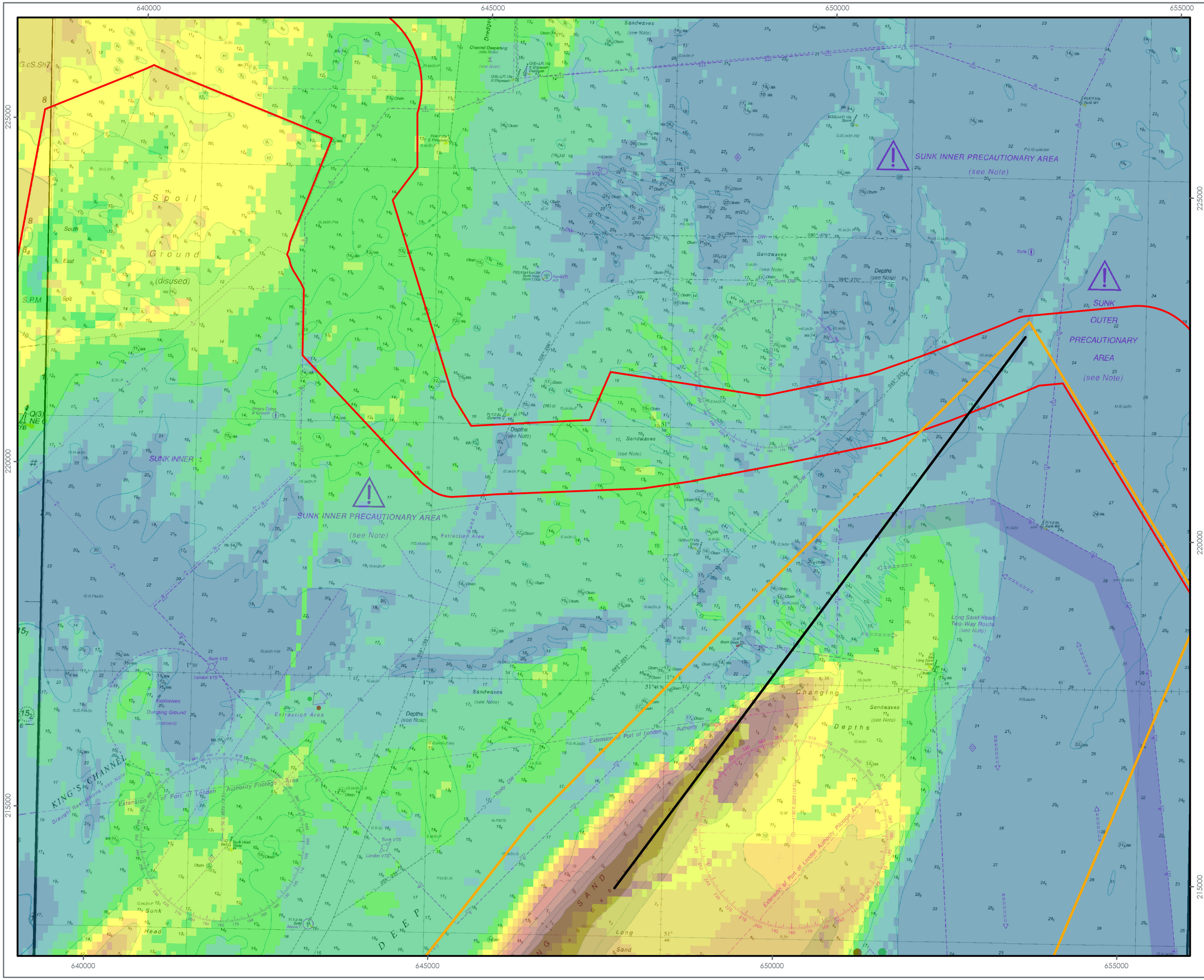
Additional seabed disturbance area to be considered for array cable repairs carried out by vessel utilising anchors (m2) per repair	6205
Indicative anchor penetration depth [m]	1.5
Volume for anchors (m^3)	9,307.5

Cable installation volume is calculated the same way as for the main installation works, (i.e. 18m wide corridor, with V-shaped trench 3.5m deep, 50% suspended, and 50% fluidised. For a 1000m export cable	15,750
Additional seabed disturbance volume to be considered for array cable repairs carried out by vessel utilising anchors (m3) per repair	25,057

4.1.13 The same value of 0.0016 failure / km / year is assumed for the export cables, however an additional failure is added to cover the increased risk of damage during installation of the export cable. This relates to experience from previous projects where export cables have been damaged during installation.

4.1.14 For the export cables it is assumed that the cable is jointed rather than wholly replaced.

ANNEX A: TRANSECTS AT 1:20 AND 1:50 V:H SCALE (PRINTED AT A3)



LEGEND

- Long Sands Transect
- Offshore Export Cable Corridor
- Special Areas of Conservation

EMODnet Bathymetry 2022

Depth (mLAT)

- <-20
- -18 to -20
- -16 to -18
- -14 to -16
- -12 to -14
- -10 to -12
- -8 to -10
- -6 to -8
- -4 to -6
- -2 to -4
- 0 to -2

0 0.5 1 2

Kilometers

Data Source:

PROJECT TITLE:

FIVE ESTUARIES OFFSHORE WINDFARM

DRAWING TITLE:

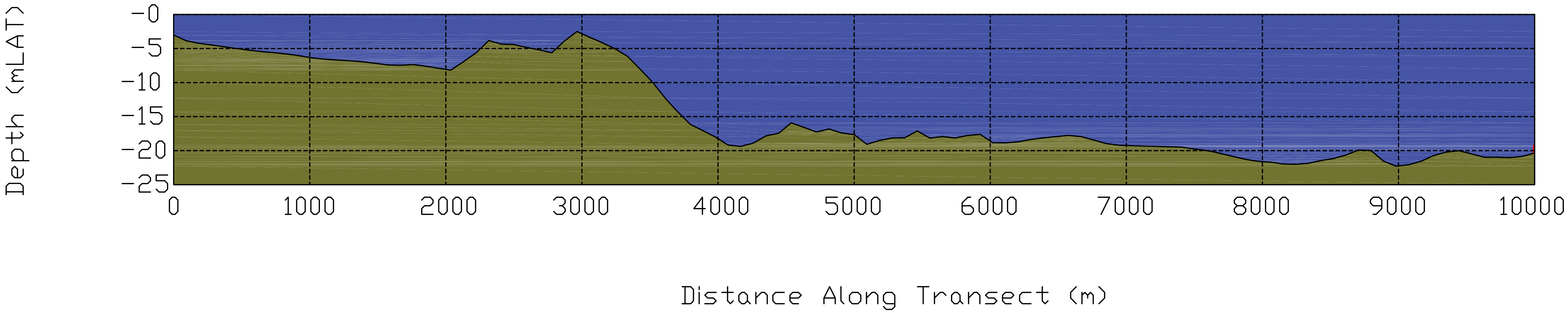
Long Sand Transect Plan View

VER	DATE	REMARKS	Drawn	Checked
1	03/12/2024	For Information	JB	AM

SCALE: 1:50,000	PLOT SIZE: A3	DATUM: WGS84	PROJECTION: UTMN31

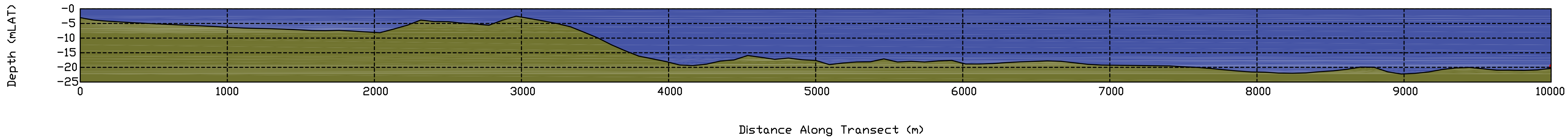
FIVE ESTUARIES OFFSHORE WIND FARM

EMODnet BATHYMETRY (2022) LONG SAND PROFILE



V:H scale 1:50

EMODnet BATHYMETRY (2022) LONG SAND PROFILE



V:H scale 1:20