Dublin Array
Generation for generations

EIAR Volume 4: Offshore Infrastructure Technical Appendices
Appendix 4.3.1-5
Physical Processes Modelling and Design Options Comparison Report

Kish Offshore Wind Ltd

RWE SLR GoBe APEM Group

www.dublinarray-marineplanning.ie

Dublin Array Offshore Wind Farm

Environmental Impact Assessment Report

Volume 4, Appendix 4.3.1-5: Physical Processes Modelling and Design Options Comparison Report

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Acronyms

Term	Definition
Dublin Array	Dublin Array Offshore Wind Farm
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
DAPPMS	Dublin Array Physical Process Modelling System
IAC	Inter-array Cables
km	Kilometres
MFE	Mass Flow Excavator
MDO	Maximum Design Option
Offshore ECC	Offshore export cable corridor
OSP	Offshore Substation Platform
OWF	Offshore Wind Farm
PT	Particle Tracking
RWCS	Realistic Worst Case Scenario
SSC	Suspended Sediment Concentration
SW	Spectral Wave
TSHD	Trailer Suction Hopper Dredger
WTG	Wind Turbine Generator

1 Introduction

1.1.1 Dublin Array Offshore Wind Farm (Dublin Array) is a proposed offshore wind farm on the Kish and Bray banks located, approximately, 10 km off the east coast of Ireland. As part of the Environmental Impact Assessment (EIA) process for Dublin Array, physical processes modelling was carried out by Intertek Energy and Water Consultancy Services (Intertek) in 2021 to inform the EIA Report (EIAR).

1.1.2 In the intervening period between completion of the modelling and finalisation of the EIAR, some of the pertinent project details that informed the analysis have been refined during the process of design iteration relating to advances in technology and increased understanding of the site. This report records a review of the numerical modelling undertaken against the revised design scenarios which have been assessed in the EIAR (hereafter referred to as the Maximum Design Option (MDO)) to confirm that the model outputs provide an appropriate basis for assessment.

1.1.3 This appendix should be read in conjunction with the following documents:

- Volume 3, Chapter 1: Marine Geology, Oceanography and Physical Processes (hereafter referred to as the Physical Processes Chapter);
- Annex B of the Physical Processes Chapter: Physical Processes Design Options (hereafter referred to as the Physical Processes Design Options Annex);
- Volume 4, Appendix 4.3.1-2: Physical Process Modelling for Dublin Array Offshore Wind Farm (hereafter referred to as the Physical Processes Modelling Report);
- Volume 4, Appendix 4.3.1-3: Hydrodynamic Calibration and Validation Report (hereafter referred to the Hydrodynamic Calibration and Validation Report); and
- Volume 4, Appendix 4.3.1-4: Spectral Wave Model Calibration and Validation Report (hereafter referred to as the Spectral Wave Model Calibration and Validation Report).

1.1.4 Full details of the methodology used in the physical processes modelling is provided in the Physical Processes Modelling Report. The suite of numerical models developed for the study are collectively termed the Dublin Array Physical Process Modelling System (DAPPMS), which includes a hydrodynamic model, a Spectral Wave (SW) model and a Particle Tracking (PT) model. The modelling includes an assessment of the potential impacts of Dublin Array upon the local hydrodynamics and wave climate, in addition to likely sediment dispersion and deposition resulting from construction activities associated with the Offshore Wind Farm (OWF) construction.

1.1.5 The infrastructure and activities modelled were identified as the Realistic Worst Case Scenario (RWCS) from the Project Description available at the time of modelling in 2021. It is important to note that the term 'RWCS' was used at the time of modelling as a way of identifying the parameters that lead to the greatest potential for impact. Terminology has since been revised, with the term 'MDO' being used in its place within the EIAR, and therefore referenced as appropriate within this document. Full detail and justification of these parameters, henceforth referred to as the "modelled scenarios", are provided in the Physical Processes Modelling Report. The following sections of this document will compare these modelled scenarios to the MDO, in order to provide justification that the modelled scenarios, although in some cases precautionary in comparison to the MDO, are nevertheless representative of the activities taken forward for assessment.

1.1.6 The DAPPMS has been constructed according to industry best practice and has undergone a full calibration and validation process. The data sources used for the study along with details of the DAPPMS calibration are reported in the Hydrodynamic Calibration and Validation Report (Intertek, 2020a) and the Spectral Wave Model Calibration and Validation Report (Intertek, 2020b). Since the model development, there have been no major changes to the large-scale hydrodynamic and morphological characteristics of the study area and therefore this model is considered to provide a realistic characterisation of the typical tidal and wave climate conditions at the site.

2 Comparison of model scenarios to the MDO

2.1.1 Three Wind Turbine Generator (WTG) layout options are being considered as part of the MDO, key details of which are summarised in Table 1.

Table 1 Summary information for WTG layout options for Dublin Array

	Option A	Option B	Option C
Maximum Number of turbines	50	45	39

2.2 Impacts on the Hydrodynamic Regime and Wave Climate

2.2.1 An indicative layout and foundation type was modelled to assess the impact of 'blockage effects' on local hydrodynamics and wave climate from the array infrastructure. This refers to the modification of the surrounding tidal currents and wave climate from the presence of structures on the seabed and within the water column. The layout, as presented within the Physical Processes Modelling Report, was modelled using the DAPPMS hydrodynamic and SW model in order to assess the impacts of the operational phase of the Dublin Array OWF, including analysis of changes to bed shear stress.

2.2.2 The RWCS, used to establish the indicative array within the modelled scenarios, is the net effect of all structures comprising the maximum number planned across the array area, which at the point of modelling included a total of 61 WTGs, in addition to two meteorological masts and three Offshore Substation Platforms (OSPs).

2.2.3 The modelled scenarios represent the foundation blockage of an array of 61 structures, based on 3-legged bucket foundations and a corresponding maximum pin-pile diameter of 6.5 m. The blockage coefficient for these scenarios is 25,635, as outlined in the Physical Processes Modelling Report. The blockage co-efficient for each foundation option is based on the total effective vertical cross-sectional area as presented to oncoming flows or waves, as applied in the Morisons Equation (Morison *et al.*, 1950).

2.2.4 An updated review of foundation options has been carried out, drawing on project description information and design drawings, in order to identify the current MDO for the design parameters. This is presented in Annex A. Based on this review, an array of 45 WTGs (Option B) with 4-legged bucket foundations is considered to have the highest array-scale blockage compared to other foundation types, with a blockage coefficient of 19,381. This is presented alongside the blockage coefficient in the modelled scenarios in Table 2.

Table 2 Comparison of MDO and modelled scenario parameters for array scale blockage coefficient[1]

	Modelled Scenario	Maximum Design Option (MDO)
Maximum array-scale blockage coefficient	25,635	19,381

2.2.5 The MDO therefore represents a reduction of, approximately, 24% in the maximum array-scale blockage coefficient. Given that all other parameters represented in the model (e.g., hydrodynamic conditions) remain consistent, the results of the modelled scenario, whilst precautionary, are considered to provide an appropriate basis for assessment of the MDO.

Scour around seabed structures

2.2.6 Scour around seabed structures occurs due to localised flow blockage, causing a compensatory acceleration of flow around the structure that may cause localised increases in bed shear stress, and potential further erosion. Scour is not modelled within the DAPPMS, however, a quantified assessment of the scour potential around the array area infrastructure is provided in the Physical Processes Modelling Report. This is presented in Table 3 alongside the total area susceptible for local scour calculated for the MDO for the design parameters to be taken forward to assessment, as outlined in the Physical Processes Design Options Annex. This value quantifies the potential maximum area that could develop during the period prior to scour protection being installed.

2.2.7 The scale of scouring is mainly related to the scale and shape of the structure as well as generalised sediment properties such as the angle of repose. For slender cylindrical monopiles, the scour depth is a function of the pile diameter, and a near-circular form of scour is created. Scour holes will continue to deepen and widen until equilibrium scour depth is reached, which eventually accommodates and dissipates the increased flow velocities and near-bed vortices. The quantitative estimate of total area susceptible to local scour, provided in Table 3, assumes that the width of scour development (to the equilibrium scour depth) is equal to 4D, where D is the diameter of the pile. This calculation has been applied in the same manner for both the modelled scenario and the MDO, with further details provided in the Physical Processes Modelling Report and Physical Processes Design Options Annex, respectively. Only foundations including piles are considered due to design considerations[2]. Of note is that this estimate is provided for the assessment of potential impacts on environmental receptors and is not intended for any engineering purposes.

[1] As calculated using the Morisons Equation (Morison *et al*., 1950).
[2] As outlined in the Physical Processes Modelling Report, for multi-pile foundations the suction bucket option includes stiffeners which are considered to mitigate turbulent effects around the base of the foundation, as well as the top of the bucket acting as a non-erodible surface.

Table 3 Comparison of MDO and modelled scenario parameters for total area susceptible to local scour

	Modelled Scenario	Maximum Design Option (MDO)
Maximum total area of scour for the array	119,282 m^2	95,567 m^2

2.2.8 The modelled scenarios represent the potential area susceptible to scour for an array of 45 WTGs with monopile foundations, with a total area of 119,282 m^2. An updated review of foundation options has identified the MDO for the design parameters to be taken forward to assessment. Based on this review, an array of 45 WTGs (Option B) with monopile foundations is considered to result in the largest scour area compared to other foundation types, with a total area of 95,567 m^2.

2.2.9 The MDO therefore represents a decrease of, approximately, 20% in the maximum total area susceptible to local scour. Given that scour is not modelled within the DAPPMS, the value for the MDO can be treated as superseding the value identified in the Physical Processes Modelling Report and is assessed, as appropriate, within the Physical Processes Chapter.

2.3 Impacts on the Sediment Regime

2.3.1 Seabed disturbance is generally a response to a short-term activity which typically occurs during installation and decommissioning periods which may result in sediment plumes and subsequent deposition. This may also occur during the operational life of the wind farm as a result of maintenance or repair activities (such as potential cable reburial); however, this will be of a lower frequency and lesser magnitude than activities taking place during the construction or decommissioning phases. A range of seabed disturbance scenarios, identified within the Physical Processes Modelling Report, were modelled using the DAPPMS PT model in order to assess the impacts of the various activities during the construction phase that will disturb or release fine fraction sediments into the water column. Proposed activities represented in the modelling include:

- Seabed preparation for foundations for structures within the array area;
- Drilling of foundation piles;
- Pre-construction sweeping of cable route:
    - Inter-array cables (IAC); and
    - Export cable route.
- Cable trenching:
    - Inter-array cables; and
    - Export cable route.

2.3.2 Full details of the modelled scenarios are provided in the Physical Processes Modelling Report, with the location of all seabed disturbance scenarios displayed in Figure 1. A description of each scenario is provided in the following sections, alongside a comparison to the MDO for the design parameters to be taken forward to assessment.

2.3.3 Modelled scenarios relate to the activity of a vessel of defined characteristics, such as a dredger of defined size, a drilling rig of defined drill rate, or cable installation tools with defined dimensions. As processes such as dredging or cable trenching occur over timescales of days and weeks, this approach simulates a unit impact, such as one full dredger hopper load or equivalent unit time for cable trenching. The full impact of sediment disturbance and deposition (identified as the MDO in the Physical Processes Chapter) must be calculated by multiplying up the modelled unit impact by the required number of events to complete the specific task. As plumes of elevated Suspended Sediment Concentration (SSC) arising from installation and preparation activities are seen to disperse within hours of the completion of the task, this process is transient, and not an additive effect.

2.3.4 A key parameter for modelling the behaviour of disturbed sediment is the settling velocity for material displaced into the water column, with coarse grained sediments (e.g. gravels and coarse sands) falling out of suspension relatively quickly in comparison to finer grained sediments (e.g. fine sands, silts, and clays), and therefore having less opportunity to be advected away from the source of the disturbance. The modelling scenarios are based on a review of available seabed sediment datasets across the study area, as outlined in the Physical Processes Modelling Report, which include both generalised mapping and sediment grab samples collected over a period between 1980 and 2020. Due to the nature of the wider geomorphological and hydrodynamic processes that influence the nature of surficial seabed sediments, the composition identified within this mapping is anticipated to be reflective of current sedimentological conditions, and therefore appropriate for the assessment.

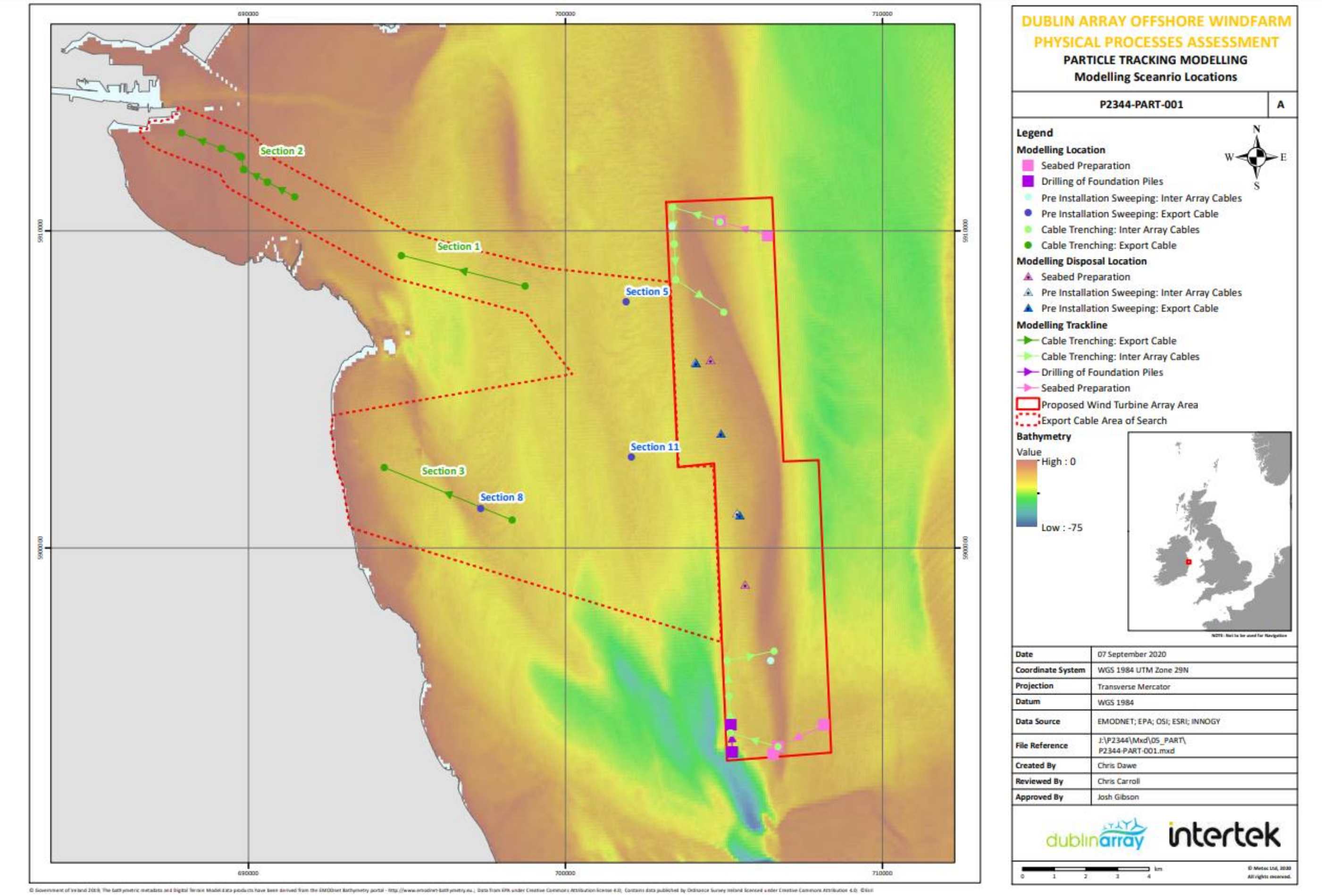

Figure 1 Dublin Array OWF Modelled Scenario Locations (Intertek, 2020)[3]

[3] This figure is taken from the Physical Processes Modelling Report, which was written at an earlier project stage, and therefore the Proposed Wind Turbine Array area and Export Cable Area of Search are not reflective of those being applied for as part of the Dublin Array infrastructure.

Seabed Preparation Around Foundations

2.3.5 Seabed preparation scenarios examine the pre-construction activities to level the seabed for foundations, following a dredger undertaking seabed clearance until the hopper is full of cleared material. During this phase, overspill is likely to develop as a near-surface sediment plume composed primarily of fine sediments. Once each hopper is filled, the dredger would make its way to a nominated disposal site and release the spoil to the bed, represented as an instantaneous bed release.

2.3.6 The modelling scenarios represent the sequential dredging of two WTG locations, each with 3,675 m^3 of sediment removed, for an equivalent excavation volume of 7,350 m^3. A total of four scenarios were modelled in order to examine the activity of one dredger load on both the Kish and Bray banks on spring and neap tides. As outlined in the Physical Processes Design Options Annex, the greatest volume of sediment to be excavated per foundation is 3,997 m^3 for the design parameters to be taken forward to assessment. This is presented alongside the volume per foundation excavated in the modelled scenarios in Table 4.

Table 4 Comparison of MDO and modelled scenario parameters for seabed preparation around foundations

	Modelled Scenario	Maximum Design Option (MDO)
Maximum spoil volume per foundation	3,675 m^3	3,997 m^3

2.3.7 As outlined in Paragraph 2.3.4, the modelled scenarios are based on sediment characterisation across the study area, including both generalised mapping and sediment grab samples. Details of the specific sediment samples relevant to seabed preparation at foundation sites are provided in the Physical Processes Modelling Report, with variation between the northern and southern release scenarios reflecting the differences in seabed composition between the Kish and Bray banks. Due to the long-term nature of the wider geomorphological and hydrodynamic processes that influence the nature of surficial seabed sediments, the seabed composition identified within this mapping is unlikely to have undergone significant changes since the collection of grab samples (collected between 1980 and 2020) and is therefore considered to represent an appropriate parameterisation of sediment type.

2.3.8 The MDO therefore represents an increase of, approximately, 8% in the maximum spoil volume excavated per foundation, which is considered as generally comparable considering the large scales of the receiving environment. Given that all other parameters represented in the model, including the generalised sediment type and hydrodynamic conditions, remain consistent with those identified at the site location, the results of the modelled scenario are considered to provide an appropriate basis for assessment of the MDO.

Drilling of Foundation Piles

2.3.9 Drilling for foundation piles will produce drill cuttings, with the potential to lead to elevated SSC within a plume that advects away from the point of discharge. Foundation pile drilling scenarios represent cuttings released from the surface of a drilling rig while the drill bit is driven into the seabed, resulting in a continuous release of sediment during the drilling process.

2.3.10 The modelling scenarios simulate drilling at two indicative foundation sites, with 8,760 m^3 of drill cuttings produced at each foundation. The model was run for both a mean spring and mean neap scenario, with the sediment release occurring intermittently over a period of 5.5 days. As outlined in the Physical Processes Design Options Annex, the greatest volume of drill arisings per foundation is 9,291 m^3 for the design parameters to be now taken forward to assessment. This is presented alongside the volume of drill arisings per foundation in the modelled scenarios in Table 5.

Table 5 Comparison of MDO and modelled scenario parameters for the drilling of foundation piles

	Modelled Scenario	Maximum Design Option (MDO)
Maximum drill arisings arisings per foundation	8,760 m^3	9,291 m^3

2.3.11 Since the relative proportion of sediment sizes within drill cuttings is unknown at this time, the modelling assumed a 50% split between material likely to disperse more widely (fine sands and smaller) and material that is likely to form a cuttings pile (medium sands and coarser). This is in order to provide the basis for assessment both for the creation of elevated SSC, and the creation of spoil mounds from drilling operations. Further detail of the modelled scenarios is provided in the Physical Processes Modelling Report.

2.3.12 The MDO therefore represents an increase of, approximately, 6% in the maximum spoil volume excavated per foundation, which is considered as generally comparable, considering the large scales of the receiving environment. Given that all other parameters represented in the model, including assumptions on sediment composition, and prevailing hydrodynamic conditions, remain consistent with those identified at the site location, the results of the modelled scenario are considered to provide an appropriate basis for assessment of the MDO.

Pre-installation Sweeping of Cable Routes

2.3.13 To ensure effective burial below the level of the stable seabed thus minimising the requirement for remedial repairs, it may be necessary (in places) to first remove areas of sandwaves through the use of a Trailer Suction Hopper Dredger (TSHD) before cables may be installed into the underlying seabed sediments. The pre-construction sweeping scenarios simulate the use of a dredger at a fixed location releasing an overspill discharge of sediments while clearance is undertaken. On completion, the hopper load is released as an instantaneous discharge at a nominated spoil disposal ground.

2.3.14 Scenarios were modelled both for activities within the array area and the export cable corridors. Within the array area (for inter-array cabling operations), a total of four scenarios were modelled over mean spring and mean neap tides on the Kish and Bray Banks, respectively, with modelling locations shown in Figure 1. For the export cable, a total of three locations (Section 5, Section 11, and Section 8)[4] were modelled over spring and neap tides, respectively. The locations are shown in Figure 2, located over potential routes considered at the time of modelling, with justification for the selection of these locations provided in the Physical Processes Modelling Report.

2.3.15 All modelling scenarios consider both dredge overspill and the fate of spoil disposal from a TSHD of an assumed capacity (nominally 11,000 m^3) at indicative spoil sites. The resulting plumes are based on a characterisation of sediment composition at the identified clearance locations, with details provided in the Physical Processes Modelling Report. The seabed composition identified within this mapping is unlikely to have undergone significant changes since the collection of grab samples and is therefore considered to represent an appropriate parameterisation of sediment type.

[4] As outlined in the Physical Processes Modelling Report, Sections 8, 12, and 14 (as shown in Figure 2) are all based on the same sediment information and have a similar area of effect. A generalisation of effect can therefore be assumed from a single section, and as such Sections 12 and 13 have not been modelled separately.

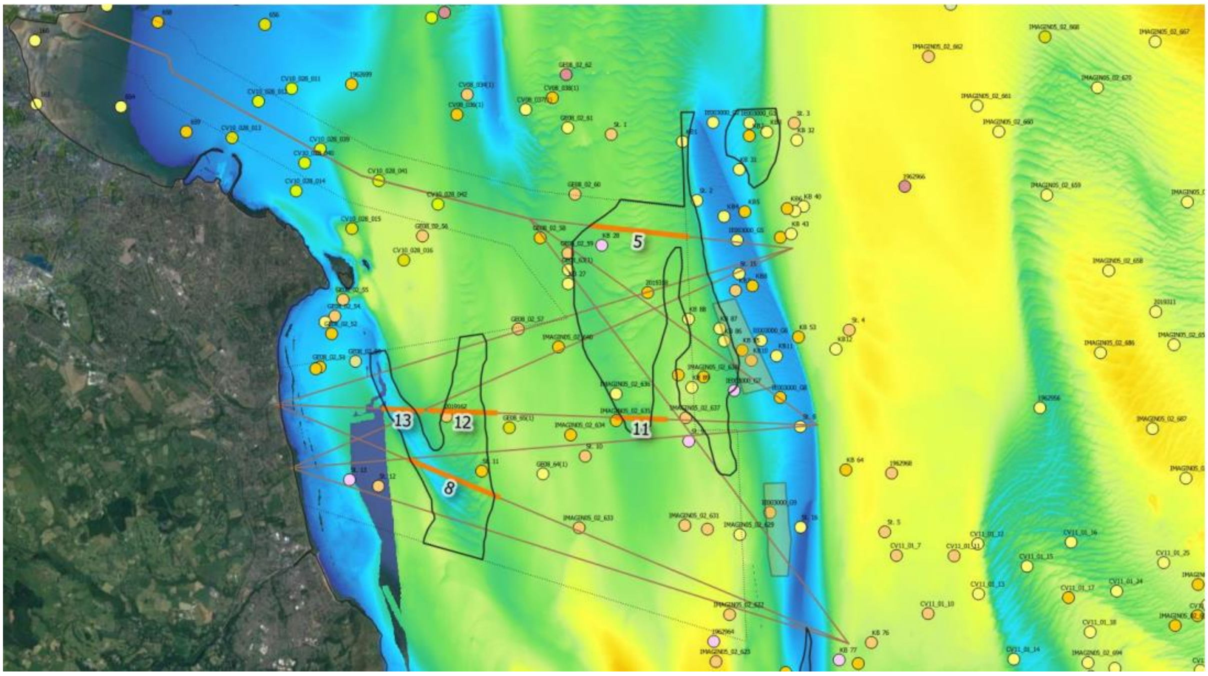

Figure 2 Sections of sandwave clearance within the modelled scenarios (Cooper Marine Advisors Ltd, 2020[5])

2.3.16 As outlined in paragraph 2.3.2, each modelling scenario simulates a unit impact, in this case one full hopper load. Plumes of elevated SSC are seen to disperse within hours of the completion of the task, and this process is therefore transient, and not an additive effect. As such, although overall total volumes (e.g. of sediment disturbed by sandwave clearance) may have changed from an earlier Project stage, the MDO is compared to the modelled scenarios in terms of unit impact, rather than overall total.

2.3.17 All model scenarios for the array area, and four out of the six modelled for the export cable routes (Section 8 and Section 11) represent construction operations that are expected to occur in the same way and the same approximate location within the current MDO, as those assessed at the time of modelling. Although two scenarios, modelled for Section 5 (see Figure 2), are no longer spatially applicable (as they are located outside the current offshore ECC), the exclusion of these results will not result in a change to the assessment of overall magnitude of these activities. Given that all other parameters represented in the model, including the generalised sediment type and hydrodynamic conditions, remain consistent with those identified at the site location, the results of the modelled scenario are considered to provide an appropriate basis for assessment of the MDO.

[5] Source contained as Appendix E of Intertek 2021 (Volume 4: Appendix 4.3.1-2 of this EIAR)

Cable Burial

2.3.18 Cable burial scenarios simulate the movement of a vessel-towed Mass Flow Excavator (MFE) tool along a series of transects between turbine sites (for the IAC) and sections of export cable, with sediments released continuously at the bed while trenching is underway. Scenarios were modelled both for activities within the array area and the export cables (modelling locations shown in Figure 1), with the MFE tool represented as a continuous moving source along a section of cable at a rate of 180 m/hr.

2.3.19 The parameters for MFE used within the modelled scenarios are presented in Table 6, with the disturbance for fluidised sediment provided as 7,194 m^3/hr for IAC, and 10,278 m^3/hr for export cables. The use of MFE has been considered as the RWCS in the modelled scenarios as it has the greatest potential for sediment disturbance impacts associated with cable installation, as outlined in Physical Processes Design Options Annex. However, for the methodology to be taken forward to assessment for Dublin Array, the use of MFE is expected as the method to backfill a trench excavated using ploughing techniques. As a conservative assumption, the MDO as presented within the Physical Processes Chapter is therefore represented by the maximum sediment volume disturbed from ploughing in addition to the sediment volume disturbed from two MFE passes to return spoil berms either side of the trench to their original position, in order to form a combined total for assessment purposes.

2.3.20 Parameters for both MFE and ploughing for the design parameters to be taken forward to assessment are therefore presented in Table 6 alongside the modelled scenarios. For parameters to be taken forward to assessment, the disturbance for fluidised sediment is 1,800 m^3/hr for MFE for both IAC and export cables. Ploughing techniques involve the controlled displacement of sediment on the seabed, with an effective spill factor of 15% assumed based on the surficial sediment characterisation across the site. The disturbance rate for ploughing is therefore estimated as 45 m^3/hr for both IAC and export cables.

Table 6 Comparison of MDO and modelled scenario parameters for cable trenching operations

	Modelled Scenario	Maximum Design Option (MDO)
Inter-array cables (IAC)	**<u>Method</u>**: Mass Flow Excavator (MFE) **Assumptions:** ▪ Trench width = 5.71 m; ▪ Trench depth = 7 m; ▪ Cross-sectional area = 40 m^2; and ▪ Trenching rate = 180 m/hr. **Disturbance for fluidised sediment:** 7,195 m^3/hr or 2.0 m^3/s	**<u>Method</u>**: MFE **Assumptions:** ▪ Disturbance width = 10m; ▪ Disturbance depth = 1 m; ▪ Cross-sectional area = 10 m^2; and ▪ Trenching rate = 180 m/hr. **Disturbance for fluidised sediment:** 1,800 m^3/hr or 0.5 m^3/s **<u>Method</u>**: Ploughing

	Modelled Scenario	Maximum Design Option (MDO)
		Assumptions: ▪ Trench width = 12 m; ▪ Trench depth = 3 m; ▪ Cross-sectional area = 1.5 m^2; ▪ Effective spill factor = 15%; and ▪ Trenching rate = 200 m/hr. **Disturbance for fluidised sediment:** 540 m^3/hr or 0.15 m^3/s
Export cables	<u>**Method**</u>: MFE **Assumptions:** ▪ Trench width = 5.71 m; ▪ Trench depth = 10 m; ▪ Cross-sectional area = 57.1 m^2; and ▪ Trenching rate = 180 m/hr. **Disturbance for fluidised sediment:** 10,278 m^3/hr or 2.9 m^3/s	<u>**Method**</u>: MFE **Assumptions:** ▪ Disturbance width = 10 m; ▪ Disturbance depth = 1 m; ▪ Cross-sectional area = 10 m^2; and ▪ Trenching rate = 180 m/hr. **Disturbance for fluidised sediment:** 1,800 m^3/hr or 0.5 m^3/s <u>**Method**</u>: Ploughing **Assumptions:** ▪ Trench width = 12 m; ▪ Trench depth = 3 m; ▪ Cross-sectional area = 18 m^2; ▪ Effective spill factor = 15%; and ▪ Trenching rate = 200 m/hr. **Disturbance for fluidised sediment:** 540 m^3/hr or 0.15 m^3/s

2.3.21 As indicated on Figure 1, three representative sections of export cable were modelled as the RWCS, two of which are associated with the (now removed) offshore ECC route to Poolbeg, which was being considered during earlier stages of the Project development. Although four scenarios, modelled for Section 1 and 2 for spring and neap, respectively, are no longer applicable, Section 3 is considered to reflect an appropriate proportion of the current offshore ECC route., The exclusion of the results modelled for Sections 1 and 2 will not result in a change to the assessment of overall magnitude of these activities.

2.3.22 As outlined in paragraph 2.3.2, each modelling scenario simulates a unit impact, in this case sections of cable trenching. Plumes of elevated SSC are seen to disperse within hours of the completion of the task, and this process is therefore transient, and not an additive effect. As such, although overall total volumes (e.g. of sediment disturbed by sandwave clearance) may have changed from an earlier Project stage, the MDO is compared to the modelled scenarios in terms of unit impact, rather than overall total. All model scenarios for the array area, and two out of the six modelled for the export cable routes (Section 3) represent construction operations that are expected to occur in the same way within the current MDO, as those assessed at the time of modelling.

2.3.23 The MDO is therefore represented by a lower disturbance for fluidised sediment for both the IAC and export cables, of the order of 75% to 82% less for MFE, with disturbance values for ploughing approximately 95% lower. The results of the modelling therefore reflect a highly precautionary scenario. Given that all other parameters represented in the model, including the generalised sediment type and hydrodynamic conditions, remain consistent with those identified at the site location, the results of the modelled scenario are considered to provide an appropriate basis for assessment of the MDO.

3 Conclusion

3.1.1 Physical processes modelling was carried out by Intertek in 2021 in order to provide support for the preparation of the EIAR for the Dublin Array OWF. Since this modelling, refinement of project parameters have taken place, resulting in the identification of an updated MDO for the design parameters to be taken forward to assessment. However, as demonstrated in the previous sections, the parameters used within the modelling scenarios are generally comparable to those that now represent the MDO, representing either an increase of less than 10% (for discrete scenarios), or a reduction. Increases of less than 10% are considered as generally comparable for discrete unit scenarios given the large scale of the receiving environment. Furthermore, since the model development, there have been no major changes to the large-scale hydrodynamic, sedimentological, and morphological characteristics of the area. Therefore, this model is considered to provide a realistic characterisation of the typical tidal and wave climate conditions at the site. In conclusion, the modelled scenarios, although in some cases precautionary in comparison to the MDO, are nevertheless representative of the activities taken forward for assessment.

4 References

Intertek (2020a). ‘Dublin Array Offshore Windfarm: Hydrodynamic Calibration and Validation Report.’ R2344_R4968_Rev1.

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Annex A: Updated Array Scale Blockage Coefficient

Table 7. Relative comparison of array-scale blockage coefficient for each foundation type and array option.

Foundation Option	Array Option		
	50 * 15 MW	45 * 18 MW	39 * 22 <W
Monopile	12,000	11,700	10,140
3-legged pile	15,971	15,759	13,781
4-legged pile	17,999	17,766	15,757
3-legged bucket	17,620	17,580	15,431
4-legged bucket	19,369	**19,381**	17,017

Assumptions:

a. Table 7 represents an update to the review of a realistic worst-case foundation option for the Dublin Array OWF and supersedes the previous review (Cooper Marine Advisors, 2020 within Intertek, 2021). The updated review draws on information provided by RWE in April 2024 which includes a copy of the latest design drawings and project description information (Issue 4.5).

b. The blockage coefficient is based on the total effective vertical cross-section area for all wind turbine foundations within the array, as presented to oncoming flows or waves, as applied in Morisons Equation.

c. Relevant conservatisms have been applied in the estimation of the blockage coefficient.

d. The monopile dimensions ignore tapering in the pile diameter towards the base of the transition piece.

e. Values for a 4-legged jacket structure assume the maximum effective area when the orientation of the foundation is at 45 degrees to incident waves or flows, noting incident conditions will not always occur at 45 degrees.

f. The solidity factor for a 4-legged structure is estimated as 0.4, i.e. 40% of the vertical plan area is represented by solid structures (i.e. main legs and cross-braces).

g. The solidity factor for a 3-legged structure is estimated as 0.5, i.e. 50% of the vertical plan area is represented by solid structures (i.e. a slightly denser configuration than the 4-legged structure).

h. A representative water depth of 20 m is used at all sites.

i. The contribution of the OSP is not included but would be the same in each case, independent of the foundation option and turbine capacity.

j. The array size is assumed constant in each case. When the useable array area is considered there is a slight moderation to relative blockage coefficient values although the same worst-case option remains.

Based on this assessment, the 4-legged bucket foundation for the 45 * 18 MW array option is considered to have the highest array-scale blockage influence compared to other foundation types and numbers.

Unit 5,
Desart house,
Lower New Street,
Kilkenny
https://www.group.rwe/en

Registered office:
Unit 5,
Desart house,
Lower New Street,
Kilkenny