Arklow Bank Wind Park 2

Environmental Impact Assessment Report

Volume II, Chapter 9: Benthic Subtidal and Intertidal Ecology

sse Renewables

Revision	Date	Status	Author	Reviewed by	Approved by
1.0	09/05/2024	Final (External)	APEM Ltd	GoBe Consultants	Sure Partners Limited

Statement of Authority

Experts	Qualifications	Relevant Experience
APEM: Connor Markham Author	BSc (Hons), Marine Biology w/ Year in Industry, Swansea University (2018).	Connor is a Senior Consultant with experience in the field of marine consultancy including EIA, HRA and WFD assessment. Throughout the production of these reports, Connor uses his extensive knowledge of marine ecology to assess the potential impacts of anthropogenic activities on a wide range of environmental receptors including benthic habitats and species, fish and marine mammals. Connor has worked on developments for the marine energy, infrastructure and transport (ports & harbours) industries where he has both led and supported on several stages of large-scale projects including environmental scoping to the production of marine ecology ES chapters. Connor is also highly experienced in the management and design of both intertidal and subtidal marine surveys to gather sufficient site characterisation data to inform ecological assessments. This also includes the analysis and interpretation of biological benthic data to characterise biological assemblages at proposed development sites.
APEM: Dr Marc Hubble Document audit	PhD, James Cook University (1998 – 2003). BSc (Hons), Applied Marine Biology, Heriot-Watt University (1994-1997).	Marc has worked in the field of marine ecology research/consultancy for over 18 years during which time he has gained extensive experience managing a diverse range of marine projects. He has an excellent knowledge of protected species and habitats and relevant policy/legislation, and a detailed understanding of the ecology and conservation requirements of biological groups encompassing plankton, macroalgae, angiosperms, invertebrates, finfish/shellfish and associated fisheries, and marine mammals. He has conducted numerous scoping studies and worked on/managed EIAs, SEAs, HRAs, WFD and MCZ assessments for a diversity of marine developments encompassing offshore windfarms, interconnectors, tidal power schemes, outfalls, bridges, tunnels, ports/harbours/marinas, including DCO applications for NSIPs. Many of these assessments have involved application of the most recent guidance criteria and best practice approaches to assess the potential effects of underwater noise and vibration on fish and marine mammals. He has completed assessments for a range of work sectors including energy (nuclear power and renewables); oil and gas; water industry; flood defence, aggregates, coastal infrastructure developments and public sector projects. He has excellent experience of engaging and consulting with clients, statutory authorities and other stakeholders throughout the EIA process. He has extensive

Experts	Qualifications	Relevant Experience
		experience of applying his multidisciplinary knowledge to impact assessments in estuarine, coastal and offshore habitats and routinely interprets and applies data from a wide range of published/grey literature sources including water quality, geophysical and oceanographic survey outputs.

Contents

Figures

Tables

Glossary

Term	Meaning
Arklow Bank Wind Park 1 (ABWP1)	Arklow Bank Wind Park 1 consists of seven wind turbines, offshore export cable and inter-array cables. Arklow Bank Wind Park 1 has a capacity of 25.2 MW. Arklow Bank Wind Park 1 was constructed in 2003/04 and is owned and operated by Arklow Energy Limited. It remains the first and only operational offshore windfarm in Ireland.
Arklow Bank Wind Park 2 – Offshore Infrastructure	"The Proposed Development", Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements under the existing Maritime Area Consent.
Arklow Bank Wind Park 2 (ABWP2) (the Project)	Arklow Bank Wind Park 2 (ABWP2) (The Project) is the onshore and offshore infrastructure. This EIAR is being prepared for the Offshore Infrastructure. Consents for the Onshore Grid Infrastructure (Planning Reference 310090) and Operations Maintenance Facility (Planning Reference 211316) has been granted on 26th May 2022 and 20th July 2022, respectively. • Arklow Bank Wind Park 2 Offshore Infrastructure: This includes all elements to be consented in accordance with the Maritime Area Consent. This is the subject of this EIAR and will be referred to as 'the Proposed Development' in the EIAR. • Arklow Bank Wind Park 2 Onshore Grid Infrastructure: This relates to the onshore grid infrastructure for which planning permission has been granted. • Arklow Bank Wind Park 2 Operations and Maintenance Facility (OMF): This includes the onshore and nearshore infrastructure at the OMF, for which planning permission has been granted. • Arklow Bank Wind Park 2 EirGrid Upgrade Works: any non-contestable grid upgrade works, consent to be sought and works to be completed by EirGrid.
Array Area	The Array Area is the area within which the Wind Turbine Generators (WTGs), the Offshore Substation Platforms (OSPs), and associated cables (export, inter- array and interconnector cabling) and foundations will be installed.
Cable Corridor and Working Area	The Cable Corridor and Working Area is the area where the export, inter array and interconnector cabling will be installed. This area will also facilitate vessel jacking operations associated with installation of WTG structures and associated foundations within the Array Area.
Competent Authority (CA)	The authority designated as responsible for performing the duties arising from the EIA Directive as amended. For this application, the Competent Authority is An Bord Pleanála (ABP).
Environmental Impact Assessment (EIA)	An Environmental Impact Assessment (EIA) is a statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the Directive 2011/92/EU on the assessment for the effects of certain public and private

Term	Meaning
	projects on the environment as amended by Directive 2014/52/EU of the European Parliament and of the Council (EIA Directive).
EirGrid	State-owned electric power transmission system operator (TSO) in Ireland and Transmission Asset Owner (TAO) for the Project's transmission assets.
Landfall	The area in which the offshore export cables make landfall and is the transitional area between the offshore cabling and the onshore cabling.
Maritime Area Consent (MAC)	A consent to occupy a specific part of the maritime area on a non-exclusive basis for the purpose of carrying out a Permitted Maritime Usage strictly in accordance with the conditions attached to the MAC granted on 22nd December 2022 with reference number 2022-MAC-002.
Mitigation Measure	Measure which would avoid, reduce, or remediate an impact.
Permitted Maritime Usage	The construction and operation of an offshore windfarm and associated infrastructure (including decommissioning and other works required on foot of any permission for such offshore windfarm).
The Application	The full set of documents submitted to An Bord Pleanála in support of the consent application.
The Developer	Sure Partners Ltd.

Acronyms

Term	Meaning
AA	Appropriate Assessment
ABP	An Bord Pleanála
ABWP1	Arklow Bank Wind Park 1
ABWP2	Arklow Bank Wind Park 2
ADCP	Acoustic Doppler Current Profiler
AL	Action Level
BAS	Burial Assessment Study
CBRA	Cable Burial Risk Assessment
CIA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CPT	Cone Penetration Test
DAHG	Department of Arts, Heritage and the Gaeltacht
DBT	Dibenzothiophene
DCCAE	Department of Communications, Climate Action and Environment
DCHG	Department of Culture, Heritage and the Gaeltacht
DECC	Department of the Environment, Climate and Communications
DHLGH	Department of Housing, Local Government and Heritage
EC	European Commission
EIA	Environmental Impact Assessment
EIAR	Environmental Impact Assessment Report
EIS	Environmental Impact Statement
EMODnet	European Marine Observation and Data Network
EMP	Environmental Management Plan
EPA	Environmental Protection Agency
EU	European Union
EUNIS	European Nature Information System

Term	Meaning
HDD	Horizontal Directional Drilling
HWM	High Water Mark
IEF	Important Ecological Feature
IMO	International Maritime Organisation
INSPIRE	Impulse Noise Sound Propagation and Impact Range Estimator
IWEA	Irish Wind Energy Association
JNCC	Joint Nature Conservation Committee
LiDAR	Light Detection and Ranging
MAP Act	Maritime Area Planning Act 2021
MarESA	Marine Evidence based Sensitivity Assessment
MarLIN	Marine Life Information Network
MPA	Marine Protected Area
MPCP	Marine Pollution Contingency Plan
MSFD	Marine Strategy Framework Directive
MSL	Mean Sea Level
NBAP	National Biodiversity Action Plan
NIS	Natura Impact Statement
NMPF	National Marine Planning Framework
NOA	North Atlantic Oscillation
NPWS	National Parks and Wildlife Service
O&M	Operations and Maintenance
OGI	Onshore Grid Infrastructure
OMF	Operations and Maintenance Facility
OREDP	Offshore Renewable Energy Development Plan
OREDPII	Offshore Renewable Energy Development Plan

Term	Meaning
OSP	Offshore Substations Platforms
OSPAR	Oslo-Paris Conventions
OWF	Offshore Wind Farm
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyl
PSA	Particle Size Analysis
RCP	Representative Concentration Pathway
ROV	Remotely Operated Vehicle
SAC	Special Area of Conservation
SBP	Sub-Bottom Profiler
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SOV	Service Operations Vessels
SPL	Sound Pressure Level
SSC	Suspended Sediment Concentrations
SSS	Side Scan Sonar
SST	Sea Surface Temperature
UHRS	Ultra High-Resolution Survey
UK	United Kingdom
UXO	Unexploded Ordnance
VMP	Vessel Management Plan
WFD	Water Framework Directive
WTG	Wind Turbine Generators

Units

Unit	Description
<	Less than
>	More than
%	Percentage
dB	Decibels
Hz	Hertz
kJ	Kilojoules
km	Kilometres
km^2	Kilometres squared
m	Metre
m^2	Metres squared
m^3	Metres cubed
m/h	Metres per hour
m/s	Metres per second
mg/l	Milligrams per litre
mm	Millimetres
µPa	Micropascal
$µPa^2s$	Micropascal squared seconds

9 Benthic Subtidal and Intertidal Ecology

9.1 Introduction

9.1.1.1. This chapter of the Environmental Impact Assessment Report (EIAR) presents the assessment of the potential impacts of the Arklow Bank Wind Park 2 Offshore Infrastructure (hereafter referred to as 'the Proposed Development') on Benthic Subtidal and Intertidal Ecology. Specifically, this chapter considers the potential impact of the Proposed Development below the High-Water Mark (HWM) during the construction, operational and maintenance, and decommissioning phases.

9.1.1.2. This chapter draws upon information contained within:

- Volume II, Chapter 4: Description of Development.
- Volume II, Chapter 5: EIA Methodology.
- Volume II, Chapter 6: Coastal Processes.
- Volume II, Chapter 7: Marine Water and Sediment Quality
- Volume II, Chapter 10: Fish Shellfish and Sea Turtle Ecology
- Volume II, Chapter 12: Offshore Ornithology
- Volume III, Appendix 6.1: Marine Physical Processes Numerical Modelling.
- Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Technical Report.
- Volume III, Appendix 11.1: Underwater Noise Assessment.

9.2 Regulatory background

9.2.1.1. Relevant legislation, policy and guidance that have been complied with for Benthic Subtidal and Intertidal Ecology is presented in Table 9.1.

Table 9.1: Summary of regulatory background

Publisher	Name of document incl. reference	Key provisions
Statutory		
Legislation		
Minister for the Environment, Community and Local Government	S.I. No. 265/2017 - European Communities (Marine Strategy Framework) (Amendment) Regulations 2017	Transposes EU Directive 2008/56/EC (Marine Strategy Framework Directive (MSFD)) into Irish law. The MSFD sets out the following qualitative descriptors for determining good environmental status that are relevant to Benthic Subtidal and Intertidal Ecology: • Descriptor 1: Biological diversity is maintained. • Descriptor 2: Non-indigenous species do not adversely alter the ecosystem. • Descriptor 4: Elements of food webs ensure long-term abundance and reproduction. • Descriptor 6: The sea floor integrity ensures functioning of the ecosystem. • Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect the ecosystem. • Descriptor 8: Concentrations of contaminants give no effects. • Descriptor 10: Marine litter does not cause harm. • Descriptor 11: Introduction of energy (including underwater noise) does not adversely affect the ecosystem.
Oireachtas	Wildlife Act 1976 (as amended)	The principal national legislation in Ireland providing for the protection of wildlife (including aquatic invertebrates) and the control of some activities that may adversely affect wildlife.
Minister for Arts, Heritage and the Gaeltacht	European Communities (Birds and Natural Habitats) Regulations 2011 (S.I. No. 477 of 2011);	Transposes the Birds Directive (2009/147/EC) and the Habitats Directive (92/43/EEC) into Irish law.

Publisher	Name of document incl. reference	Key provisions
		The Habitats Directive aims to protect over a thousand species, including aquatic invertebrates, and 230 characteristic habitat types which include benthic habitats. The overall objective is to ensure that these species and habitat types are maintained, or restored, to a favourable conservation status.
Minister for the Environment, Heritage and Local Government	European Communities (Water Policy) Regulations 2003 (S.I. No. 722/2003);	Gives further effect to the European Communities (Water Framework Directive) (Directive 2000/60/EC). The Water Framework Directive (WFD) requires all Member States to protect and improve water quality in all waters so that they achieve good ecological status by 2015 or, at the latest, by 2027. Benthic invertebrates are one of five biological quality elements to be assessed under the WFD. They are an important component of marine ecological systems and are effective indicators of certain types of disturbance or 'pressure'. Habitats are also assessed under the WFD as either higher or lower sensitivity habitats.
European Union, 2016	Planning and Development (Amendment) Act 2018 S.I. 16/2018	Gives effect to 2014/89/EU (Marine planning framework) following the revocation of European Union (Framework for Maritime Spatial Planning) Regulations 2016 (S.I. No. 352/2016).
Planning Policy and Development Control		
Department of the Environment, Climate, and Communications (DECC), 2022	Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDPII) in Ireland: Environmental Report https://www.gov.ie/en/publication/71e36-offshore-	Contains the AA screening process and SEA scoping report of the Maritime area associated with OREDPII. This resource has some important information on existing baseline conditions in the maritime area including benthic habitats.

Publisher	Name of document incl. reference	Key provisions
	renewable-energy-development-plan-ii-oredp-ii/#environmental-assessments	
Department of Housing, Local Government and Heritage (DHLGH), 2021	The National Marine Planning Framework (NMPF) https://www.gov.ie/pdf/?file=https://assets.gov.ie/139100/f0984c45-5d63-4378-ab65-d7e8c3c34016.pdf#page=null	Biodiversity Policy 1: Proposals incorporating features that enhance or facilitate species adaptation or migration, or natural native habitat connectivity will be supported, subject to the outcome of statutory environmental assessment processes and subsequent decision by the competent authority, and where they contribute to the policies and objectives of this NMPF. Proposals that may have significant adverse impacts on species adaptation or migration, or on natural native habitat connectivity must demonstrate that they will, in order of preference and in accordance with legal requirements: a) avoid, b) minimise, or c) mitigate significant adverse impacts on species adaptation or migration, or on natural native habitat connectivity. The assessment in section 9.9 and 9.10 examines a range of potential impacts which could have significant adverse impacts on species adaptation or migration, or on natural native habitat connectivity.
DHLGH, 2021	The National Marine Planning Framework (NMPF) https://www.gov.ie/pdf/?file=https://assets.gov.ie/139100/f0984c45-5d63-4378-ab65-d7e8c3c34016.pdf#page=null	Biodiversity Policy 2: Proposals that protect, maintain, restore and enhance the distribution and net extent of important habitats and distribution of important species will be supported, subject to the outcome of statutory environmental assessment processes and subsequent decision by the competent authority, and where they contribute to the policies and objectives of this NMPF. Proposals must avoid significant reduction in the distribution and

Publisher	Name of document incl. reference	Key provisions
		net extent of important habitats and other habitats that important species depend on, including avoidance of activity that may result in disturbance or displacement of habitats. The assessment in section 9.9 and 9.10 examines a range of potential impacts which could result in the reduction in the distribution and net extent of important habitats and other habitats that important species depend on.
DHLGH, 2021	The National Marine Planning Framework (NMPF) https://www.gov.ie/pdf/?file=https://assets.gov.ie/139100/f0984c45-5d63-4378-ab65-d7e8c3c34016.pdf#page=null	Protected Marine Sites Policy 1: Proposals must demonstrate that they can be implemented without adverse effects on the integrity of Special Areas of Conservation (SACs) or Special Protection Areas (SPAs). Where adverse effects from proposals remain following mitigation, in line with Habitats Directive Article 6(3), consent for the proposals cannot be granted unless the prerequisites set by Article 6(4) are met. Table 9.5 identifies the designated sites which may be impacted by the Proposed Development. The assessment in section 9.9.2 and 9.10.2 examines the potential of impact of increased suspended sediment concentrations and associated deposition to identified designated sites during the construction, operation and maintenance and decommissioning of the Proposed Development.
DHLGH, 2021	The National Marine Planning Framework (NMPF) https://www.gov.ie/pdf/?file=https://assets.gov.ie/139100/f0984c45-5d63-4378-ab65-d7e8c3c34016.pdf#page=null	Non-indigenous Species Policy 1: Reducing the risk of the introduction and / or spread of non-indigenous species is a requirement of all proposals. Proposals must demonstrate a risk management approach to prevent the introduction of and / or spread of non-indigenous species, particularly when:

Publisher	Name of document incl. reference	Key provisions
		a) moving equipment, boats or livestock (for example fish or shellfish) from one water body to another, b) introducing structures suitable for settlement of non-indigenous species, or the spread of non-indigenous species known to exist in the area of the proposal. The assessment provided in section 9.9.8 and 9.10.8 examines the potential impact of increased risk of introduction and spread of invasive and non-native species during the construction, operation and maintenance, and decommissioning of the Proposed Development.
DHLGH, 2021	The National Marine Planning Framework (NMPF) https://www.gov.ie/pdf/?file=https://assets.gov.ie/139100/f0984c45-5d63-4378-ab65-d7e8c3c34016.pdf#page=null	Underwater Noise Policy 1: Proposals must take account of spatial distribution, temporal extent, and levels of impulsive and / or continuous sound (underwater noise) that may be generated and the potential for significant adverse impacts on marine fauna. Where the potential for significant impact on marine fauna from underwater noise is identified, a Noise Assessment Statement must be prepared by the proposer of development. The findings of the Noise Assessment Statement should demonstrably inform determination(s) related to the activity proposed and the carrying out of the activity itself. The content of the Noise Assessment Statement should be relevant to the particular circumstances and must include: • Demonstration of compliance with applicable legal requirements, such as necessary assessment of proposals likely to have underwater noise implications, including but not limited to: – Appropriate Assessment (AA); – Environmental Impact Assessment (EIA); – Strategic Environmental Assessment (SEA);

Publisher	Name of document incl. reference	Key provisions
		– Specific response to 'strict protection' requirements of Article 12 of the Habitats Directive in relation to certain species listed in Annex IV of the Directive; and – Species protected under the Wildlife Acts. • An assessment of the potential impact of the development or use on the affected species in terms of environmental sustainability; • Demonstration that significant adverse impacts on marine fauna resulting from underwater noise will, in order of preference and in accordance with legal requirements be: a) avoided, b) minimised, or c) mitigated, or d) if it is not possible to mitigate significant adverse impacts on marine fauna, the reasons for proceeding must be set out. This policy should be included as part of statutory environmental assessments where such assessments require consideration of underwater noise. The assessment provided in section 9.9.3 and 9.10.3 examines the potential impact of injury and/or disturbance from underwater noise and vibration during the construction of the Proposed Development.
DHLGH, 2021	Article 17 update to Ireland's Marine Strategy Part 2: Monitoring Programme (Article 11) 2021;	Update to Ireland's Marine Strategy Part 2: Monitoring Programme (Article 11), under the Marine Strategy Framework Directive).

Publisher	Name of document incl. reference	Key provisions
DECC, 2014	Offshore Renewable Energy Development Plan I (OREDP I) https://www.gov.ie/pdf/?file=https://assets.gov.ie/27215/2bc3cb73b6474beebbe810e88f49d1d4.pdf#page=null	Published in 2014, Ireland's first Offshore Renewable Energy Development Plan (OREDP) provided a framework for the sustainable development of Ireland's ORE resources, setting out key principles, policy actions and enablers for delivery of Ireland's significant potential in this area.
DECC, 2018	Offshore Renewable Energy Development Plan I (OREDP I), Interim Review https://www.gov.ie/pdf/?file=https://assets.gov.ie/77207/ae15d6ae-7230-4b2a-9178-9d8d326656cb.pdf#page=null	OREDP I identifies the opportunity for the sustainable development of Ireland's abundant offshore renewable energy resources. It sets out the clear principles, policy actions and enablers for the delivery of Ireland's potential in offshore renewable energy. Action 10 of the OREDP I recommends the support of early mover projects to stimulate the supply chain and act as a clear signal that Ireland is open for business.
Guidelines and technical standards		
DCCAE, 2018	Guidance on Marine Baseline Ecological Assessments & Monitoring Activities for Offshore Renewable Energy Projects (Parts 1); 2caa8f12-f1e7-4d76-ab34-19174ff5b9e6.pdf (www.gov.ie) Guidance on Marine Baseline Ecological Assessments & Monitoring Activities for Offshore Renewable Energy Projects (Parts 2); faca0c4e-8255-419a-a518-9457ec4734e7.pdf (www.gov.ie)	Provides technical guidance for the baseline data requirements and monitoring necessary to evaluate potential environmental impacts of offshore renewable energy projects in the marine area including Benthic Subtidal Ecology and Sediments (benthic macrofauna).
DCCAE, 2017	Guidance on Environmental Impact Statement (EIS) and Natura Impact Statement (NIS) Preparation for Offshore Renewable Energy Projects; https://assets.gov.ie/76533/6a82b451-e09f-483b-849e-07d4c7baa728.pdf	To assist developers in preparing Environmental Impact Statements (EIS) and Natura Impact Statements (NIS) that may be required for development projects. More specifically, it sets out the type of information that needs to be provided and the assessment approach to be used for benthic ecology receptors.

Publisher	Name of document incl. reference	Key provisions
National Parks and Wildlife Service (NPWS),	Ireland's 4th National Biodiversity Action Plan; https://www.gov.ie/pdf/?file=https://assets.gov.ie/281711/d424b166-763b-4916-8eba-8afff955c5e5.pdf#page=null	Ireland's 4th National Biodiversity Action Plan (NBAP) has been in development since October 2021 and will set the national biodiversity agenda for the period 2023-2027. The plan aims to deliver the transformative changes required to the ways in which nature is protected within Ireland.
Non-Statutory		
Planning Policy and Development Control		
Wicklow County Council, 2010	Wicklow Biodiversity Action Plan 2010-2015; County_Wicklow_Biodiversity_Plan_2010-15.pdf	The Wicklow Biodiversity Action Plan provides a focussed approach for the county, identifying priority habitats and species and the action required to secure their future. This includes coastal habitats (sand dunes, shingle habitats and coastal headlands).
Wicklow County Council, 2022	Wicklow County Development Plan 2022 – 2028; Adopted Plan (wicklow.ie)	The plan provides for, and controls, the physical, economic and social development of the County, in the interests of the overall common good and in compliance with environmental controls. It includes a set of development objectives and standards, which set out where land is to be developed, and for what purposes. For example, to ensure that there is no removal of sand dunes, beach sands or gravels and to ensure the County's natural coastal defences (beaches, sand dunes, salt marshes and estuary lands) are protected and ensure they are not put at risk by inappropriate works or development.
Guidelines and technical standards		

Publisher	Name of document incl. reference	Key provisions
EPA, 2022	Guidelines on the Information to be Contained in Environmental Impact Assessment Reports https://www.epa.ie/publications/monitoring--assessment/assessment/EIAR_Guidelines_2022_Web.pdf	These Guidelines apply to the preparation of all Environmental Impact Assessment Reports undertaken in the State (Ireland)
Irish Wind Energy Association (IWEA), 2021	Best Practice Guidelines for the Irish Wind Energy Industry, 2021; Microsoft Word - LE11-563-01_Rpt001-2.doc (windenergyireland.com)	Guidance to development of renewable energy in Ireland and includes examples of typical ecology impacts that might be considered within an EIA.
EPA, 2011	Assessment and Monitoring of Ocean Noise in Irish Waters 2011; Water | Environmental Protection Agency (epa.ie)	Guidance on effects of anthropogenic noise in Irish waters.
Chartered Institute of Ecology and Environmental Management (CIEEM), 2018	Guidelines For Ecological Impact Assessment In The UK And Ireland; Combined-EclA-guidelines-2018-compressed.pdf (cieem.net)	Guidelines to the preparation of all Environmental Impact Assessment Reports undertaken in the UK and Ireland.
OSPAR, 2008	Guidance on Environmental Considerations for Offshore Wind Farm Development; 08-03e_agreement_consolidated_guidance_for_offshore_windfarms.doc (live.com)	Sets out the potential impacts associated with the development of offshore windfarms.
Tyler-Walters *et al*. 2023	Guidance from the Marine Life Information Network (MarLIN) on assessing habitat sensitivity using Marine Evidence based Sensitivity Assessment (MarESA); TITLE (marlin.ac.uk).	Provides an approach to examine the biology or ecology of a feature, compile the evidence of the effect of a given pressure on the feature (species or habitat) in question, assess the likely sensitivity of the feature to the pressure against standard scales, and to document the evidence used and justify assessments made.

9.3 Consultation

9.3.1.1. Consultation activities have been undertaken with various statutory and non-statutory authorities as part of the EIA for the Proposed Development. A summary of the key issues raised to date that are specific to Benthic Subtidal and Intertidal Ecology, together with how these issues have been considered in production of this EIAR Chapter is presented in Table 9.2.

Table 9.2: Summary of consultation relating to Benthic Subtidal and Intertidal Ecology

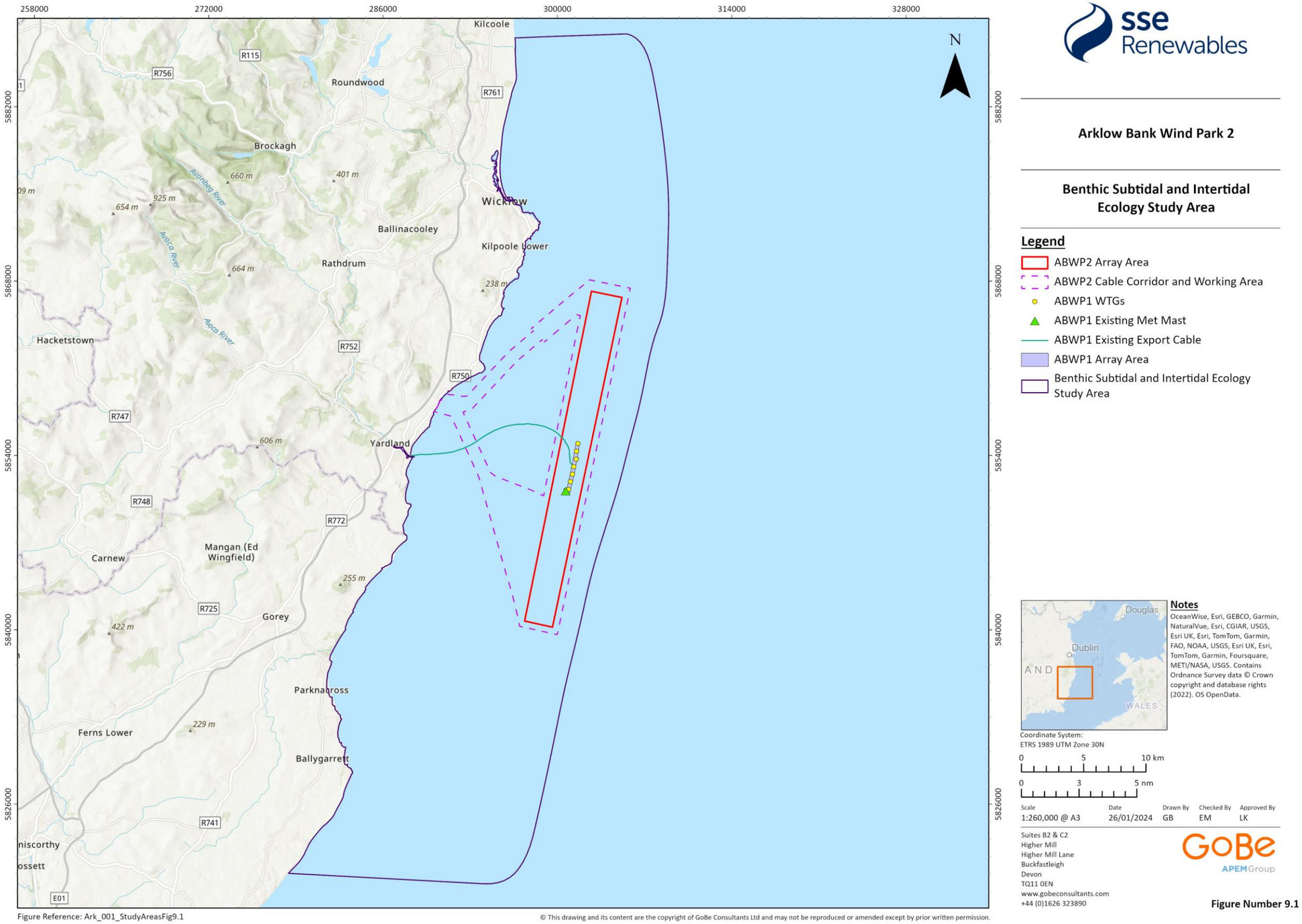
Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
October 2020	Department of Agriculture, Environment and Rural Affairs (Northern Ireland) – Scoping Response	Polypropylene is likely to be involved with mattresses and fronds so there is potential for the introduction of plastic into marine environment. The impact of polypropylene ropes degrading in the marine environment of the Arklow Bank is likely to be assessed as imperceptible or slight adverse. However best practice would still be to avoid its introduction to the marine environment.	Specific materials to be used for the Proposed Development are detailed in Volume II, Chapter 4, Description of Development, and will be addressed in the detailed project design stage post consent. Mitigation measures for the potential impact of Litter during construction, operation and maintenance and decommissioning of the Proposed Development is outlined in the Environmental Management Plan (EMP).
		Will the rock used for protection be similar in nature to that present naturally in the vicinity of the cables etc.? Particularly if rock is going to be left permanently in place at the end of the project rather than being removed then ideally it would be of a type similar to that already present.	Specific materials to be used for the Proposed Development are detailed in Volume II, Chapter 4, Description of Development, and will be addressed in the detailed project design stage post consent. The assessment provided in sections 9.9.5 and 9.10.5 examines the potential impact of the colonisation of hard structures including rock cable protection during construction, operation and maintenance and

Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
			decommissioning of the Proposed Development.
October 2020	Marine Institute – Scoping Response	The chemicals to be used should be identified and quantified, and that potential impacts of discharge and spillage be considered in the EIAR.	Specific chemicals to be used for the Proposed Development are detailed in Volume II, Chapter 4, Description of Development, and will be addressed in the detailed project design stage post consent. The assessment provided in sections 9.9.9 and 9.10.9 examines the potential impact of accidental pollution during construction, operation and maintenance and decommissioning of the Proposed Development.
October / November 2020	Public Consultation	Potential impacts to the seabed and protected habitat such as oyster beds.	The assessment provided in Sections 9.9 and 9.10 examines the potential disturbance to habitats and species, including habitats of conservation importance (e.g. reefs) during construction, operation and maintenance and decommissioning (including removal of infrastructure). The baseline environment is informed by site-specific surveys (Table 9.4) and by the most recent information gathered through a desk-top study (Table 9.3). No oyster beds were recorded during site specific surveys, although measures are included to avoid reef habitats (see Table 9.13).

Date	Consultation type	Consultation and key issue raised	Section where provision is addressed
		The location of the Landfall to the Buckroney-Brittas Dunes and Fen Special Area of Conservation (SAC).	Effects on the Buckroney-Brittas Dunes and Fen SAC is presented within the Natura Impact Statement.
		At the end of the project, it was noted that foundations would provide suitable habitat for flora and fauna if foundations remained.	The assessment provided in sections 9.9.5 and 9.10.5 examines the potential impact of the colonisation of hard structures including rock cable protection during construction, operation and maintenance and decommissioning of the Proposed Development.

9.4 Study area

9.4.1.1. For the purposes of the Benthic Subtidal and Intertidal EIAR Chapter, the Benthic Subtidal Ecology Study Area is defined as the area encompassing the Array Area, Cable Corridor and Working Area, and surrounding area (delineated as one tidal excursion from the Proposed Development which is the maximum extent to which secondary impacts associated with sediment mobilisation (i.e. Suspended Sediment Concentration (SSC) and deposition) could occur), (See Volume II, Chapter 6: Coastal Processes), (Figure 9.1). The Benthic Intertidal Ecology Study Area is defined by the intertidal habitats up to the HWM within the Cable Corridor and Working Area (Figure 9.1).



sse Renewables

Arklow Bank Wind Park 2

Benthic Subtidal and Intertidal Ecology Study Area

Legend

- ABWP2 Array Area
- ABWP2 Cable Corridor and Working Area
- ABWP1 WTGs
- ABWP1 Existing Met Mast
- ABWP1 Existing Export Cable
- ABWP1 Array Area
- Benthic Subtidal and Intertidal Ecology Study Area

Notes

OceanWise, Esri, GEBCO, Garmin, NaturalVue, Esri, CGIAR, USGS, Esri UK, Esri, TomTom, Garmin, FAO, NOAA, USGS, Esri UK, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS. Contains Ordnance Survey data © Crown copyright and database rights (2022). OS OpenData.

Coordinate System:
ETRS 1989 UTM Zone 30N

0 5 10 km

0 3 5 nm

Scale	Date	Drawn By	Checked By	Approved By
1:260,000 @ A3	26/01/2024	GB	EM	LK

Suites B2 & C2
Higher Mill
Higher Mill Lane
Buckfastleigh
Devon
TQ11 0EN
www.gobeconsultants.com
+44 (0)1626 323890

GoBe APEM Group

Figure Number 9.1

Figure Reference: Ark_001_StudyAreasFig9.1

Figure 9.1: Benthic Subtidal and Intertidal Ecology Study Area

9.5 Methodology

9.5.1 Methodology to inform the baseline

Desktop studies

9.5.1.1. Information on Benthic Subtidal and Intertidal Ecology within the Benthic Subtidal and Intertidal Ecology Study Area was collected through a detailed desktop review of existing studies and datasets. These reports are summarised in Table 9.3.

Table 9.3: Summary of key desktop reports and data resources

Title	Source	Year	Author
EUSeaMap 2021: European Marine Observation and Data Network (EMODnet) broad-scale seabed habitat map for Europe	EMODnet	2021 (accessed 27/07/2023)	EMODnet
Wicklow Reef SAC – Conservation objectives	NPWS	2013 (accessed 27/07/2023)	NPWS
Wicklow Reef SAC – Site Synopsis	NPWS	2014 (accessed 27/07/2023)	NPWS
Blackwater Bank SAC – Conservation objectives	NPWS	2023 (accessed 27/07/2023)	NPWS
Blackwater Bank SAC – Site Synopsis	NPWS	2014 (accessed 27/07/2023)	NPWS
Seabed Habitats of the Southern Irish Sea. In 'Seafloor Geomorphology as Benthic Habitat'.	Scientific publication – Seafloor Geomorphology as Benthic Habitat	2012 (accessed 27/07/2023)	Robinson *et al.*
Diversity of demersal and megafaunal assemblages inhabiting sandbanks of the Irish Sea	Scientific publication – Marine Biodiversity	2013 (accessed 27/07/2023)	Atalah *et al.*
Littoral and Benthic Investigations on the South Coast of Ireland: II. The	Scientific publication – Proceedings of the Royal Irish Academy	1987 (accessed 27/07/2023)	Keegan *et al.*

Title	Source	Year	Author
Macrobenthic Fauna of Carnsore Point.			
Seabed mapping in the southern Irish Sea: Predicting benthic biological communities based on sediment characteristics	Scientific publication – Hydrobiologica	2008 (accessed 27/07/2023)	McBreen *et al.*
Benthic surveys of sandbanks in the Irish Sea	Scientific publication – (NPWS, Department of Environment, Heritage and Local Government	2007 (accessed 27/07/2023)	Roche *et al.*
Proposed Dredge Disposal Sites for Arklow Harbour Commissioner	Survey of proposed dredge sites around Arklow Harbour	2008 (accessed 27/07/2023)	Aquafact International Services Ltd.
Ecological sensitivity analysis of the western Irish Sea to inform future designation of Marine Protected Areas (MPAs)	Marine Protected Area Advisory Group	2023 (accessed 27/07/2023)	Marine Protected Area Advisory Group
ABWP1 baseline survey	Survey of anchor dredge sites for ABWP1	2000 (accessed 27/07/2023)	EcoServe
	Survey of anchor dredge sites and otter trawls for ABWP1	2000 (accessed 27/07/2023)	
	Survey of anchor dredge sites and agassiz trawls for ABWP1	2001 (accessed 27/07/2023)	
ABWP1 post-construction survey	Survey of anchor dredge sites and beam trawls for ABWP1	2004 (accessed 27/07/2023)	HydroServ Projects Ltd.
		2004 (accessed 27/07/2023)	

Title	Source	Year	Author
		2005 (accessed 27/07/2023)	
		2005 (accessed 27/07/2023)	
		2006 (accessed 27/07/2023)	
		2007 (accessed 27/07/2023)	
		2008 (accessed 27/07/2023)	
		2009 (accessed 27/07/2023)	
		2010 (accessed 27/07/2023)	
		2011 (accessed 27/07/2023)	
		2021 (accessed 27/07/2023)	
Proposed Dredge Disposal Sites for Arklow Harbour Commissioner.	Dive survey using corers for benthic infauna, particle size analysis and organic carbon.	2007 (accessed 27/07/2023)	Aqua-fact International Services Ltd.
Diversity of demersal and megafaunal assemblages inhabiting sandbanks of the Irish Sea.	Beam trawls (demersal fish and megafaunal invertebrates).	2007 (accessed 27/07/2023)	Atalah *et al*.
Sediment chemistry sampling to support dredge dumping as sea permit application for ABWP1	Van Veen grabs for sediment chemistry.	2016 (accessed 27/07/2023)	Aquatic Services Unit

Site specific surveys

9.5.1.2. In order to inform the EIAR, site-specific surveys were undertaken. A summary of the surveys used to inform the Benthic Subtidal and Intertidal Ecology impact assessment is outlined in Table 9.4.

Table 9.4: Site specific surveys

Data source	Date(s) of survey	Overview of survey	Survey contractor	Reference to further information
ABWP2 Intertidal Phase I walkover survey and on-site dig-over sediment sampling of the Landfall site.	June 2019	• Phase I walkover survey and on-site digging.	RPS	RPS (2019a); Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Technical Report.
Site-specific geophysical surveys of the ABWP2 Array Area and Cable Corridor and Working Area.	July/August 2019	• Multibeam echo sounder, sidescan sonar, sub-bottom profiler and magnetometer sampling.	Ultrabeam Ltd.	Ultrabeam Ltd. (2019); Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Technical Report.
Site-specific geophysical and hydrographic surveys of the ABWP2 Array Area and Cable Corridor and Working Area.	August to November 2022	• Sub-bottom profiler, Ultra High-Resolution Survey (UHRS), sidescan sonar and magnetometer, multi-beam bathymetry and backscatter.	Green Rebel	Green Rebel (2022); Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Technical Report.

Identification of designated sites

9.5.1.3. All designated sites within the Benthic Subtidal and Intertidal Ecology Study Area and qualifying interests that could be affected by the construction, operational and maintenance, and decommissioning phases of the Proposed Development were identified using the three-step process described below:

- Step 1: All designated sites of international, national and local importance within the Benthic Subtidal and Intertidal Ecology Study Area were identified via a desk based-search of all relevant sources. These included the Environmental Protection Agency (EPA) and National Parks and Wildlife Service (NPWS) websites.
- Step 2: Information was compiled on the relevant qualifying interest for each of these sites which may make them a sensitive receptor in terms of Benthic Subtidal and Intertidal Ecology. For example, changes in sediment transport may affect dune evolution.
- Step 3: Using the above information and expert judgement, sites were included for further consideration if:
  - A designated site directly overlaps with the Proposed Development; or
  - Sites and associated qualifying interests were located within the potential extent of secondary impacts associated with the Proposed Development.

9.5.1.4. The designated sites and relevant qualifying interests for Benthic Subtidal and Intertidal Ecology are presented in Table 9.5 and Figure 9.2. The effects on the integrity of designated sites are fully considered in a Natura Impact Statement (NIS), which has been completed for the construction, operational and maintenance, and decommissioning phases of the Proposed Development.

Table 9.5: Designated sites and relevant qualifying interests for Benthic Subtidal and Intertidal Ecology

Designated Site	Closest Distance to the Array Area (km)	Closest Distance to the Cable Corridor and Working Area (km)	Relevant Qualifying Interest
Wicklow Reef SAC	4.5	3.6	[1170] Reefs
Blackwater Bank SAC	19.7	19.1	[1110] Sandbanks

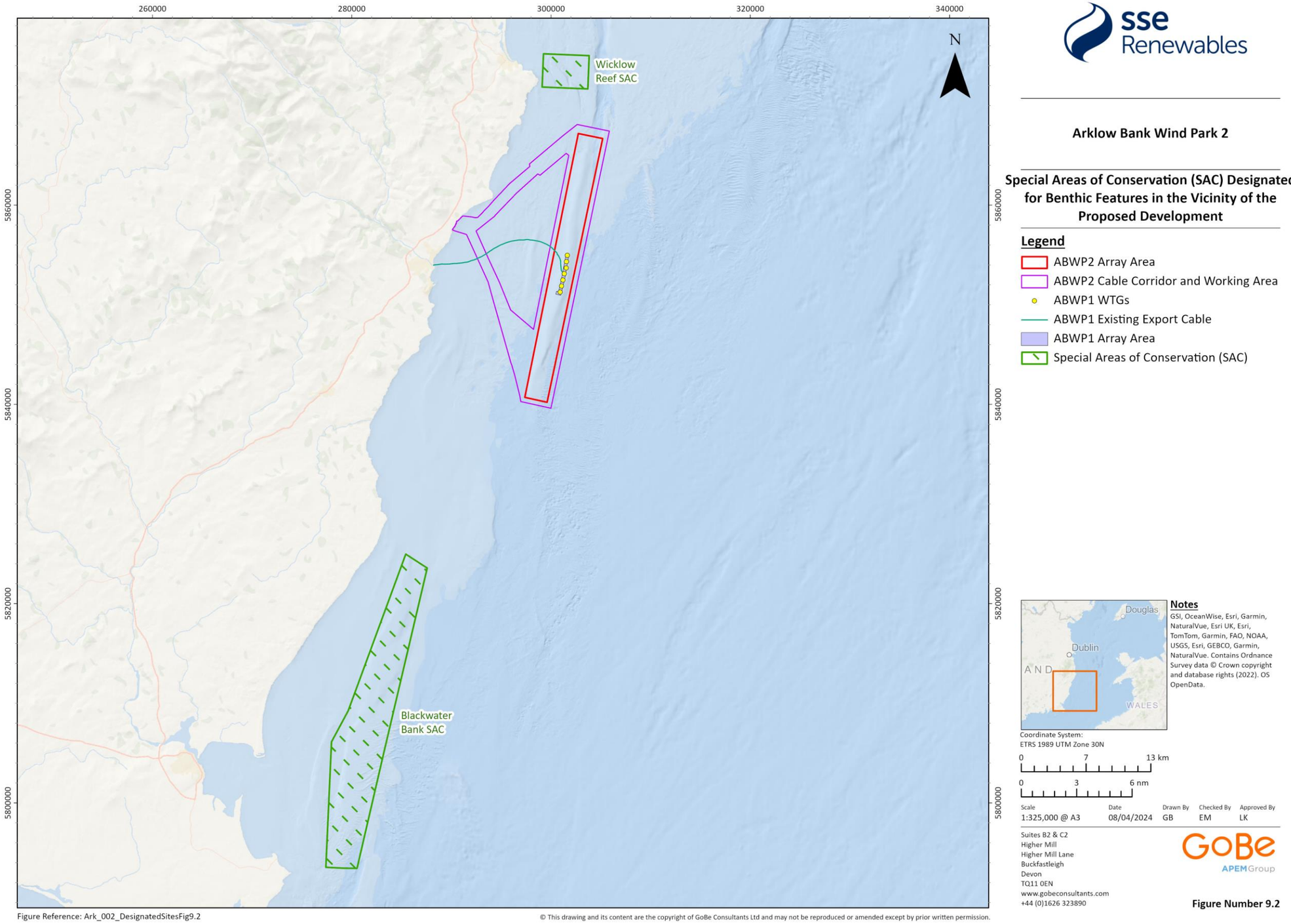


Figure 9.2: Designated sites for Benthic Subtidal and Intertidal Ecology

9.5.2 Baseline environment

9.5.2.1. A technical report has been prepared to provide a detailed characterisation of the receiving benthic baseline (Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Ecology Technical Report). The relevant findings from that study have been incorporated into the description of the receiving environment, presented in this chapter in the following paragraphs.

9.5.2.2. This EIAR chapter should therefore be read alongside Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Technical Report which describes and analyses the range of species and habitats that could potentially be impacted by the Proposed Development, informed by desktop studies and site-specific data collected covering the Benthic Subtidal and Intertidal Study Area (see section 9.5.1 for details of sources used).

Subtidal Ecology

9.5.2.3. The seabed of the western Irish Sea comprises current swept coarse sediments which consist of compact sand with gravel, shell, and/or cobbles in varying proportions which support low faunal diversity. The most common sediment type in the southern Irish Sea is sand, followed by sandy gravel, gravelly sand and muddy sand (McBreen *et al.*, 2008). Broad scale habitats within the southern Irish Sea primarily consists of circalittoral coarse sediment, circalittoral sand and circalittoral mixed sediments (EUSeaMap, 2021).

9.5.2.4. Infaunal communities associated with these sediments are typically impoverished and reflective of the mobile nature of sediments within the western Irish Sea (Keegan *et al.* 1987). Epifaunal communities are characterised by erect hydroids such as *Hydrallmania falcata*, *Sertularia argentea*, *Nemertesia* spp., attaching to cobbles or shells. Whilst the bryozoan *Flustra foliacea* is abundant on bedrock exposed to strong currents and sand scour (Keegan *et al.* 1987).

9.5.2.5. Robinson *et al.* (2012) identified several biotopes within the wider area of the Proposed Development. Species-rich gravelly plains throughout St George's Channel were typically characterised by the biotope '*Mediomastus fragilis*, *Lumbrineris* spp., and venerid bivalves in circalittoral coarse sand or gravel' (JNCC code: SS.SCS.CCS.MedLumVen; EUNIS code: MC3212), (Robinson *et al.* 2012). Fine sand communities within Blackwater Bank, located to the south of the Proposed Development resembled 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSA; EUNIS code: MB5231) or '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (JNCC code: SS.SSa.IFiSa.NcirBat; EUNIS code: MB5233) biotopes (Roche *et al.*, 2007; Robinson *et al.*, 2012). Sandy substrate within Kish Bank, located to the north of the Proposed Development were characterised by the following four biotopes (Roche *et al.*, 2007; Robinson *et al.*, 2012):

- '*Glycera lapidum* in impoverished infralittoral mobile gravel and sand' (JNCC code: SS.SCS.ICS.Glap; EUNIS code: MB3235);
- '*Abra prismatica*, *Bathyporeia elegans* and polychaete spp. in circalittoral fine sand' (JNCC code: SS.SSA.CFiSa.ApriBatPo; EUNIS code: MC5212);
- '*Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand' (JNCC code: SS.SSA.IFiSa.NcirBat; EUNIS code: MB5233); and
- '*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slight adversely mixed sediment' (JNCC code: SS.SSA.CMuSa.AalbNuc; EUNIS code: MC5214).

ARRAY AREA

9.5.2.6. Offshore sediments near Arklow Bank, within the Array Area, consists of a highly mobile upper layer of infralittoral, circalittoral and offshore circalittoral sand, ranging from medium to coarse sandy sediment (Creane *et al.* 2023; EUSeaMap, 2021; Marine Protected Area Advisory Group, 2023). The northern end of the Arklow Bank is characterised by sand habitat and cobbles with

shells/pebbles, while the southern end of the Arklow Bank is characterised by fine sand (Fehily Timoney and Co 2001; Panigrahi *et al.* 2009). Keegan *et al.* (1987) describes the seabed around Arklow Bank as having varying proportions of current-swept coarse sediments, consisting of compact sand, gravel, shell and/or cobbles.

9.5.2.7. Site-specific geophysical surveys of the Array Area in 2019 identified boulder fields to the north east of Arklow Bank, sandwaves to the south, and mobile sandy sediment across the bank itself (Ultrabeam Ltd., 2019). Patches of coarse sediment were also observed within the central section of Arklow Bank, along the western flank (Figure 9.3). This is in line with site-specific benthic surveys conducted between 2004 and 2011, and in 2021 which found varying proportions of sand, gravelly sand and gravel in the north of Arklow Bank; predominately sand sediment with areas of gravel and mud in to the south; and slight adversely gravelly sand, with coarser gravelly sands characterising the eastern and western parts of the bank (HydroServ, 2004 to 2009; Aquatic Services Unit, 2010; GE Wind Energy, 2011 to 2012; GE Wind Energy, 2021).

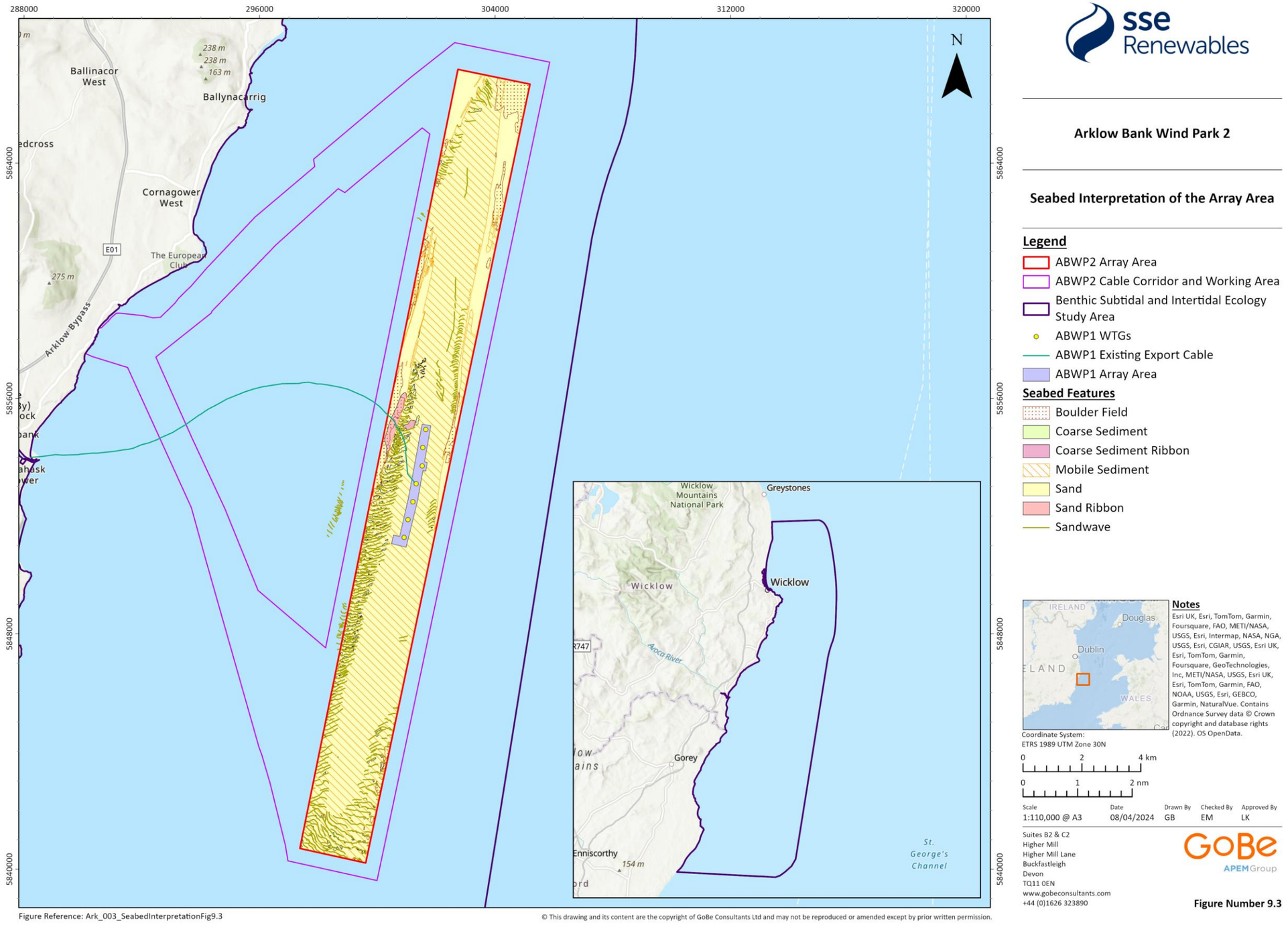


Figure 9.3: Seabed interpretation of the Array Area (Ultrabeam Ltd., 2019)

9.5.2.8. Atalah *et al.* (2013) conducted beam trawls at three locations on Arklow Bank in 2007 (after the construction of ABWP1) and found that benthic communities were typical of those found across the east coast of Ireland. The most abundant taxa recorded included the hermit crab *Pagurus bernhardus*, the common starfish *Asterias rubens*, the elliptical surf clam *Spisula elliptica*, and the flying crab *Liocarcinus holsatus*.

9.5.2.9. Site-specific benthic surveys conducted in 2021 indicated the presence of low diversity communities. The four sites sampled within the Array Area were extremely species poor, with a total of 12 taxa (13 individuals) recorded (GE Wind Energy, 2021). Within these stations, the most abundant taxa were the polychaete *Eunereis longissima*, and the crustaceans *Gastrosaccus spinifer* and *Gammaropsis nitida*, with only two individuals recorded across stations. This is in contrast to three stations sampled just outside of the Array Area to the east, at which the total number of taxa recorded in samples was a lot higher ranging from 41 to 61 (186 to 706 individuals).

9.5.2.10. The number of taxa recorded at stations within the Array Area in 2021, were concordant with previous site-specific surveys (HydroServ, 2004 to 2009; Aquatic Services Unit, 2010; GE Wind Energy, 2011 to 2012) and desktop data, including observations made by Keegan *et al.* (1987) and mapping by Robinson *et al.* (2012). The only biotope that was recorded within the Array Area was 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231), due to the lack of taxa recorded.

9.5.2.11. Other biotopes recorded during the 2021 benthic survey, at the three separate stations just outside of the Array Area were:

- 'Moderate Energy Circalittoral rock' (JNCC code: CR.MCR; EUNIS code: MC12)
- '*Flustra foliacea* on slight adversely scoured silty circalittoral rock' (JNCC code: CR.MCR.EcCr.FaAlCr.Flu; EUNIS code: MC12241); and
- '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211).

9.5.2.12. '*Sabellaria* spinulosa on stable circalittoral mixed sediment' (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211) was assigned due to the abundance of the Ross worm *Sabellaria* spinulosa. *S. spinulosa* is a common polychaete species found on all Irish and British coasts. It is most commonly found in low densities as a crust or as individuals that construct tubes from coarse, cemented sand or shell grains. Over some of its range it can form ephemeral and localised reefs up to several metres across and 60 cm high. At stations just outside of the Array Area the biotope '*Sabellaria* spinulosa on stable circalittoral mixed sediment' was not recorded in 2007 and 2011 (HydroServe, 2007b; GE Wind Energy, 2012), it was only recorded at one station in 2006 and 2021 (HydroServe, 2007a; GE Wind Energy, 2021), and at two stations in 2009 and 2010 (Aquatic Services Unit, 2010; GE Wind Energy, 2011). The biotope '*Sabellaria* spinulosa on stable circalittoral mixed sediment' was not recorded at any sites within the Array Area. As part of confirmatory surveys, a geophysical survey will be conducted prior to construction, to confirm any potential areas of Annex I *Sabellaria* reef habitat which will then be ground truthed via underwater video (i.e. Remotely Operated Video (ROV)). Any areas of Annex I *Sabellaria* reef habitat identified in the Array area will be avoided via micro-siting of infrastructure. This also applies to Annex I bedrock and stony reef habitat which, if detected, will also be avoided via micro-siting.

9.5.2.13. Aquatic Services Unit (2016) conducted sediment chemistry sampling and analysis at three locations at Arklow Bank (within the Array Area) to support dredge dumping at sea permit application for ABWP1. The survey found that levels of contaminants were typically low and below the respective lower Irish Action Levels (ALs), (Cronin *et al.*, 2006). The only exception to this was arsenic, which exceeded the lower Irish AL at a single station. At the time of sampling, the lower Irish action levels for arsenic was 9 mg/kg and therefore 'Sample 3' exceeded this by 0.47

mg/kg at a single station. Consultation with the Marine Institute confirmed that this was acceptable for the material to be disposed of at sea (Ramboll Environ UK Ltd, 2016). However, after the Irish ALs were updated in 2019, the lower Irish AL for arsenic now sits at 20 mg/kg and therefore 'Sample 3' falls well below this limit.

CABLE CORRIDOR AND WORKING AREA

9.5.2.14. Inshore sediments near Arklow town and within the Cable Corridor and Working Area are indicated to be a combination of circalittoral fine sand or circalittoral muddy sand and, to a lesser extent, circalittoral sandy mud (EUSeaMap, 2021; Marine Protected Area Advisory Group, 2023).

9.5.2.15. Site-specific geophysical surveys of the Cable Corridor and Working Area in 2022, found that the distribution of sediments indicated predominant facies of medium to coarse sands which coincide with the presence of sandwaves, megaripples and sediment waves on the approach to Arklow Bank. Finer grained facies of sandy mud and clay were identified in troughs between sand wave crests (Green Rebel, 2022), (Figure 9.4). There was no evidence of potential presence of Annex I bedrock and stony reef habitat within the Cable Corridor and Working Area. However, if present these habitats will be detected via the detailed confirmatory surveys which will involve geophysical survey and subsequent ground truthing via underwater video (i.e. ROV) prior to construction. If any Annex I bedrock or stony reef habitat is found to be present, it will be avoided via micro-routing of the cable route.

9.5.2.16. The Marine Protected Area Advisory Group (2023) indicated that an area of potential subtidal blue mussel *Mytilus edulis* beds lies within the vicinity of the Cable Corridor and Working Area. However, based on Green Rebel (2022) geophysical surveys of the Cable Corridor and Working Area, there was no evidence of potential presence of Annex I blue mussel beds. If present, these habitats will be detected via the detailed confirmatory surveys which will involve geophysical survey and subsequent ground truthing via underwater video (i.e. ROV) prior to construction. If any Annex I blue mussel bed habitat is found to be present, it will be avoided via micro-routing of the cable route.

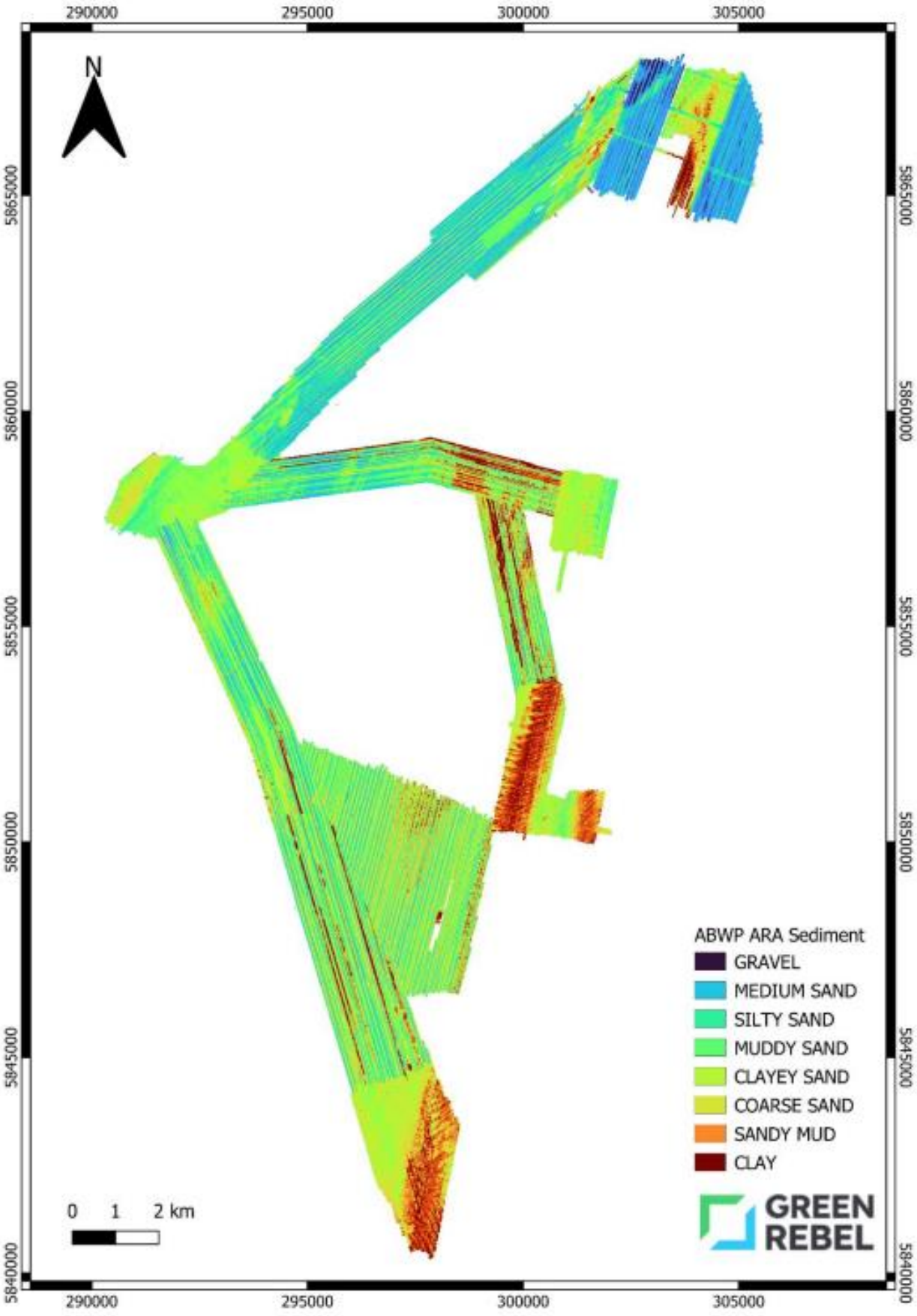


Figure 9.4: Seabed interpretation of the Cable Corridor and Working Area (Green Rebel, 2022)

9.5.2.17. In contrast to stations sampled within the Array Area, site-specific benthic surveys conducted in 2021 within the Cable Corridor and Working Area indicated more diverse benthic communities, with a total of 116 taxa (533 individuals) recorded from the four sites sampled (GE Wind Energy, 2021). Within these stations the most abundant taxa were the wart barnacle *Verruca stroemia* (48 individuals), followed by polychaetes including *Ampharetidae* spp. (31 individuals), *Anobothrus gracilis* (29 individuals), *Spirobranchus lamarcki* (28 individuals) and *Dipolydora coeca* (27 individuals) and the common brittlestar *Ophiothrix fragilis* (27 individuals). All other taxa were recorded with an abundance of less than 20 individuals across stations. The number of taxa recorded at stations within the Cable Corridor and Working Area in 2021 were concordant with previous site-specific surveys (HydroServ, 2004 to 2009; Aquatic Services Unit, 2010; GE Wind Energy, 2011 to 2012) and desktop data (Keegan *et al.*, 1987; EUSeaMap, 2021); Robinson *et al.* (2012).

9.5.2.18. Unlike the Array Area, sites surrounding the Cable Corridor and Working Area were characterised by several biotopes including 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) and '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214) within the southern Cable Corridor and Working Area, and '*Flustra foliacea* on slight adversely scoured silty circalittoral rock' (JNCC code: CR.MCR.EcCr.FaAlCr.Flu; EUNIS code: MC12241), within the northern Cable Corridor and Working Area.

9.5.2.19. Biotopes recorded at eight sites located just outside of the Cable Corridor and Working Area during the 2021 benthic survey included:

- 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231);
- '*Flustra foliacea* on slight adversely scoured silty circalittoral rock' (JNCC code: CR.MCR.EcCr.FaAlCr.Flu; EUNIS code: MC12241);
- 'Moderate Energy Circalittoral rock' (JNCC code: CR.MCR; EUNIS code: MC12)
- 'Infralittoral fine sand' (JNCC code: SS.SSa.IFISa; EUNIS code: MB5) and
- '*Sabellaria spinulosa* on stable circalittoral mixed sediment' (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211).

9.5.2.20. Sites assigned to the biotope 'Sabellaria spinulosa on stable circalittoral mixed sediment' (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211) were due to the abundance of S. spinulosa. This biotope was recorded just outside the Cable Corridor and Working Area at only one site in 2006, 2007, 2009, and 2011 (HydroServe, 2007a; HydroServe, 2007b; Aquatic Services Unit, 2010; GE Wind Energy, 2012); and at two sites 2010 and 2021 (GE Wind Energy, 2011; GE Wind Energy, 2021). The biotope 'Sabellaria spinulosa on stable circalittoral mixed sediment' was not recorded at any sites within the Cable Corridor and Working Area. As part of confirmatory surveys, a geophysical survey will be conducted prior to construction, to confirm any potential areas of Annex I Sabellaria reef habitat which will then be ground truthed via underwater video (i.e. ROV). Any areas of Sabellaria reef habitat identified will be avoided via micro-routing of the cable route.

9.5.2.21. The site-specific subtidal survey did not indicate the presence of rare species or species of conservation importance. The only non-native species recorded was the bryozoan *Fenestrulina delicia*, which was recorded at just one station located towards the south east of the Array Area.

9.5.2.22. In 2009, Arup Consulting Engineers (Arup) were commissioned by Arklow Harbour Commissioners to prepare an application for the Arklow Port Dredge Disposal Licence Application. Legislative requirements for the disposal of dredge spoil include the undertaking of a full contamination assessment of the sediment. The output of these samples are presented in Volume II, Chapter 7: Marine Water and Sediment Quality. Sediment contamination was found to be higher in the inshore area when compared with sampling results from the offshore area. Of note, the upper ALs were exceeded for copper, zinc, lead and Dibenzothiophene (DBT). The

lower ALs were exceeded for cadmium, arsenic, Polychlorinated biphenyls (PCBs), and TEH. These contaminants are typical of industrial port/harbour sediment and are legacy of historical pollution and it is anticipated that these substances will fall as the sources are reduced (EPA 2016 – 2019). Therefore, as the samples were collected in 2009 and contaminants are characteristic of historical pollution, it is anticipated that volumes have since also reduced.

9.5.2.23. In a more recent EIA Report conducted to support the application of Arklow Wastewater Treatment Plant, the results of borehole investigations with 15 sediment samples taken near the long sea outfall (in Arklow Harbour) were shown in comparison to Irish ALs. In accordance with the older (2006) Irish ALs, the survey found that seven of the samples were classified as 'uncontaminated' where eight of the samples were classified as 'marginally polluted'. However, if the same results are compared with the updated (2019) Irish ALs, only 3 samples are classified as 'marginally polluted' (Irish Hydrodata Limited, 2018). The Irish ALs take into consideration naturally elevated levels of arsenic that can occur. The three remaining 'marginally polluted' samples were exceeded for one or more of the following metals:

- Arsenic: 20.6mg/kg, AL 1 Limit 20 mg/kg;
- Copper: 88.9mg/kg, AL1 limit 40mg/kg;
- Cadmium: 0.92 mg/kg, AL1 limit 0.7 mg/kg;
- Nickel: 30.5 and 38.8 mg/kg, AL1 limit 21 mg/kg.

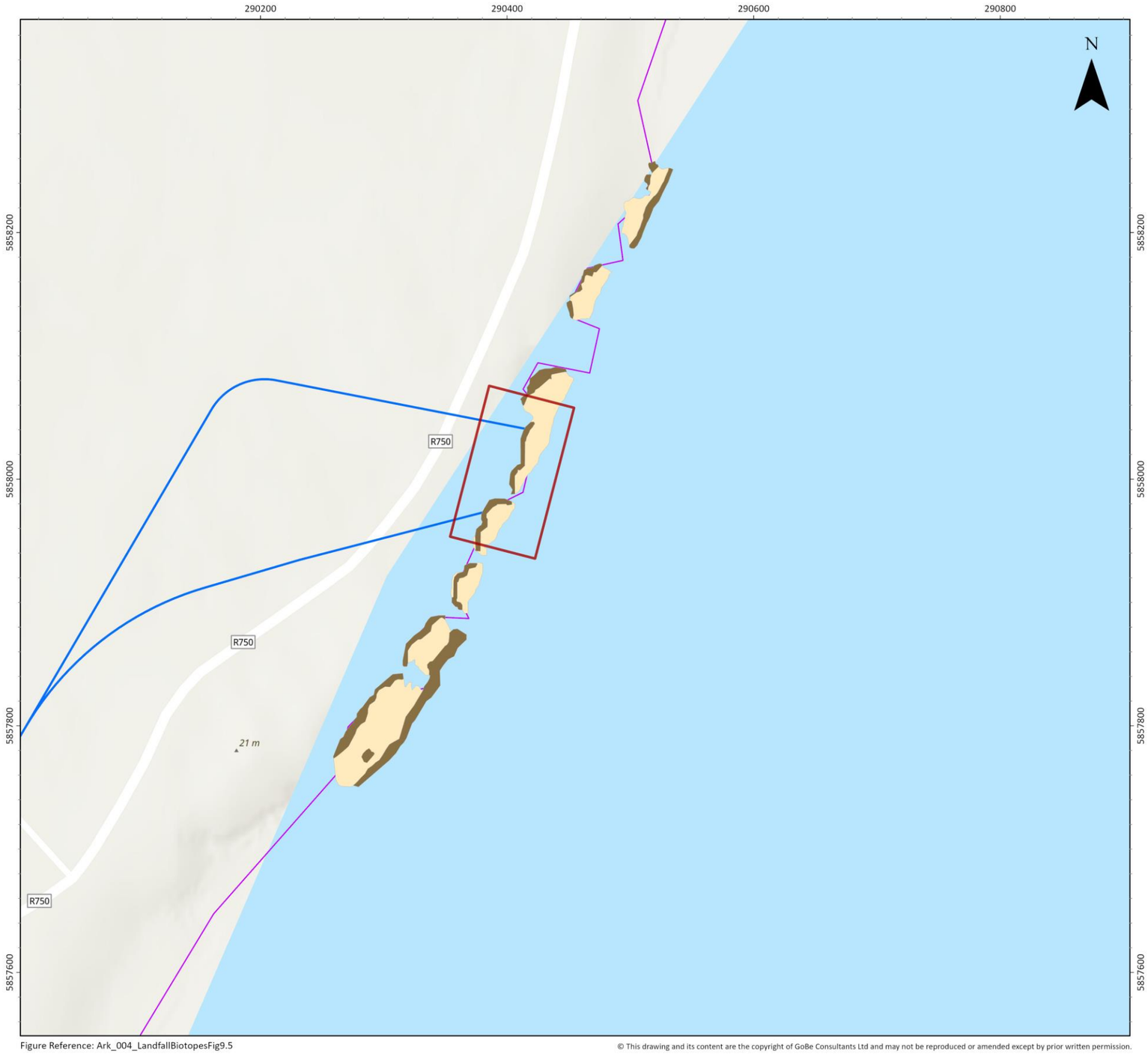
9.5.2.24. Copper and cadmium were both present at only one location and represented as isolated occurrences. The EIAR concluded that the marine sediments were very slightly contaminated at relatively low levels for some specific parameters. Overall, when these results are compared with the earlier survey of Arklow Harbour, the concentration of metal contaminants are substantially lower in volume.

9.5.2.25. A more recent survey of Dublin Port was conducted in 2020 to support the application of a permit to carry out a Maintenance Dredging Programme at the site (RPS, 2021a). The sediment chemistry results displayed low level contamination of arsenic, cadmium, copper, lead, nickel and zinc at select locations within Dublin Harbour. The results also showed some localised, slightly elevated levels of PCBs, Polycyclic Aromatic Hydrocarbons (PAHs), and TEH over the lower ALs at select locations. However, none of the 31 samples they collected exceeded the upper AL and therefore are not classed as heavily contaminated. Whilst Dublin Harbour is a significant distance away from Arklow Harbour, they are both characterised by similar pollution sources and are located adjacently to the Irish sea. Therefore, it is of relevance to compare these more recent results with the survey of Arklow Harbour from 2009. Further, the same report carried out sediment chemistry trend analysis of Dublin Ports navigation channel between 2006 and 2020 and found that metal concentrations have generally reduced, PCBs showed a modest decrease, and PAHs showed a substantial decrease over this timeframe (RPS, 2021a).

Intertidal Ecology

9.5.2.26. The site-specific intertidal surveys conducted by RPS (2019a) at the Landfall indicated that the lower shore comprised rounded clean pebbles, which gave way to coarse to fine sand sediments on the mid-shore. The upper shore sediments were composed of a mixture of coarse sand and cobble with occasional patches of coarse to fine sand sediment. In general, lower and upper shore coarse sediments were characterised by the habitat 'barren littoral shingle' (JNCC code: LS.LCS.Sh.BarSh; EUNIS code: A2.111) and 'mid-shore sediments were characterised by the habitat 'barren littoral coarse sand' (JNCC code: LS.LSa.MoSa.BarSa; EUNIS code: A2.221), (RPS, 2019a).

9.5.2.27. The site-specific intertidal survey also recorded native oyster *Ostrea edulis* shell hash. *O. edulis* is listed under Annex V of the OSPAR convention. However, no live specimens were recorded during surveys.



sse Renewables

Arklow Bank Wind Park 2

Intertidal Benthic Ecology Biotypes at the Landfall Location

Legend

- ABWP2 Onshore Export Cable Route
- ABWP2 Cable Corridor and Working Area
- ABWP2 Landfall Area

Biotype

- Barren littoral coarse sand
- Barren littoral shingle

Notes

GSI, OceanWise, Esri, Garmin, NaturalVue, Esri Community Maps Contributors, Esri UK, Esri, TomTom, Garmin, Foursquare, GeoTechnologies, Inc, METI/ NASA, USGS, Sources: Esri, Airbus DS, USGS, NGA, NASA, CGIAR, N Robinson, NCEAS, NLS, OS, NMA, Geodatastyrelsen, Rijkswaterstaat, GSA, Geoland, FEMA, Intermap and the GIS user community, Esri UK, Esri, TomTom, Garmin, Foursquare, METI/NASA, USGS. Contains Ordnance Survey data © Crown copyright and database rights (2022). OS OpenData.

Coordinate System:
ETRS 1989 UTM Zone 30N

0 180 360 Feet

0 40 80 Meters

Scale	Date	Drawn By	Checked By	Approved By
1:3,000 @ A3	08/04/2024	GB	EM	LK

Suites B2 & C2
Higher Mill
Higher Mill Lane
Buckfastleigh
Devon
TQ11 0EN
www.gobeconsultants.com
+44 (0)1626 323890

GoBe APEM Group

Figure Number 9.5

Figure Reference: Ark_004_LandfallBiotopesFig9.5

Figure 9.5: Intertidal benthic ecology biotopes at the Landfall location (RPS, 2019a)

Important Ecological Features

9.5.2.28. Criteria to inform the valuation of the Important Ecological Features (IEFs) in the Benthic Subtidal and Intertidal Ecology Study Area are presented in Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Ecology Technical Report. The IEFs to be taken forward to the assessment are also presented in Table 9.6 below.

9.5.2.29. Representative biotopes for Annex I habitat features of SACs within the Benthic Subtidal and Intertidal Ecology Study Area have been derived from the description of the habitat and species found during surveys of the SACs, as presented in the NPWS site synopses (NPWS, 2014a; NPWS, 2014b).

Table 9.6: IEFs within the Benthic Subtidal and Intertidal Ecology Study Area to be Assessed

IEF	Description and representative biotopes	Protection Status	Conservation interest	Importance within the Benthic Subtidal and Intertidal Ecology Study Area
Annex I Habitat Features of SACs within the Benthic Subtidal and Intertidal Ecology Study Area				
Reefs	Rocky marine habitats or biological concretions that rise from the seabed. Wicklow Reef is an example of a subtidal reef constructed by the honeycomb worm *Sabellaria alveolata*[1]	Annex I Habitats Directive	Qualifying feature of the Wicklow Reef SAC	International – part of European designated site (Wicklow Reef SAC) National – where present but not a designated feature of a site
Sandbanks which are slight adversely covered by sea water all the time	Sandbanks which are slight adversely covered by sea water all the time. Distinct banks of sandy sediments that are permanently covered by shallow sea water, typically at depths of less than 20 m below chart datum. Blackwater Bank SAC consists of a series of sandbanks running roughly parallel to the coastline[2]	Annex I Habitats Directive	Qualifying feature of the Blackwater Bank SAC	International – part of European designated site (Blackwater Bank SAC) National – where present but not a designated feature of a site
Subtidal Habitats within the Benthic Subtidal and Intertidal Ecology Study Area				

[1] Representative biotope of LS.LBR.Sab.Salv for the Annex I Reef habitat feature of the nearby Wicklow Reef SACs has been derived from the description of the habitat and species found during surveys of the SACs, as presented in the National Park and Wildlife Service (NPWS) site synopses (NPWS, 2014a).

[2] Representative biotope of SS.SSa.IFiSa.IMoSa and SS.SSa.IFiSa.NcirBat for the Annex I sandbank habitat feature of the nearby Blackwater Bank SACs has been derived from the description of the habitat and species found during surveys of the SACs, as presented in the National Park and Wildlife Service (NPWS) site synopses (NPWS, 2014b).

IEF	Description and representative biotopes	Protection Status	Conservation interest	Importance within the Benthic Subtidal and Intertidal Ecology Study Area
Subtidal Sands Sediment	Infralittoral fine sand (JNCC code: SS.SSa.IFISa; EUNIS code: MB5 Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) Infralittoral muddy sand (JNCC code: SS.SSa.IMuSa; EUNIS code: MB5) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232)[3]	None	Of local conservation interest	Local
Subtidal Coarse and Mixed Sediments	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (JNCC code: MCR.SNemAdia; EUNIS code: MC1217)	None	Of local conservation interest	Local

[3] The representative biotope '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles' (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232) was not recorded within the latest 2021 benthic survey, but has previously been identified during previous surveys.

IEF	Description and representative biotopes	Protection Status	Conservation interest	Importance within the Benthic Subtidal and Intertidal Ecology Study Area
	Moerella spp. with venerid bivalves in infralittoral gravelly sand (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214)			
Sabellaria on Stable Sediments	*Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock (JNCC code: CR.MCR.CSab.Sspi.As; EUNIS code: MC12812) *Sabellaria spinulosa* on stable circalittoral mixed sediment (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211)	None (non-reef communities)	Of local conservation interest	Local (non-reef communities)
Moderate Energy Subtidal Rock	Moderate Energy Circalittoral rock (JNCC code: CR.MCR; EUNIS code: MC12),	None	Of local conservation interest	Local

IEF	Description and representative biotopes	Protection Status	Conservation interest	Importance within the Benthic Subtidal and Intertidal Ecology Study Area
	Flustra foliacea on slight adversely scoured silty circalittoral rock (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241) Moderate Energy Infralittoral Rock (JNCC code: IR.MIR; ENIS code: MB12)			
Intertidal Habitats within the Benthic Subtidal and Intertidal Ecology Study Area				
Barren coarse intertidal sediment	Barren littoral shingle (JNCC code: LS.LCS.Sh.BarSh; EUNIS code: MA3211) Barren littoral coarse sand (JNCC code: LS.LSa.MoSa.BarSa; EUNIS code: MA5231)	None	Of local conservation interest	Local
Moderately exposed intertidal rock	Barnacles and fucoids on moderately exposed shores (JNCC code: LR.MLR.BF; EUNIS code: MA1245) *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock (JNCC code:	None	Of local conservation interest	Local

IEF	Description and representative biotopes	Protection Status	Conservation interest	Importance within the Benthic Subtidal and Intertidal Ecology Study Area
	LR.HLR.MusB.Sem.Sem; EUNIS code: MA12231)			

9.5.3 'Do nothing' scenario

9.5.3.1. Annex IV of the EIA Directive sets out the information required to be included in an EIAR. This includes "a description of the relevant aspects of the current state of the environment (baseline scenario) and an outline of the likely evolution thereof without implementation of the project as far as natural changes from the baseline scenario can be assessed with reasonable effort on the basis of the availability of environmental information and scientific knowledge". In the event that the Proposed Development does not proceed, an assessment of the future benthic baseline conditions has been carried out and is described within this section.

9.5.3.2. The baseline environment is not static and will exhibit some degree of natural change over time, due to naturally occurring cycles and processes. Therefore, when undertaking impact assessments, it is necessary to place any potential impacts in the context of the envelope of change that might occur naturally over the timescale of the Proposed Development.

9.5.3.3. In addition to potential change due to existing cycles and processes, it is also important to recognise and consider the potential effects of climate change on the marine environment. The quality of the marine environment and integrity of marine ecosystems, is at risk from the impact of global climate change including increasing sea temperatures, changing wind patterns, shifting oceanic circulation patterns, increasing acidification and altering precipitation rates and hence salinity (OREDP, 2010). These changes have the potential to change the distribution, abundance, size and behaviour of aquatic organisms (NPWS, 2019). Climate change impacts will change species distribution, reproduction, growth, migration and interactions (EPA, 2014).

9.5.3.4. Benthic subtidal ecology studies over the last three decades in the North Sea have indicated an increase in biomass of at least 250% to 400% (Krönke, 1995; Krönke, 2011). Furthermore, the abundance of opportunistic and short-lived species has increased; and the abundance of long-living sessile animals has decreased (Krönke, 1995; Krönke, 2011). Sea surface temperatures in Irish waters have increased at a rate of approximately 0.6°C per decade since the early 1990s and the warming observed in the last three decades has been particularly strong in parts of the north-east Atlantic, with the sea surface around Ireland warming at rates up to six times greater than the global average (OREDP, 2010; Dye *et al.* 2013).

9.5.3.5. Climate change also results in deoxygenation of the water column and there has been a measurable decline in dissolved oxygen content in the global ocean in response to sea temperature increases (Mahaffey *et al.*, 2020). Additionally, a further 7% decrease in global ocean dissolved oxygen has been predicted for the year 2100 (IPCC, 2013). Caswell *et al.* (2018), conducted a 26-year monitoring study of a benthic community within the Firth of Clyde, UK. The study concluded that benthic communities had been impacted by the decreasing levels of oxygen including changes to morphology, burrowing depth, bioturbation and feeding mode (Caswell *et al.* 2013). These findings are also in line with other short-term studies from Breitburg *et al.* (2018) and Levin *et al.* (2009).

9.5.3.6. A consideration of the future baseline, including the associated variation, is provided in the context of the operating lifetime of the Proposed Development. For the current purposes of this EIAR Chapter, the Representative Concentration Pathway (RCP) 8.5 (high emissions) scenario (Palmer *et al.*, 2018) has been considered as a future baseline and is the worst-case climate change scenario. UK Climate Projections, 2018 (UKCP18) estimates an increase in mean sea level (MSL) of 0.6 to 0.8 m at 2100 along the eastern coast of Ireland (Palmer *et al.*, 2018) and an extreme sea level (RCP 8.5; 100-year event) rise of 3.28 m at 2100 at the nearest data point (approximately 25 km north from Arklow) has been predicted (Vousdoukas *et al.*, 2018).

9.5.3.7. Wave energy is predicted to increase, such that by 2100 an increase of up to 5% of the 100-year return period has been modelled in the Celtic Sea (RCP 8.5 scenario; Meucci *et al.*, 2020). Of note however, is that there is no significant increase in the frequency of occurrence of these events over the same period (Meucci *et al.*, 2020). Assessments of historical wave buoy data has

shown a general increase in storminess around Ireland since 2004 (RPS, 2021b). Storminess has also been linked to the cyclic behaviour of the North Atlantic Oscillation (NAO), with pronounced cyclical frequency changes occurring since the 1940s at a quasi-decadal scale (Devoy, 2009).

9.5.3.8. The coast, specifically between Arklow and 4 km to the north, is predicted to undergo erosion by 2050, based on existing management and climate conditions (OPW, 2023; Vousdoukas *et al.*, 2020).

9.5.3.9. The baseline environment within the Benthic Subtidal and Intertidal Study Area for the Proposed Development described in section 9.5.2 is a 'snapshot' of the present benthic ecosystem within a gradually yet continuously changing environment. Any changes that may occur during the 36.5-year design life span of the Proposed Development should be considered in the context of both greater variability and sustained trends occurring on national and international scales in the marine environment.

9.5.3.10. Should the Proposed Development not be constructed, the future baseline environment is likely to evolve in accordance with the natural variations summarised above.

9.5.4 Data limitations

9.5.4.1. The data sources used in this chapter are detailed in Table 9.3 and Table 9.4. The desktop data used are the most up to date publicly available information which can be obtained from the applicable data sources as cited. Data that has been collected is based on existing literature and site-specific surveys which provide information for the likely benthic subtidal and intertidal habitats and species present.

9.5.4.2. Benthic surveys, whilst providing detailed information on the sediment types and fauna present, represent point samples that must be interpreted in combination with the other appropriate datasets. As mentioned in section 9.5.2, several site-specific benthic surveys have been conducted and replicated over a 20-year period which show good validation against desktop data. It is noted that the majority of anchor dredge stations sampled during site-specific surveys were located just beyond the boundary of the Array Area and Cable Corridor and Working Area but still within the Benthic Subtidal and Intertidal Study Area, whilst four stations were sampled within the Array Area and four stations were sampled within the Cable Corridor and Working Area.

9.5.4.3. The classification of survey data into benthic habitats/biotopes, while highly useful for assessment purposes, has two main limitations:

- Difficulties in defining the precise extents of each biotope, even when using site specific geophysical survey data to characterise the seabed; and
- There is generally a transition from one biotope to another, rather than fixed limits and therefore, the boundaries of where one biotope ends, and another starts often cannot be precisely defined.

9.5.4.4. As mentioned above, the biotope '*Sabellaria* spinulosa on stable circalittoral mixed sediment' was recorded at some stations during site-specific surveys. However, none of these were recorded within the Array Area and Cable Corridor and Working Area. Confirmatory surveys will include a geophysical survey carried out prior to construction which will confirm the location and extent of any potential areas of Annex I *Sabellaria* reef habitat which will then be ground truthed via underwater video (i.e. ROV). Any areas of Annex I *Sabellaria* reef habitat identified will be avoided via micro-routing and micro-siting of infrastructure. In addition, the presence of Annex I bedrock or stony reef will be identified and avoided via micro-routing and micro-siting.

9.5.4.5. The results of the site-specific intertidal survey (RPS, 2019a) were based on qualitative Phase I survey techniques, with on-site digs to semi-quantitatively record fauna. Results of the survey indicated only two habitat types (see 9.5.2.26) and no fauna were observed during the on-site

digs. However, this is not unexpected for the habitats identified and it is considered highly unlikely that the habitat types in the intertidal zone will have changed notably since the survey in 2019.

9.5.4.6. As mentioned in section 9.5, the assessment of sediment contamination encompassed a thorough evaluation of various contaminant types (i.e. PAHs, THC, PCBs, organotins and metals), where site-specific samples of the Array Area revealed no indications of reportable contamination and did not exceed lower Irish ALs (Ramboll Environ UK Ltd, 2016). The transitional water (Avoca Estuary) samples, from 2009, were more notable. However, it is anticipated that much of the pollution (i.e. heavy metals and DBT) identified from Avoca Estuary samples were largely due to historical and legacy pollutants and therefore are likely to continue to reduce as the source inputs reduce (EPA, 2016 – 2019). This point is further backed up by the more recent report by RPS (2021a), using sediment chemistry trend analysis, showed that metals, PCBs and PAHs presented decreasing trends at sample locations in Dublin Port from 2006 to 2020 (RPS, 2021a). While a decrease in contamination sources based on the general trend of reducing historic pollution sources, there is still a present risk of pollution (e.g. wastewater and agricultural run-off). Of note, the low proportion of fines and majority sand and gravel sediments found in the Study Area are accepted to carry a much lower contamination risk. Furthermore, cross-referencing site-specific data (Ramboll Environ UK Ltd, 2016) with existing surveys (RPS, 2021; Arklow Port 2009) conducted in nearby areas enhances the validation of the findings. Therefore, it is not anticipated that sediment contamination is present in the MW&SQ Study Area in concentrations that are likely to cause ecotoxicological effects or exceed the Irish Action Levels.

9.6 Impact assessment methodology

9.6.1 Key parameters for assessment

9.6.1.1. The assessment of significance of effects has been carried out on both of the two discrete project design options detailed in Volume II, Chapter 4: Description of Development. This approach has allowed for a robust and full assessment of the Proposed Development.

9.6.1.2. The two project design options and parameters relevant to each potential impact are detailed in Table 9.7 and Table 9.8.

Table 9.7: Project design parameters and impacts assessed – Project Design Option 1

Potential impact	Phase			Project design option 1
	C	O	D	
Impact 1 – Temporary subtidal habitat loss/disturbance	✓	✓	✓	**Construction phase** 9,929,060 m^2 of temporary subtidal habitat loss during the construction phase will occur as a result of: <u>Site investigation:</u> A suite of site (Array Area, Cable Corridor and Working Area) investigations will be undertaken to confirm on the seabed and geological conditions prior to the installation of the infrastructure. Complete details of the full suite of surveys proposed are provided in Volume II, Chapter 4: Description of Development. Those which are relevant to Temporary subtidal habitat loss/disturbance are: <u>Geotechnical survey:</u> • boreholes (131 samples); • CPT (431 samples); • vibrocore/ gravity core (300 samples); and • grab samples (240 samples). <u>Metocean survey:</u> • Floating LiDAR (includes seabed anchor points); • Acoustic Doppler Current Profiler (ADCP) (deployed on a seabed frame and includes mooring structure); and • Wave buoy (includes seabed mooring). <u>Sediment dynamics survey:</u> • Benthic flume; • Benthic lander (ballasted structure which requires no mooring/ anchor).

Potential impact	Phase			Project design option 1
	C	O	D	
				Site preparation: Site preparation activities prior to inter-array, interconnector, and offshore export cable installation to include sandwave clearance. Total of 4,219,460 m^2 temporary habitat loss and disturbance. • For inter-array cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the inter-array cables length. Total seabed area of 2,562,000 m^2. • For export cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the export cables length. Total seabed area of 840,000 m^2. • For OSP interconnector, sandwaves cleared along a width of 70 m, to a depth of 0-2.5 m, along 30% of the OSP interconnector length. Total seabed area of 588,000 m^2. • For scour protection, sandwaves cleared along a diameter of 99 m, to a depth of 10 m, along 50%. Total seabed area of 215,540 m^2. • For OSP/WTG installation, sandwaves cleared along a diameter of 100 m, to a depth of 5 m, at 20% of locations. Total seabed area of 13,920 m^2. Site preparation activities also include boulder clearance ploughing and picking of 100% of inter-array, export and interconnector cables at a width of 15 m and depth of 500 mm equating to a total of 2,850,000 m^2 temporary habitat loss and disturbance. Foundation installation: WTGs and OSPs installed on monopile foundations: • Drilled installation of 25 WTG piles 7-11 m in diameter at 0.2 – 1.0 m/h to full depth of 37 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 132,000 m^3 of drill arisings. • Drilled installation of 2 OSP piles 7-14 m in diameter at 0.2 – 1.0 m/h to full depth of 45 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 27,720 m^3 of drill arisings.

Potential impact	Phase C O D	Project design option 1

Potential refusal of monopolies during construction (where required). Volume of 4,474 m^3 per refusal and a total volume of 22,370 m^3 for a maximum of 5 refusals.

1,100 m^2 of habitat loss/disturbance during UXO clearance.

Cable installation:

Installation of inter-array, export and interconnector cables, equating to a total of 2,850,000 m^2 temporary habitat loss and disturbance:

- For inter-array cables, total length of 110-122 km with a seabed disturbance width of 15 m equating to 1,830,000 m^2 of seabed disturbance.
- For export cable, total length of 35-40 km with a seabed disturbance width of 15 m equating to 600,000 m^2 of seabed disturbance.
- For interconnector, total length of 25-28 km with a seabed disturbance width of 15 m equating to 420,000 m^2 of seabed disturbance.

Vessels:

- Disturbance of 278,400 m^2 of seabed from jack-up barge across construction period, with a total combined leg area of 1,200 m^2 per jack-up barge.

Operational and maintenance phase

WTG and OSP scour protection:

Repair and maintenance of scour protection for all WTG and OSP assets every five years.

Cable repair and maintenance:

Operational dredging of inter-array, export and interconnector cables:

- For inter-array cables, operational dredging of 300,000 m^3 every five years.

Potential impact	Phase			Project design option 1
	C	O	D	
				• For export cable and interconnector cables, operational dredging of 100,000 m^3 every five years. • Total area of 275,000 m^2 of temporary habitat loss. Inter-array, export and interconnector cable repair/reburial activities: • For inter-array cables, repair and reburial of cables between 110 km and 122 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 1.5 m deep trench (cable repair and reburial once every three years). • For export cables, repair and reburial of cables between 35 km and 40 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 2.5 m deep trench (cable repair and re-burial once every five years). • Interconnector cables: repair and reburial of cables of between 25 km and 28 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 10 m deep trench (cable repair and reburial once every three years). <u>Jack-up Vessels:</u> Presence of jack-up vessels during operational and maintenance activities: Disturbance of 613,200 m^2 of seabed from jack-up barge across O&M period, with a total combined maximum leg area of 1,200 m^2 per jack-up barge. **Decommissioning phase** • Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.

Potential impact	Phase			Project design option 1
	C	O	D	
Impact 2 – Increased suspended sediment concentrations and associated deposition	✓	✓	✓	**Construction phase** Site investigation: A suite of site (Array Area, Cable Corridor and Working Area) investigations will be undertaken to confirm on the seabed and geological conditions prior to the installation of the infrastructure. Complete details of the full suite of surveys proposed are provided in Volume II, Chapter 4: Description of Development. Those which are relevant to Increased suspended sediment concentrations and associated deposition are: Geotechnical survey: • boreholes (131 samples); • CPT (431 samples); • vibrocore/ gravity core (300 samples); and • grab samples (240 samples). Metocean survey: • Floating LiDAR (includes seabed anchor points); • Acoustic Doppler Current Profiler (ADCP) (deployed on a seabed frame and includes mooring structure); and • Wave buoy (includes seabed mooring). Sediment dynamics survey: • Benthic flume; • Benthic lander (ballasted structure which requires no mooring/ anchor). Site preparation:

Potential impact	Phase			Project design option 1
	C	O	D	
				Site preparation activities prior to inter-array, interconnector, and offshore export cable installation to include sandwave clearance: • For inter-array cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the inter-array cables length. Total volume of 1,000,000 m^3. • For export cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the export cables length. Total volume of 500,000 m^3. • For OSP interconnector, sandwaves cleared along a width of 70 m, to a depth of 0-2.5 m, along 30% of the OSP interconnector length. Total volume of 500,000 m^3. • For scour protection, sandwaves cleared along a diameter of 99 m, to a depth of 10 m, along 50%. Total volume of 1,000,000 m^3. • For OSP/WTG installation, sandwaves cleared along a diameter of 100 m, to a depth of 5 m, at 20% of locations. Total volume of 139,200 m^3. Sandwave clearance has been modelled at representative locations across the Array Area and Cable Corridor and Working Area. Site preparation activities also include boulder clearance ploughing and picking of 100% of inter-array, export and interconnector cables at a width of 15 m and depth of 500 mm equating to a total seabed area of 2,850,000 m^2. <u>Foundation installation:</u> WTGs and OSPs installed on monopile foundations: • Drilled installation of 25 WTG piles 7-11 m in diameter at 0.2 – 1.0 m/h to full depth of 37 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 132,000 m^3 of drill arisings. • Drilled installation of 2 OSP piles 7-14 m in diameter at 0.2 – 1.0 m/h to full depth of 45 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 27,720 m^3 of drill arisings.

Potential impact	Phase			Project design option 1
	C	O	D	
				Modelled at representative locations across the Array Area. <u>Potential refusal of monopolies during construction (where required). Volume of 4,474 m^3 per refusal and a total volume of 22,370 m^3 for a maximum of 5 refusals.</u> <u>Cable installation:</u> • For inter-array cables, total length of 110 – 122 km with a seabed disturbance width of 15 m equating to 1,830,000 m^2 of seabed disturbance. • For export cable, total length of 35 – 40 km with a seabed disturbance width of 15 m equating to 600,000 m^2 of seabed disturbance. • For interconnector, total length of 25-28 km with a seabed disturbance width of 15 m equating to 420,000 m^2 of seabed disturbance. Modelled at representative locations across Array Area and Cable Corridor and Working Area. **Operational and maintenance phase** <u>Cable repair and maintenance:</u> Operational dredging of inter-array, export and interconnector cables: • For inter-array cables, operational dredging of 300,000 m^3 every five years. • For export cable and interconnector cables, operational dredging of 100,000 m^3 every five years.

Potential impact	Phase			Project design option 1
	C	O	D	
				Inter-array, export and interconnector cable repair/reburial activities: • For inter-array cables, repair and reburial of cables between 110 km and 122 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 1.5 m deep trench (cable repair once every three years and cable re-burial once every three years). • For export cables, repair and reburial of cables between 30 km and 40 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 2.5 m deep trench (cable repair once every five years and cable re-burial once every five years). • Interconnector cables: repair and reburial of cables of between 25 km and 28 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 10 m deep trench (cable repair once every three years and cable re-burial once every three years). <u>Jack-up Vessels:</u> Presence of jack-up vessels during operational and maintenance activities: • Disturbance of 613,200 m^2 of seabed from jack-up barge across construction period. **Decommissioning phase** Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.
Impact 3 – Injury and/or disturbance from underwater noise and vibration	✓	×	×	**Construction phase** <u>Foundation installation:</u> WTGs installed on monopile foundations:

Potential impact	Phase C O D	Project design option 1
		• Installation of 56 WTGs with a pile diameter between 7 and 11 m within the Array Area. • Maximum of one foundation installed at any one time (within any 24 hour period). • Maximum hammer energy 6,600 kJ, average hammer energy 4,400 kJ and a strike rate of 30 strikes per minute. • Soft start at 825 kJ. • Maximum duration of piling at 5 hours per pile with an average duration of 4 hours per pile. • Maximum piling per day of 5 hours 10 minutes. • Expected total of approximately 75 days when piling over construction period. • Drilled installation of 25 WTG piles 7-11 m in diameter at 0.2 – 1.0 m/h to full depth of 37 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 132,000 m^3 of drill arisings. Offshore Substations Platforms (OSP) installed on monopile foundations: • Installation of two OSPs with a pile diameter between 7 and 14 m within the Array Area. • Maximum of one foundation installed at any one time (within any 24 hour period). • Maximum hammer energy 6,600 kJ and an average hammer energy 6,000 kJ. • Soft start at 825 kJ. • Average duration of 5 hours per pile. • Expected total of approximately 4 days when piling over construction period. • Drilled installation of 2 OSP piles 7-14 m in diameter at 0.2 – 1.0 m/h to full depth of 45 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 27,720 m^3 of drill arisings. Unexploded Ordnance (UXO) clearance via detonation or relocation/wet storage:

Potential impact	Phase			Project design option 1
	C	O	D	
				The type, size and number of possible UXO that may require clearance is unknown. Geophysical surveys of inter-array, interconnector and export cables every six months for the first two years and yearly after that.
Impact 4 – Long-term subtidal habitat loss/change	×	✓	×	**Operational phase** 662,800 m^2 of long-term subtidal habitat loss/change during the operational phase will occur as a result of: <u>Foundations:</u> • Presence of 56 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 2,128-5,380 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 34,440-267,624 m^2. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. <u>Cables:</u> • For inter-array cables, presence of 18,300 m of cables requiring protection (15%), equating to 146,400 m^2. • For export cables, presence of 8,000 m of cable requiring protection (20%), equating to 64,000 m^2. • For export cables, presence of cable crossings, equating to 750-24,000 m^2.

Potential impact	Phase			Project design option 1
	C	O	D	
				• For interconnector, presence of 14,000 m of cables requiring protection (50%), equating to 140,000 m^2.
Impact 5 – Colonisation of hard structures	✓	✓	✓	**Construction** The colonisation of slow moving and stationary vessels and a potential 662,800 m^2 and 1,460,644 m^3 of hard structures during the construction phase as a result of: <u>Foundations:</u> • Presence of 56 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 2,128-5,380 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 34,440-267,624 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 17,192-802,872 m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 614-30,172 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3.

Potential impact	Phase C O D	Project design option 1
		• For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3. <u>Vessels:</u> • Maximum of 66 installation vessels at any one time (including 12 installation vessels along the offshore export cable routes at any one time, and maximum of 7 installation vessels in the vicinity of the Landfall at any one time) during the construction phase. • Maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels. **Operational and maintenance phase** The colonisation of a potential 662,800 m^2 and 1,460,644 m^3 of hard structures during the operational and maintenance phase as a result of: <u>Foundations:</u> • Presence of 56 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 2,128-5,380 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2.

Potential impact	Phase			Project design option 1
	C	O	D	
				• For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 34,440-267,624 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 17,192-802,872m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 14,429-678,163 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3. • For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3. **Decommissioning** • Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.
Impact 6 – Alteration of seabed habitat arising from effects on physical processes	×	✓	×	**Operational and maintenance phase** <u>Foundations:</u>

Potential impact	Phase			Project design option 1
	C	O	D	
				• Presence of 56 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 2,128-5,380 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 34,440-267,624 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 17,192-802,872m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 14,429-678,163 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3. • For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3.
Impact 7 – Removal of hard substrates resulting in loss of colonising communities	×	×	✓	**Decommissioning phase** Removal of WTGs and OSPs on monopile foundations:

Potential impact	Phase			Project design option 1
	C	O	D	
				• For the WTG and OSP foundations, removal of 56 WTGs with base diameter of 7-11 m and two OSPs with base diameter of 7-14 m, equating to 5,690 m^2. • Scour protection, cables and cable protection would be left *in situ*.
Impact 8 – Increased risk of introduction and spread of invasive and non-native species	✓	✓	✓	**Construction phase** <u>Vessels:</u> Presence and movement of vessels during the construction phase: • Maximum of 66 installation vessels at any one time (including 12 installation vessels along the offshore export cable routes at any one time, and maximum of 7 installation vessels in the vicinity of the Landfall at any one time) during the construction phase. • Maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels. **Operational and maintenance phase** <u>Foundations:</u> • Presence of 56 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 2,128-5,380 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 34,440-

Potential impact	Phase C O D	Project design option 1
		267,624 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 17,192-802,872m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 14,429-678,163 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3. • For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 <u>Vessels:</u> Presence and movement of vessels during the operational and maintenance phase: • Maximum of 30 operational and maintenance vessels at any one time during the operational and maintenance phase; and • Maximum of 1,359 vessel return trips per year during the operational and maintenance phase, comprised of crew transfer vessels, jack-up vessels, cable repair vessels, Service Operations Vessels (SOV), SOV daughter draft and excavator or backhoe dredger vessels.

Potential impact	Phase			Project design option 1
	C	O	D	
				Decommissioning phase Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*. <u>Vessels:</u> Presence and movement of vessels during the decommissioning phase (Volume III, Appendix 4.1: Rehabilitations Schedule),
Impact 9 – Accidental pollution	✓	✓	✓	**Construction phase** <u>Foundation installation:</u> • Installation of 56 WTGs and two OSPs within the Array Area. <u>Cable installation:</u> • Installation of inter-array cables between 110 – 122 km in length, OSP interconnector cables between 25 – 28 km in length, and offshore export cables between 35 – 40 km in length. <u>Vessels:</u> • 66 vessels on site at one time comprised of jack up barges, cargo, support, tug/anchor, cable installation, guard, survey, crew transfer, sandwave clearance and UXO clearance vessels. • 4,150 return trips across construction period and 1,797 return trips per year. • Construction schedule of 24 hours a day, 7 days a week for a period of five years. • 294 helicopter return trips over the construction phase and 118 helicopter return trips per year.

Potential impact	Phase C O D	Project design option 1
		Operational and maintenance phase Foundations: • Presence of 56 WTGs and two OSPs. • Maintenance activities of 56 WTGs and two OSPs. Vessels: • 30 vessels on site at one time comprised of crew transfer, jack-up, cable repair, service operations, cable survey and excavator vessels. • 1,359 return trips per year. • 485 helicopter return trips per year. **Decommissioning phase** Foundations: • Decommissioning of 56 WTGs and two OSPs Vessels: • Presence and movement of vessels during the decommissioning phase (Volume III, Appendix 4.1: Rehabilitation Schedule).

Table 9.8: Project design parameters and impacts assessed – Project Design Option 2

Potential impact	Phase			Project design option 2
	C	O	D	
Impact 1 – Temporary subtidal habitat loss/disturbance	✓	✓	✓	**Construction phase** 9,892,260 m^2 of temporary subtidal habitat loss during the construction phase will occur as a result of: <u>Site investigation:</u> A suite of site (Array Area, Cable Corridor and Working Area) investigations will be undertaken to confirm on the seabed and geological conditions prior to the installation of the infrastructure. Complete details of the full suite of surveys proposed are provided in Volume II, Chapter 4: Description of Development. Those which are relevant to Temporary subtidal habitat loss/disturbance are: <u>Geotechnical survey:</u> • boreholes (131 samples); • CPT (431 samples); • vibrocore/ gravity core (300 samples); and • grab samples (240 samples). <u>Metocean survey:</u> • Floating LiDAR (includes seabed anchor points); • Acoustic Doppler Current Profiler (ADCP) (deployed on a seabed frame and includes mooring structure); and • Wave buoy (includes seabed mooring). <u>Sediment dynamics survey:</u> • Benthic flume; • Benthic lander (ballasted structure which requires no mooring/ anchor).

Site preparation:

Site preparation activities prior to inter-array, interconnector, and offshore export cable installation to include sandwave clearance, equating to a total of 4,182,660 m^2 temporary habitat loss and disturbance.

- For inter-array cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the inter-array cables length, equating to a seabed area of 2,562,000 m^2.
- For export cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the export cables length, equating to a seabed area of 840,000 m^2.
- For OSP interconnector, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the OSP interconnector length, equating to a seabed area of 588,000 m^2.
- For scour protection, sandwaves cleared along a diameter of 99 m, to a depth of 10 m, along 50%, equating to a seabed area of 180,900 m^2.
- For OSP/WTG installation, sandwaves cleared along a diameter of 100 m, to a depth of 5 m, at 20% of locations, equating to a seabed area of 11,760 m^2.

Site preparation activities also include boulder clearance ploughing and picking of 100% of inter-array, export and interconnector cables at a width of 15 m and depth of 500 mm equating to a total of 2,850,000 m^2 temporary habitat loss and disturbance.

Foundation installation:

WTGs and OSPs installed on monopile foundations:

- Drilled installation of 25 WTG piles 7-11 m in diameter at 0.2 – 1.0 m/h to full depth of 37 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 176,000 m^3 of drill arisings.
- Drilled installation of 2 OSP piles 7-14 m in diameter at 0.2 – 1.0 m/h to full depth of 45 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 27,720 m^3 of drill arisings.

Potential impact	Phase			Project design option 2
	C	O	D	
				Potential refusal of monopolies during construction (where required). Volume of 4,474 m^3 per refusal and a total volume of 22,370 m^3 for a maximum of 5 refusals. 1,200 m^2 of habitat loss/disturbance per UXO clearance. <u>Cable installation:</u> Installation of inter-array, export and interconnector cables, equating to a total of 2,850,000 m^2 temporary habitat loss and disturbance: • For inter-array cables, total length of 110 – 122 km with a seabed disturbance width of 15 m equating to 1,830,000 m^2 of seabed disturbance. • For export cable, total length of 35-40 km with a seabed disturbance width of 15 m equating to 600,000 m^2 of seabed disturbance. • For interconnector, total length of 25-28 km with a seabed disturbance width of 15 m equating to 420,000 m^2 of seabed disturbance. <u>Vessels:</u> • Disturbance of 278,400 m^2 of seabed from jack-up barge across construction period, with a total combined leg area of 1,200 m^2 per jack-up barge. **Operational and maintenance phase** <u>Cable repair and maintenance:</u> Operational dredging of inter-array, export and interconnector cables: • For inter-array cables, operational dredging of 300,000 m^3 every five years. • For export cable and interconnector cables, operational dredging of 100,000 m^3 every five years. • Total area of 275,000 m^2 of temporary habitat loss. Inter-array, export and interconnector cable repair/reburial activities:

Potential impact	Phase			Project design option 2
	C	O	D	
				• For inter-array cables, repair and reburial of cables between 110 km and 122 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 1.5 m deep (cable repair and reburial once every three years). • For export cables, repair and reburial of cables between 35 km and 40 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 2.5 m deep trench (cable repair once every five years and cable re-burial once every five years). • Interconnector cables: repair and reburial of cables of between 25 km and 28 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 2.5 m deep trench (cable repair and reburial once every three years). <u>Jack-up Vessels:</u> Presence of jack-up vessels during operational and maintenance activities: • Disturbance of 613,200 m^2 of seabed from jack-up barge across O&M period, with a total combined maximum leg area of 1,200 m^2 per jack-up barge. **Decommissioning phase** • Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.
Impact 2 – Increased suspended sediment concentrations and associated deposition	✓	✓	✓	**Construction phase** <u>Site investigation:</u> A suite of site (Array Area, Cable Corridor and Working Area) investigations will be undertaken to confirm on the seabed and geological conditions prior to the installation of the infrastructure. Complete details of the full suite of surveys proposed are provided in Volume II, Chapter 4: Description of Development. Those which are relevant to Increased suspended sediment concentrations and associated deposition are: <u>Geotechnical survey:</u>

Potential impact	Phase C O D	Project design option 2
		• boreholes (131 samples); • CPT (431 samples); • vibrocore/ gravity core (300 samples); and • grab samples (240 samples). <u>Metocean survey:</u> • Floating LiDAR (includes seabed anchor points); • Acoustic Doppler Current Profiler (ADCP) (deployed on a seabed frame and includes mooring structure); and • Wave buoy (includes seabed mooring). <u>Sediment dynamics survey:</u> • Benthic flume; • Benthic lander (ballasted structure which requires no mooring/ anchor). <u>Site preparation:</u> Site preparation activities prior to inter-array, interconnector, and offshore export cable installation to include sandwave clearance: • For inter-array cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the inter-array cables length. Total volume of 1,000,000 m^3. • For export cables, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the export cables length. Total volume of 500,000 m^3. • For OSP interconnector, sandwaves cleared along a width of 70 m, to a depth of 10 m, along 30% of the OSP interconnector length. Total volume of 500,000 m^3. • For scour protection, sandwaves cleared along a diameter of 99 m, to a depth of 10 m, along 50%. Total volume of 1,000,000 m^3.

Potential impact	Phase			Project design option 2
	C	O	D	

- For OSP/WTG installation, sandwaves cleared along a diameter of 100 m, to a depth of 5 m, at 20% of locations. Total volume of 117,600 m^3.

Sandwave clearance has been modelled at representative locations across the Array Area and Cable Corridor and Working Area.

Site preparation activities also include boulder clearance ploughing and picking of 100% of inter-array, export and interconnector cables at a width of 15 m and depth of 500 mm equating to a total seabed area of 2,850,000 m^2.

Foundation installation:

WTGs and OSPs installed on monopile foundations:

- Drilled installation of 25 WTG piles 7-11 m in diameter at 0.2 – 1.0 m/h to full depth of 37 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 176,000 m^3 of drill arisings.
- Drilled installation of 2 OSP piles 7-14 m in diameter at 0.2 – 1.0 m/h to full depth of 45 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 27,720 m^3 of drill arisings.

Modelled at representative locations across the Array Area.

Potential refusal of monopolies during construction (where required). Volume of 4,474 m^3 per refusal and a total volume of 22,370 m^3 for a maximum of 5 refusals.

Cable installation:

- For inter-array cables, total length of 110 – 122 km with a seabed disturbance width of 15 m equating to 1,830,000 m^2 of seabed disturbance.
- For export cable, total length of 35 – 40 km with a seabed disturbance width of 15 m equating to 600,000 m^2 of seabed disturbance.
- For interconnector, total length of 25-28 km with a seabed disturbance width of 15 m equating to 420,000 m^2 of seabed disturbance.

Modelled at representative locations across Array Area and Cable Corridor and Working Area.

Operational and maintenance phase

Cable repair and maintenance:

Operational dredging of inter-array, export and interconnector cables:

- For inter-array cables, operational dredging of 300,000 m^3 every five years.
- For export cable and interconnector cables, operational dredging of 100,000 m^3 every five years.

Inter-array, export and interconnector cable repair/reburial activities:

- For inter-array cables, repair and reburial of cables between 110 km and 122 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 1.5 m deep trench (cable repair and reburial once every three years).
- For export cables, repair and reburial of cables between 30 km and 40 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 2.5 m deep trench (cable repair once every five years and cable re-burial once every five years).
- Interconnector cables: repair and reburial of cables of between 25 km and 28 km in length over the lifetime of the Proposed Development with disturbance of seabed material from 15 m wide and 2.5 m deep trench (cable repair and reburial once every three years).

Jack-up Vessels:

Presence of jack-up vessels during operational and maintenance activities:

- Disturbance of 613,200 m^2 of seabed from jack-up barge across construction period.

Decommissioning phase

Potential impact	Phase			Project design option 2
	C	O	D	
				Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.
Impact 3 – Injury and/or disturbance from underwater noise and vibration	✓	×	×	**Construction phase** <u>Foundation installation:</u> WTGs installed on monopile foundations: • Installation of 47 WTGs with a pile diameter between 7 and 11 m within the Array Area. • Maximum of one foundation installed at any one time (within any 24 hour period). • Maximum hammer energy 6,600 kJ, average hammer energy 4,400 kJ and a strike rate of 30 strikes per minute. • Soft start at 825 kJ. • Maximum duration of piling at 5 hours per pile with an average duration of 4 hours per pile. • Maximum piling per day of 5 hours 10 minutes. • Expected total of approximately 63 days when piling over construction period. • Drilled installation of 25 WTG piles 7-11 m in diameter at 0.2 – 1.0 m/h to full depth of 37 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 132,000 m^3 of drill arisings. Offshore Substations Platforms (OSP) installed on monopile foundations: • Installation of two OSPs with a pile diameter between 7 and 14 m within the Array Area. • Maximum of one foundation installed at any one time (within any 24 hour period). • Maximum hammer energy 6,600 kJ and an average hammer energy 6,000 kJ. • Soft start at 825 kJ. • Average duration of 4 hours per pile. • Expected total of approximately 4 days when piling over construction period. • Drilled installation of 2 OSP piles 7-14 m in diameter at 0.2 – 1.0 m/h to full depth of 45 m. 1 concurrent drilling event with a drilling duration per pile of up to 88 hours and a total volume of approximately 27,720 m^3 of drill arisings.

Potential impact	Phase			Project design option 2
	C	O	D	
				Unexploded Ordnance (UXO) clearance via detonation or relocation/wet storage: The type, size and number of possible UXO that may require clearance is unknown. Geophysical surveys of inter-array, interconnector and export cables every six months for the first two years and yearly after that.
Impact 4 – Long-term subtidal habitat loss/change	×	✓	×	**Operational phase** 618,930 m^2 of long-term subtidal habitat loss/change during the operational phase will occur as a result of: <u>Foundations:</u> • Presence of 47 WTGs with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 1,786-4,512 m^2. • Presence of two OSPs with base diameter of 7-14 m and seabed footprint of 38-154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 224,613 m^2. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. <u>Cables:</u> • For inter-array cables, presence of 18,300 m of cables requiring protection (15%), equating to 146,400 m^2. • For export cables, presence of 8,000 m of cable requiring protection (20%), equating to 64,000 m^2. • For export cables, presence of cable crossings, equating to 750-24,000 m^2. • For interconnector, presence of 14,000 m of cables requiring protection (50%), equating to 140,000 m^2.

Potential impact	Phase			Project design option 2
	C	O	D	
Impact 5 – Colonisation of hard structures	✓	✓	✓	**Construction** The colonisation of slow moving and stationary vessels and a potential 618,930 m^2 and 1,335,935 m^3 of hard structures during the construction phase as a result of: <u>Foundations:</u> • Presence of 47 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 1,786-4,521 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 244,163 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 14,429-678,163 m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 614-30,172 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3. • For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3. <u>Vessels:</u>

Potential impact	Phase C O D	Project design option 2
		• Maximum of 66 installation vessels at any one time (including 12 installation vessels along the offshore export cable routes at any one time, and maximum of 7 installation vessels in the vicinity of the Landfall at any one time) during the construction phase. • Maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels. **Operational and maintenance phase** The colonisation of a potential 618,930 m^2 and 1,335,935 m^3 of hard structures during the operational and maintenance phase as a result of: <u>Foundations:</u> • Presence of 47 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 1,786-4,521 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 244,163 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 14,429-678,163 m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 614-30,172 m^3 for OWF. Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u>

Potential impact	Phase			Project design option 2
	C	O	D	
				• For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3. • For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3. **Decommissioning** • Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.
Impact 6 – Alteration of seabed habitat arising from effects on physical processes	×	✓	×	**Operational and maintenance phase** <u>Foundations:</u> • Presence of 47 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 1,786-4,521 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 244,163 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 14,429-678,163 m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 614-30,172 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3.

Potential impact	Phase			Project design option 2
	C	O	D	
				• For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3.
Impact 7 – Removal of hard substrates resulting in loss of colonising communities	×	×	✓	**Decommissioning phase** Removal of WTGs and OSPs on monopile foundations: • For the WTG and OSP foundations, removal of 47 WTGs with base diameter of 7-11m and two OSPs with base diameter of 7-14 m equating to 4,831 m^2. • Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*.
Impact 8 – Increased risk of introduction and spread of invasive and non-native species	✓	✓	✓	**Construction phase** <u>Vessels:</u> Presence and movement of vessels during the construction phase: • Maximum of 66 installation vessels at any one time (including 12 installation vessels along the offshore export cable routes at any one time, and maximum of 7 installation vessels in the vicinity of the Landfall at any one time) during the construction phase. • Maximum of 4,150 vessel return trips over the construction phase and a maximum of 1,797 vessel return trips per year during the construction phase, comprised of jack-up vessels, tug/anchor handlers, cable installation vessels, guard vessels, survey vessels, crew transfer vessels, scour/cable protection installation vessels, pre-installation boulder clearance vessels, sandwave clearance vessels, UXO clearance vessels and other support vessels. **Operational and maintenance phase** <u>Foundations:</u>

Potential impact	Phase			Project design option 2
	C	O	D	
				• Presence of 47 Wind Turbine Generators (WTGs) with base diameter of 7-11m and seabed footprint of 38-96 m^2 per pile, equating to a total seabed footprint of 1,786-4,521 m^2. • Presence of two Offshore Substation Platforms (OSPs) with base diameter of 7-14 m and seabed footprint of 154 m^2 per pile, equating to a total seabed footprint of 76-310 m^2. • For the WTG foundations, presence of 615-4,779 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 244,163 m^2. Total scour protection volume of 307-14,429 m^3 per WTG foundation and total volume of 14,429-678,163 m^3. • For OSPs, presence of 615-7,543 m^2 of scour protection (scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers) per pile, equating to a total seabed footprint of 1,230-15,086 m^2. Total scour protection volume of 307-22,629 m^3 per OSP and total volume of 614-30,172 m^3 for OWF. • Scour protection material type may include scour mattresses, rock dumping, artificial fronds, rock bags and/or geotextile sand containers. <u>Cables:</u> • For inter-array cables, total cable protection footprint of 146,400 m^2 and volume of 219,600 m^3. • For export cables, total cable protection footprint of 64,000 m^2 and volume of 96,000 m^3. • For export cables, total of cable crossings required, with a total cable crossings footprint of 750-24,000 m^2 and volume of 375-60,000 m^3. • For interconnector cables, total cable protection footprint of 140,000 m^2 and volume of 252,000 m^3. <u>Vessels:</u> Presence and movement of vessels during the operational and maintenance phase: • Maximum of 30 operational and maintenance vessels at any one time during the operational and maintenance phase; and • Maximum of 1,359 vessel return trips per year during the operational and maintenance phase, comprised of crew transfer vessels, jack-up vessels, cable repair vessels, Service Operations Vessels (SOV), SOV daughter draft and excavator or backhoe dredger vessels.

Potential impact	Phase			Project design option 2
	C	O	D	
				Decommissioning phase Piles will be cut 2 m below the seabed and lifted. Scour protection, cables and cable protection would be left *in situ*. <u>Vessels:</u> Presence and movement of vessels during the decommissioning phase (Volume III, Appendix 4.1: Rehabilitation Schedule).
Impact 9 – Accidental pollution	✓	✓	✓	**Construction phase** <u>Foundation installation:</u> • Installation of 47 WTGs and two OSPs within the Array Area. <u>Cable installation:</u> • Installation of inter-array cables between 110 – 122 km in length, OSP interconnector cables between 25 – 28 km in length, and offshore export cables between 35 – 40 km in length. <u>Vessels:</u> • 66 vessels on site at one time comprised of jack up barges, cargo, support, tug/anchor, cable installation, guard, survey, crew transfer, sandwave clearance and UXO clearance vessels. • 4,150 return trips across construction period and 1,797 return trips per year. • Construction schedule of 24 hours a day, 7 days a week for a period of five years. • 294 helicopter return trips over the construction phase and 118 helicopter return trips per year. **Operational and maintenance phase**

Potential impact	Phase			Project design option 2
	C	O	D	
				Foundations: • Presence of 47 WTGs and two OSPs. • Maintenance activities of 47 WTGs and two OSPs. Vessels: • 30 vessels on site at one time comprised of crew transfer, jack-up, cable repair, service operations, cable survey and excavator vessels. • 1,359 return trips per year. • 485 helicopter return trips per year. **Decommissioning phase** Foundations: • Decommissioning of 56 WTGs and two OSPs Vessels: Presence and movement of vessels during the decommissioning phase (Volume III, Appendix 4.1: Rehabilitation Schedule).

9.6.2 Impacts scoped out of the assessment

9.6.2.1. On the basis of the baseline environment and the description of development outlined in Volume II, Chapter 4: Description of Development, a number of impacts are proposed to be scoped out of the assessment for Benthic Subtidal and Intertidal Ecology. These impacts are outlined, together with a justification for scoping them out, in Table 9.9.

Table 9.9: Impacts scoped out of the assessment for Benthic Subtidal and Intertidal Ecology

Potential impact	Justification
Temporary and long-term intertidal habitat loss/disturbance	At the Landfall, offshore export cables are to be installed via trenchless technologies (such as HDD or direct steerable pipe thrusting), thereby avoiding any direct impacts on intertidal habitats. As such, there will be no direct impact on intertidal habitats during construction, operational and maintenance and decommissioning phases, with any direct effects of trenchless operations limited to either the terrestrial or subtidal environments. Other indirect effects on intertidal habitats, e.g. increases in suspended sediments, will remain scoped into the EIAR.
Remobilisation of contaminated sediments	Seabed disturbance associated with construction, maintenance and decommissioning activities (e.g. foundation and cable installation) could lead to the remobilisation of sediment-bound contaminants that may result in harmful and adverse effects on benthic communities. Sampling undertaken in support of a permit application to undertake dredging and disposal works for ABWP1 (Ramboll Environ UK Ltd, 2016) has demonstrated that contamination in the offshore sediments is low and at levels which are unlikely to result in adverse effects on benthic communities (further detail is presented in Volume II, Chapter 7: Marine Water and Sediment Quality). Furthermore, the coarse nature of the sediments on site (i.e. sand and gravels with minimal proportion of fines) means that significant contamination is unlikely to be present in sediments (contaminants such as metals and hydrocarbons are typically bound to fine sediments such as mud). Therefore, it is considered unlikely that there would be any pathways for an impact on benthic communities. It is therefore proposed to scope this impact out of further consideration within the EIAR for construction, operational and maintenance, and decommissioning phases.
Injury and/or disturbance from underwater noise and vibration from site investigation surveys and activities during construction generating low levels of noise.	Site investigation surveys and some construction activities (e.g. cable laying, dredging and rock placement) are not anticipated to be a consideration for Benthic Subtidal and Intertidal Ecology due to the low noise levels generated.
Injury and/or disturbance from underwater noise and vibration from activities during operational	Underwater noise and vibration generated from activities, vessels and rotating machinery during the operational and maintenance

Potential impact	Justification
and maintenance and decommissioning phases	phase, and vessels and other activities during decommissioning are anticipated to have a negligible effect on benthic ecology.

9.7 Methodology for assessing the significance of effects

9.7.1 Overview

9.7.1.1. The Benthic Subtidal and Intertidal Ecology impact assessment has followed the methodology set out in Volume II, Chapter 5: EIA Methodology. Specific to the Benthic Subtidal and Intertidal Ecology impact assessment, the following guidance documents have also been complied with:

- Guidelines on the information to be contained in Environmental Impact Assessment Reports (EPA, 2022);
- Guidance for Ecological Impact Assessment in the UK and Ireland. Terrestrial, Freshwater, Coastal and Marine (CIEEM, 2018);
- MarESA (Tyler-Walters *et al.*, 2023).

9.7.2 Impact assessment criteria

9.7.2.1. The criteria for determining the significance of effects is a two-stage process that involves defining the sensitivity of receptors and the magnitude of the impacts. This section describes the criteria applied in this chapter to assign values to the sensitivity of the receptors (Table 9.10) and the magnitude of potential impacts (Table 9.11). The terms used to define sensitivity and magnitude are adapted from those which are described in further detail in Volume II, Chapter 5: EIA Methodology.

9.7.2.2. Both sensitivity and magnitude are assessed on a four-level scale to align with the EPA (2022) guidance: High, Medium, Low and Negligible. Magnitude is also further assessed as to whether the magnitude of the impact is adverse, neutral, or positive (see Volume II: Chapter 5: EIA Methodology).

SENSITIVITY

9.7.2.3. Sensitivity refers to the potential of a receptor to be significantly affected (EPA, 2022). In defining the sensitivity for each receptor, the adaptability, tolerance, recoverability and value of that resource or user group has been taken into consideration.

9.7.2.4. The criteria used to define the sensitivity of the receptors in this chapter are outlined in Table 9.10 and based on EPA (2022) guidance.

9.7.2.5. The sensitivities of different species and biotopes have also been classified by the Marine Life Information Network (MarLIN) on the MarESA four-point scale (high, medium, low and not sensitive) and can be applied to ecological groups, which are found in the Irish Sea (Tillin and Tyler-Walters, 2014). The scale takes account of the resistance (tolerance) and resilience (recoverability) of a species or biotope in response to a stressor (Tyler-Walters *et al.*, 2023).

9.7.2.6. The MarESA methodology is based on scientific evidence and has also been used to assess sensitivity for the purposes of this assessment.

Table 9.10: Definitions of criteria relating to the sensitivity of the receptor

Receptor sensitivity	Definition
High	Adaptability: The receptor cannot avoid or adapt to an impact. Tolerance *(resistance)*: The receptor has no or very low capacity to accommodate the proposed form of change. Recoverability *(resilience)*: Negligible or prolonged recovery possible; at least 25 years to recover structure and function. Value: The receptor is of international importance.
Medium	Adaptability: The receptor has a limited ability to avoid or adapt to an impact. Tolerance: The receptor has a moderate to low capacity to accommodate the proposed form of change. Recoverability: The receptor is anticipated to recover fully within 10-25 years. Value: The receptor is of national or international importance.
Low	Adaptability: The receptor has a reasonable capacity to avoid or adapt to an impact. Tolerance: The receptor has a high capacity to accommodate the proposed form of change. Recoverability: The receptor is anticipated to recover within two-10 years Value: The receptor is of national importance.
Negligible	Adaptability: The receptor has a high capacity to avoid or adapt to an impact. Tolerance: The receptor has a high capacity to accommodate the proposed form of change. Recoverability: The receptor is anticipated to recover fully within two years. Value: The receptor is of local importance.

MAGNITUDE

9.7.2.7. In assigning magnitude, the spatial extent, duration, frequency, probability[4] and consequences of the impact from the construction, operational and maintenance, or decommissioning phases of the Proposed Development have been considered, where applicable.

9.7.2.8. The criteria used to define magnitude of impact in this chapter are outlined in Table 9.11 and based on EPA (2022) guidance. It should be noted that a combination of these factors are considered when assigning magnitude, for example a change could occur constantly throughout a relevant project phase and be permanent but the magnitude of impact could still be low if the impact was highly localised and other criteria for low magnitude applied.

[4] All impacts assessed within this EIAR Chapter are considered reasonably likely to occur, and so the probability of the impact has been a consideration in defining the magnitude of the impact.

9.7.2.9. For the purposes of the definitions below in Table 9.11, near-field has been defined as within the Array Area and Cable Corridor and Working Area. Far-field has been defined as extending beyond these limits but within the defined Benthic Subtidal and Intertidal Ecology Study Area.

Table 9.11: Definitions of terms relating to the magnitude of an impact

Magnitude	Definition
High	Extent: The maximum extent of the impact is beyond the study area (i.e. beyond the far-field area). Duration: The impact is anticipated to be permanent (i.e., over 60 years). Frequency: The impact will occur constantly throughout the relevant project phase. Consequences: Permanent changes to key characteristics or features of the particular environmental aspect's character or distinctiveness
Medium	Extent: The maximum extent of the impact is within the far field (i.e. within the study area). Duration: The impact is anticipated to be medium-term (i.e., seven to 15 years) to long-term (15 – 60 years). Frequency: The impact will occur constantly throughout a relevant project phase. Consequences: Noticeable change to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Low	Extent: The maximum extent of the impact is restricted to the near-field (i.e. within the boundary of the Array Area and Cable Corridor and Working Area) and immediately adjacent far-field (i.e. within the study area). Duration: The impact is anticipated to be temporary (i.e., lasting less than one year) to short-term (i.e., one to seven years). Frequency: The impact will occur frequently throughout a relevant project phase. Consequences: Barely discernible change to key characteristics or features of the particular environmental aspect's character or distinctiveness.
Negligible	Extent: The maximum extent of the impact is restricted to the near-field (i.e. within the boundary of the Array Area and Cable Corridor and Working Area). Duration: The impact is anticipated to be momentary (seconds to minutes) to brief (lasting less than one day). Frequency: The impact will occur once or infrequently throughout a relevant project phase. Consequences: No discernible to barely discernible change to key characteristics or features of the particular environmental aspect's character or distinctiveness.

SIGNIFICANCE OF EFFECT

9.7.2.10. The significance of the effect upon Benthic Subtidal and Intertidal Ecology is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method

employed for this assessment is presented in Table 9.12. Where a range of significance of effect is presented in Table 9.12, the final assessment for each effect is based upon expert judgement.

Table 9.12: Significance of effect matrix

			Baseline Environment – Sensitivity			
			High	Medium	Low	Negligible
Description of Impact – Magnitude	Adverse Impact	High	Profound or Very Significant (significant)	Significant	Moderate*	Imperceptible
		Medium	Significant	Moderate*	Slight adverse	Imperceptible
		Low	Moderate*	Slight adverse	Slight adverse	Imperceptible
	Neutral Impact	Negligible	Not Significant	Not Significant	Not Significant	Imperceptible
	Positive Impact	Low	Moderate*	Slight adverse	Slight adverse	Imperceptible
		Medium	Significant	Moderate*	Slight adverse	Imperceptible
		High	Profound or Very Significant (significant)	Significant	Moderate*	Imperceptible

*Moderate levels of effect have the potential, subject to the assessor's professional judgement to be significant or not significant. Moderate will be considered as significant or not significant in EIA terms, depending on the sensitivity and magnitude of change factors evaluated. These evaluations are explained as part of the assessment, where they occur.

9.7.3 Factored in measures

9.7.3.1. The Project Design Options set out in Volume II, Chapter 4: Description of Development includes a number of designed-in measures and management measures (or controls) which have been factored into the Proposed Development and are committed to be delivered by the Developer as part of the Proposed Development.

9.7.3.2. These factored-in measures are standard measures applied to offshore wind development, including lighting and marking of the Proposed Development, use of 'soft-starts' for piling operations etc, to reduce the potential for impacts. Factored-in measures relevant to the assessment on Benthic Subtidal and Intertidal Ecology are presented in Table 9.13. These measures are integrated into the description of development and have therefore been considered in the impact assessment (i.e. the determination of magnitude and therefore significance assumes implementation of these measures). These measures are considered standard industry practice for this type of development. This approach is in line with EPA guidance which states that 'in an EIAR it may be useful to describe avoidance measures that have been integrated into the proposed proposal' (EPA, 2022).

Table 9.13: Factored in measures

Factored in measures	Justification
Scour protection	In the absence of scour protection, there is potential for scour pits to develop around foundations. This may result in the release of sediment into the water column and a change to seabed habitat in the vicinity of the foundation. Scour protection will be installed as described in Volume II, Chapter 4: Description of Development.
Cables will be buried where possible and protected where not possible.	Commitment to the burial of cables where possible and protected where not possible, as set out in Volume II, Chapter 4: Description of Development.
Adherence to the Rehabilitation Schedule which outlines the measures for the decommissioning of the Proposed Development.	The Rehabilitation Schedule outlines measures for the decommissioning of the Proposed Development (Volume III, Appendix 4.1: Rehabilitation Schedule).
Implementation of an Environmental Management Plan (EMP), (Volume III, Appendix 25.1)	The EMP this includes mitigation/monitoring measures and commitments made within the EIAR, including to chemical usage, minimisation of the spread and introduction of invasive and non-native species, pollution prevention and waste management. The EMP will include a MPCP which will include key emergency contact details (e.g. Environmental Protection Agency (EPA))
A Marine Pollution Contingency Plan (MPCP) is included in the EMP (Volume III, Appendix 25.1, Annex 2)	Ensures plans are in place to manage any marine pollution spills and including key emergency contact details.
Adherence to soft start and maximum piling energies as set out in Volume II, Chapter 4 Description of Development	Implementation of and adherence to the piling parameters and use of soft starts.
Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area	Confirmatory surveys will include a geophysical survey carried out prior to construction which will confirm the location and extent of any potential areas of Annex I *Sabellaria* reef habitat which will then be ground truthed via underwater video (i.e. ROV). Any areas of Annex I *Sabellaria* reef habitat identified will be avoided via micro-routing and micro-siting of infrastructure. In addition, the presence of Annex I bedrock or stony reef and blue mussel beds will be identified and avoided via micro-routing and micro-siting.
An Invasive Non-Indigenous Species Management Plan will be	The plan outlines measures to ensure vessels comply with the International Maritime Organisation (IMO) ballast water

Factored in measures	Justification
implemented and is included in the EMP (Volume III, Appendix 25.1, Annex IV)	management guidelines, it will consider the origin of vessels and contain standard housekeeping measures for such vessels as well as measures to be adopted in the event that a high alert species is recorded.
Adherence to the Vessel Management Plan (VMP) (Volume III, Appendix 25.7)	Adherence to the Vessel Management Plan (VMP) which outlines considerations for anchoring.
Operational and Maintenance asset monitoring	Operational and Maintenance asset monitoring commitments include survey of seabed and assets every six months for the first two years and annually thereafter (Volume II: Chapter 4: Description of Development).
Management of bentonite spills as set out in Volume II, Chapter 4 Description of Development.	Monitoring of mud volumes and pressure, detection of break outs and pausing drilling, plugging fissures and ongoing monitoring.
The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence for Site Investigations (FS007339).	The Developer was granted a Foreshore Licence (FS007339) for Site Investigations (associated with the Proposed Development) from the Minister for Housing, Local Government and Heritage in May 2022. The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence for Site Investigations (FS007339) being carried out. As such there is no temporal overlap between the activities consented in this Foreshore Licence and the Proposed Development and there will be no potential for cumulative effects.
The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence Application for Site Surveys FS007555 (should a licence be granted) are being carried out.	The Developer submitted a Foreshore Licence Application for Site Surveys to the Minister for Housing, Local Government and Heritage in April 2023 (FS007555) and this application is pending determination. The Developer confirms and commits that it will not carry out any works in respect of the Proposed Development under the planning permission (if granted) at the same time as any activities the subject of the Foreshore Licence Application for Site Surveys FS007555 (should a licence be granted) are being carried out. As such there is no temporal overlap between the activities proposed in the Foreshore Licence Application and the Proposed Development.

9.8 Assessment of the significance of effects

9.8.1.1. The impacts of the construction, operational and maintenance and decommissioning phases of both project design options forming the Proposed Development have been assessed for Benthic Subtidal and Intertidal Ecology. The potential impacts arising from the construction, operational and maintenance and decommissioning phases of the Proposed Development are listed in Table 9.7 and Table 9.8, along with the project parameters against which each impact has been assessed.

9.8.1.2. A description of the potential effect on Benthic Subtidal and Intertidal Ecology caused by each identified impact is provided in section 9.9 and section 9.10.

9.9 Assessment of Project Design Option 1

9.9.1 Impact 1 – Temporary subtidal habitat loss/disturbance

9.9.1.1. Direct temporary subtidal habitat loss/disturbance within the Proposed Development will occur during the construction, operational and maintenance, and decommissioning phases as a result of a range of activities including site investigation surveys, installation and maintenance of inter-array, interconnector and offshore export cables and associated seabed preparation, and use of jack-up vessels during installation/maintenance activities.

9.9.1.2. Representative biotopes of IEFs associated with SACs within the Benthic Subtidal and Intertidal Study Area, are located beyond the Array Area and Cable Corridor Working Area. Therefore, there is no potential for interaction between the activities associated with temporary subtidal habitat loss/disturbance, and IEF features of SACs.

SENSITIVITY OF THE RECEPTOR

9.9.1.3. The key IEFs which may be affected by temporary subtidal habitat loss/disturbance are presented in Table 9.13.

9.9.1.4. The MarESA assessment for the 'Subtidal Sands Sediment' IEF indicates that representative biotopes have a low tolerance (resistance) and high recoverability (resilience) to 'Abrasion / disturbance of the surface of the substratum' and a low to medium tolerance (resistance) and high recoverability (resilience) to 'Penetration or disturbance of the substratum subsurface' (Tillin *et al.*, 2023a; Readman *et al.*, 2023a). For instance, associated species of the biotope 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IfiSa.ImoSa; EUNIS code: MB5231) are generally present in low abundances and those present such as amphipods and isopod species are characterised by their ability to withstand sediment disturbance (Elliott *et al.* 1998). Other species such as the polychaete *Nephtys cirrosa* lives within, and is well adapted to, unstable sediments and is therefore likely to be protected from surface abrasion (Tillin *et al.*, 2023a). Studies on *Bathyporeia* spp. and other characterising species indicated some mortality (approximately 25%) following intense clam dredging, but with abundance recovering within one day (Constantino *et al.* 2009). This is also consistent with other studies in which benthic populations of clean sands recovered quickly (Ferns *et al.*, 2000; Dernie *et al.*, 2003). For '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles' (JNCC code: SS.Ssa.IfiSa.ScupHyd; EUNIS code: MB5232), characterising species have no protection from high levels of abrasion from scouring by mobile sands and gravels which may prevent succession (Connor *et al.*, 2004). Additionally, where individuals are attached to mobile cobbles and boulders, surfaces can be displaced and turned over preventing feeding (Readman *et al.*, 2023a). However, Bradshaw *et al.* (2002) suggested that the benthic larvae of the colonial hydroid *Nemertesia* spp. could rapidly colonise disturbed areas with newly exposed substrata close to the adults and that hydroids may also recover rapidly. Consequently, it is considered that representative biotopes of the 'Subtidal Sands Sediment' IEF has a reasonable

capacity to avoid or adapt to the impact with high recoverability (i.e. within months up to years) and these habitats are of local importance. Therefore, the 'Subtidal Sands Sediment' IEF is considered to have Low sensitivity to temporary habitat loss and disturbance.

9.9.1.5. Representative biotopes of the 'Subtidal Coarse and Mixed Sediments' IEF have a low to medium tolerance (resistance) and medium to high recoverability (resilience) to 'Abrasion / disturbance of the surface of the substratum' and a low to medium tolerance (resistance) and medium to high recoverability (resilience) to 'Penetration or disturbance of the substratum subsurface' (Readman *et al.*, 2023b; Tillin and Watson, 2023; Readman and Watson, 2024). Species characterising the biotopes 'Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata' (JNCC code: MCR.SnemAdia; EUNIS code: MC1217) and '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214) have no protection from surface abrasion and can be subject to high levels of abrasion from scouring by mobile sands and gravels (Connor *et al.*, 2004). However, studies from Bradshaw *et al.* (2002) suggest that the hydroids *Nemertesia* spp. have a high resistance to abrasion pressures and benthic larvae could rapidly colonise disturbed areas. Studies examining disturbed and undisturbed areas of the biotope '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233), indicated that abrasion and disturbance reduced the abundance of characterising species (Collie *et al.*, 1997). Abrasion would also displace epifauna and flora such as *Ulva* spp. and *Laminaria saccharina* that occur in the biotope '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233), whilst burrowing species such as *Spio filicornis* and *Lumbrineris latreilli* may be unaffected (Tillin and Watson, 2023). Larger, fragile species are more likely to be damaged by sediment penetration (Tillin *et al.*, 2006), whilst small, mobile species such as amphipods and small errant and predatory polychaetes may increase in abundance following sediment disturbance (Capasso *et al.*, 2010). Consequently, the 'Subtidal Coarse and Mixed Sediments' IEF has a reasonable capacity to avoid or adapt to the impact with recovery taking two to 10 years, and this habitat is of local importance. Therefore, the 'Subtidal Coarse and Mixed Sediments' IEF is considered to have Low sensitivity to temporary habitat loss and disturbance.

9.9.1.6. The MarESA assessment for the '*Sabellaria* on Stable Sediments' IEF indicates that representative biotopes have a low tolerance (resistance) and medium recoverability (resilience) to 'Abrasion / disturbance of the surface of the substratum'; and no tolerance (resistance) and medium recoverability (resilience) to 'Penetration or disturbance of the substratum subsurface'. Where *S. spinulosa* reef biotopes are present, direct physical damage can affect the surface layers (abrasion) and penetrate deeper beneath the surface of the reef (Tillin *et al.*, 2023b; Tillin *et al.*, 2023c). Additionally, *S. spinulosa* reefs are often approximately 10 cm thick and abrasion and/or penetration of the substratum surface can severely damage representative biotope. No direct observations of recovery, through repair from abrasion have been made for *S. spinulosa*. However, observations made by Vorberg (2000) on *S. spinulosa* reefs indicated that as long as the reef is not completely destroyed, recovery can occur rapidly. Consequently, the '*Sabellaria* on Stable Sediments' IEF has a moderate to low capacity to accommodate the impact with recovery taking two to 10 years. The '*Sabellaria* on stable sediments' IEF is of local importance. There was no evidence of Annex I *Sabellaria* reef during site characterisation surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site). Overall, the '*Sabellaria* on Stable Sediments' IEF and 'Reef' IEF (if present) are both considered to have Medium sensitivity to temporary habitat loss and disturbance. As highlighted in Table 9.13, confirmatory surveys will include a geophysical survey carried out prior to construction which will confirm the location and extent of any potential areas of Annex I *Sabellaria* reef habitat which will then be ground truthed via underwater video (i.e. ROV). Any areas of Annex I *Sabellaria* reef habitat identified will be avoided via micro-routing and micro-siting of infrastructure.

9.9.1.7. Representative biotopes for the 'Moderate Energy Subtidal Rock' IEF have a medium tolerance (resistance) and high recoverability (resilience) to 'Abrasion / disturbance of the surface of the substratum' (Readman *et al.*, 2023c). The pressure 'Penetration or disturbance of the substratum subsurface' is not considered relevant for representative rock biotopes as characterising species are epifaunal (Readman *et al.,* 2023c). Evidence for the biotope '*Flustra foliacea* on slight adversely scoured silty circalittoral rock' (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241) indicates that *Flustra foliacea* is tolerant of sediment abrasion, whilst other characterising epifaunal species may be adversely affected. Studies conducted by Van Dolah *et al.* (1987) found that the abundance of sponges had increased just one year following impacts of abrasion. Consequently, the 'Moderate Energy Subtidal Rock' IEF has a reasonable capacity to avoid or adapt to the impact with recovery taking one to 10 years and it is of local importance. Therefore, the ''Moderate Energy Subtidal Rock' IEF is considered to have Low sensitivity to temporary habitat loss and disturbance.

9.9.1.8. Temporary subtidal habitat loss/disturbance is likely to be very localised and would occur in the immediate vicinity of the construction, operational and maintenance and decommissioning activities and within the boundaries of the Proposed Development. Following completion of the relevant construction, operational and maintenance and decommissioning activities it is anticipated that the habitats would recover within one to 10 years. The sensitivity of the benthic subtidal IEFs to temporary subtidal habitat loss/disturbance has been assessed as Low to Medium.

Table 9.14: Sensitivity of Benthic Subtidal Ecology IEFs to temporary subtidal habitat loss/disturbance.

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Abrasion / disturbance of the surface of the substratum or seabed'	'Penetration or disturbance of the substratum subsurface'
Reefs	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261)	Low (based on medium resistance and high resilience)	Medium (based on low resistance and medium resilience)
Sandbanks which are slight adversely covered by sea water all the time	Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.Ssa.IfiSa.ImoSa; EUNIS code: MB5231) *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (JNCC code: SS.Ssa.IfiSa.NcirBat; EUNIS code: MB5233)	Low (based on low resistance and high resilience)	Low (based on medium resistance and high resilience)
Subtidal Sands Sediment	Infralittoral fine sand (JNCC code: SS.Ssa.IFISa; EUNIS code: MB5 Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.Ssa.IfiSa.ImoSa; EUNIS code: MB5231) Infralittoral muddy sand (JNCC code : SS.Ssa.ImuSa ; EUNIS code : MB5) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles (JNCC code :	Low (based on low resistance and high resilience)	Low (based on low to medium resistance and high resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Abrasion / disturbance of the surface of the substratum or seabed'	'Penetration or disturbance of the substratum subsurface'
	SS.Ssa.IfiSa.ScupHyd ; EUNIS code : MB5232)		
Subtidal Coarse and Mixed Sediments	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (JNCC code: MCR.SnemAdia; EUNIS code: MC1217) *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214)	Low to Medium (based on low to medium resistance and medium to high resilience)	Low to Medium (based on low to medium resistance and medium to high resilience)
Sabellaria on Stable Sediments	*Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock (JNCC code: CR.MCR.Csab.Sspi.As; EUNIS code: MC12812) *Sabellaria spinulosa* on stable circalittoral mixed sediment (JNCC code : SS.SBR.PoR.SspiMx ; EUNIS code : MC2211)	Medium (based on low resistance and medium resistance)	Medium (based on no resistance and medium resistance)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Abrasion / disturbance of the surface of the substratum or seabed'	'Penetration or disturbance of the substratum subsurface'
Moderate Energy Subtidal Rock	Moderate Energy Circalittoral rock (JNCC code: CR.MCR; EUNIS code: MC12) *Flustra foliacea* on slight adversely scoured silty circalittoral rock (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241) Moderate Energy Infralittoral Rock (JNCC code: IR.MIR; ENIS code: MB12)	Low (based on high resistance and medium resistance)	Not Relevant[5]

[5] Not relevant is recorded where the evidence base indicates that there is no direct interaction between the pressure and the biotope group.

Construction phase

MAGNITUDE OF THE IMPACT

9.9.1.9. During construction, subtidal habitat will be temporarily lost/disturbed during the certain confirmatory surveys and site preparation activities including sandwave and boulder clearance, installation of 110-122 km of inter-array cable, 25-28 km of interconnector cables and 35-40 km of offshore export cable, and during the temporary placement of spud legs from jack up vessels and anchors associated with construction vessels (Table 9.7).

9.9.1.10. A suite of site investigations (for the Array Area, Cable Corridor and Working Area) will be undertaken to confirm the seabed and geological conditions prior to the installation of the Proposed Development. Complete details of the full suite of surveys proposed are provided in Volume II, Chapter 4: Description of Development. Site investigation activities include a range of methods which will disturb the seabed, on a short-term and localised basis, such as placement of an instrument and mooring system on the seabed or sediment removal (e.g. boreholes/grabs). Temporary habitat loss/disturbance resulting from site investigation activities will typically be of lesser magnitude and more localised when compared to that resulting from site preparation, foundation and cable installation works.

9.9.1.11. Seabed preparation activities will also occur in advance of installation of the inter-array, inter-connector and offshore export cables, with sandwave clearance required for 30% of inter-array, interconnector and offshore export cables. Boulder clearance would be required for 100% of inter-array, interconnector and offshore export cables. Cable burial will occur within the same area where sandwave clearance has previously been completed, therefore cable burial will represent a repeat disturbance of some of the area affected by pre-construction clearance. The design scenario is for temporary habitat loss of 4,219,460 m^2 as a result of sandwave clearance, 2,850,000 m^2 as a result of boulder clearance and 2,850,000 m^2 of disturbance for cable installation. Additionally, the design scenario factors in 278,400 m^2 of temporary habitat loss as a result of the use of jack-up barges/vessels.

9.9.1.12. The total area of temporary subtidal habitat loss/disturbance is 9,929,060 m^2. However, this only covers a small proportion (approximately 1%) of the Benthic Subtidal and Intertidal Ecology Study Area and the IEFs potentially affected are widespread throughout the wider area. It should also be noted that habitat disturbance will occur throughout the five-year construction phase, with only a small proportion of the overall footprint presented above affected at any one time, and recovery is anticipated to occur quickly following installation of infrastructure. It should be noted that the 9,929,060 m^2 area of disturbance is conservatively high due to a proportion of this area representing repeat disturbance.

9.9.1.13. The exact number of anchors or anchor repositions required is not known however the disturbance area will be very small, particularly in the context of activities such as cable burial and sand wave clearance. Therefore, the extent of temporary subtidal habitat loss/disturbance will only be slight adversely increased when disturbance of sediment by anchors is included.

9.9.1.14. The impact will affect the IEFs directly through removal of characterising species of representative biotopes. The impact will occur as a series of discrete events associated with each of the activities over the construction phase of the Proposed Development, which will take place over a period of up to five years. Temporary habitat loss is expected to be localised to within the immediate vicinity of the activity and therefore will occur within the Array Area and Cable Corridor and Working Area.

9.9.1.15. A review of the effects of cable installation in subtidal sediments and habitats has recently been conducted by RPS (2019b). The review drew upon monitoring reports from over 20 UK offshore windfarms and indicated that sandy sediments recover quickly following cable installation, with trenches infilling quickly and little or no evidence of disturbance in the years following cable installation. The review also indicated that remnant cable trenches in coarse and mixed sediments

and muddy sediments were conspicuous for several years following installation. It should be noted however, that depressions were of limited depth relative to the surrounding seabed (i.e. tens of centimetres) and over a distance of several metres and did not represent a large shift from the baseline environment (RPS, 2019b).

9.9.1.16. Jack-up footprints associated with foundation and wind turbine installation will result in compression of seabed sediments beneath spud cans or tubular legs where these are placed on the seabed. Monitoring studies of UK offshore windfarms indicate that depressions will infill over time but may remain on the seabed for several years (BOWind, 2008; ESG, 2011). Monitoring at the Barrow offshore windfarm showed depressions were almost entirely infilled approximately one year after construction (BOWind, 2008). Additionally, infilling of depressions was also observed during monitoring of the Lynn and Inner Dowsing offshore windfarm but were still visible two years post-construction (ESG, 2011). In areas where mobile sands and coarse sediments are present such as in the majority of the Array Area (see section 9.5.2 and Volume III, Appendix 9.1: Benthic Subtidal and Intertidal Technical Report), jack-up depressions are likely to be temporary features which will only persist for a period of months to a small number of years.

9.9.1.17. The extent of the impact would be restricted to subtidal areas in discrete locations within the Benthic Subtidal and Intertidal Study Area and is therefore regarded as near field.

9.9.1.18. The duration of the impact will be short-term (i.e. one to seven years). However, the duration of works in any given discrete location within the Benthic Subtidal and Intertidal Study Area will often be much shorter (i.e. less than one year). The impact is expected to occur frequently at discrete areas within the near-field throughout the construction phase. Construction activities will result in loss and/or disturbance of subtidal benthic habitat, however, this will be temporary, with habitats expected to recover following the cessation of construction activities. The overall magnitude of the impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.9.1.19. The magnitude of the impact has been assessed as **Low.**

9.9.1.20. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

9.9.1.21. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF is also **Medium** but if it was found to be present following confirmatory surveys prior to construction, this habitat would be avoided via micro-routing and micro-siting of infrastructure). Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.1.22. The effect of temporary subtidal habitat loss/disturbance is not significant in EIA terms, therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.1.23. The significance of effect from temporary subtidal habitat loss/disturbance is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to temporary subtidal habitat loss/disturbance.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.9.1.24. Operational and maintenance activities within the Array Area and Cable Corridor and Working Area may lead to temporary subtidal habitat loss/disturbance. The design scenario covers the repair and reburial of sections of inter-array and interconnector cables once every three years, export cables once every five years and disturbance of 613,200 m^2 of seabed from jack-up barges and 275,000 m^2 from operational dredging once every five years.

9.9.1.25. Recovery of seabed habitats would be expected to occur quickly following removal of spud cans from jack-up vessels. Cable repair or reburial activities will affect seabed habitats in the immediate vicinity of these operations, with effects on seabed habitats also expected to be similar to the construction phase. The spatial extent of this impact is very small in relation to the Array Area and Cable Corridor and Working Area, although there is the potential for repeat disturbance to the habitats due to these activities (e.g. placement of spud cans on or in close proximity to where these were placed during construction; remedial burial of a length of cable installed during the construction phase, affecting the same area of seabed). Activities resulting in the temporary subtidal habitat loss/disturbance will occur intermittently throughout the operational and maintenance phase.

9.9.1.26. The impact is predicted to be restricted to the near-field, have short term duration, be infrequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. Habitats are expected to recover following cessation of repair activities. The magnitude of impact is therefore, considered to be Negligible.

SIGNIFICANCE OF EFFECT

9.9.1.27. The magnitude of the impact has been assessed as **Negligible.**

9.9.1.28. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is **Not Significant**, which is not significant in EIA terms.

9.9.1.29. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF is also **Medium** but any Annex I reef habitat present would be avoided via micro-routing / micro-siting). Therefore, the significance of effect from temporary habitat loss is **Not Significant**, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.1.30. The effect of temporary subtidal habitat loss/disturbance is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.1.31. The significance of effect from temporary subtidal habitat loss/disturbance is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to temporary subtidal habitat loss/disturbance.

Decommissioning phase

MAGNITUDE OF IMPACT

9.9.1.32. For the purposes of this assessment, the impacts of decommissioning are predicted to be similar to those for the construction phase. Piles will be cut 2 m below the seabed and lifted. However,

the area of temporary subtidal habitat loss/disturbance will be significantly reduced in scale as cables, cable protection and scour protection will be left *in situ*.

9.9.1.33. The impact is predicted to be restricted to the near-field, short term duration, frequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. Habitats are expected to recover following cessation of the decommissioning activities. It is predicted that the impact will affect the receptor both directly and indirectly. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.1.34. The magnitude of the impact has been assessed as **Low.**

9.9.1.35. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

9.9.1.36. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF is also **Medium**). Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.1.37. The effect of temporary subtidal habitat loss/disturbance is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.1.38. The significance of effect from temporary subtidal habitat loss/disturbance is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to temporary subtidal habitat loss/disturbance.

9.9.2 Impact 2 – Increased suspended sediment concentrations and associated deposition

9.9.2.1. Increases in suspended sediment concentrations and associated sediment deposition are predicted to occur during the construction, operational and maintenance and decommissioning phases as a result of the installation and removal of foundations and the installation and maintenance (repair and reburial) of inter-array, interconnector and offshore export cables. Volume II, Chapter 6: Coastal Processes provides a full description of the physical assessment, including numerical modelling used to inform the predictions made with respect to increases in suspended sediment and subsequent sediment deposition.

SENSITIVITY OF THE RECEPTOR

9.9.2.2. The key IEFs which may be affected by increased suspended sediment concentrations and associated deposition are presented in Table 9.15.

9.9.2.3. The representative biotope of the 'Reefs' IEF, is '*Sabellaria alveolata* reefs on sand-abraded eulittoral rock' (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261), and is characteristic of the Annex I reef habitat feature of the Wicklow Reef SAC (DCHG, 2014a). Associated elevated suspended sediment concentrations (above background levels) are shown to be immeasurable beyond 10 km from the Array Area and Cable Corridor and Working Area (see Volume II, Chapter 6: Coastal Processes). In addition, although Wicklow Reef SAC is located approximately 4.5 km and 3.6 km from the Array Area and Cable Corridor and Working Area respectively, modelling

shows that increased suspended sediment and associated deposition will not reach the SAC due to the direction of the prevailing current (Volume II, Chapter 6: Coastal Processes). Therefore, there is no potential for interaction between the activities associated with increased suspended sediment and deposition, and this IEF in the Wicklow Reef SAC.

9.9.2.4. Similarly, the representative biotope, 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) of the 'Sandbanks' IEF is characteristic of the Annex I habitat 'Sandbanks which are slight adversely covered by sea water all the time' feature of the Blackwater Bank SAC (DCHG, 2014b) and is located approximately 19.7 km and 19.1 km from the Array Area and Cable Corridor and Working Area, respectively (which is beyond the potential distance of impact for suspended sediment concentrations and associated deposition). Therefore, there is no potential for interaction between the activities associated with increased suspended sediment and deposition, and this IEF in the Blackwater Bank SAC.

9.9.2.5. The MarESA assessment for the 'Subtidal Sands Sediment' IEF indicates that representative biotopes have a medium to high tolerance (resistance) and high recoverability (resilience) to 'Changes in suspended solids (water clarity)' and a high tolerance (resistance) and recoverability (resilience) to 'Smothering and siltation rate changes' (Tillin *et al.*, 2023a; Readman *et al.*, 2023a). For the biotope 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231), some effects on feeding and diatom productivity may occur from increases in suspended solids. However, characterising species within mobile sand sediments are well adapted to storm events or spring tides resulting in varying levels of suspended solids (Tillin *et al.*, 2023a). Additionally, as the biotope is associated with wave exposed habitats, sediment removal will occur and minimise the effects of deposition and smothering (Tillin *et al.*, 2023a). For the biotope '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles' (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232), increases in suspended sediments may have an adverse effect on suspension feeding communities causing a decrease in growth rate (Jackson, 2004). However, Tyler-Walters and Ballerstedt (2007) reported that *F. foliacea* was tolerant to increased suspended sediment levels based on its occurrence in areas of high suspended sediment. Light deposition may bury some characterising species, but the '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles' biotope experiences moderate water flow and sediment is likely to be removed rapidly (Readman *et al.*, 2023a). Consequently, the 'Subtidal Sands Sediment' IEF has a reasonable capacity to avoid or adapt to the impact with high recoverability (i.e. within months up to years) and is of local importance. Therefore, 'Subtidal Sands Sediment' IEF is considered to have Low sensitivity to increased suspended sediment concentrations and associated deposition.

9.9.2.6. Representative biotopes of the 'Subtidal Coarse and Mixed Sediments' IEF have a medium to high tolerance (resistance) and medium to high recoverability (resilience) to 'Changes in suspended solids (water clarity)' and a medium to high tolerance (resistance) and medium to high recoverability (resilience) to smothering and siltation rate change (Readman *et al.*, 2023b; Tillin and Watson, 2023; Readman and Watson, 2024). Characterising species of the biotope 'Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata' (JNCC code: MCR.SNemAdia; EUNIS code: MC1217) and '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214), may be adversely affected by increases in suspended sediment levels such as clogging of feeding apparatus and increased energy expenditure (Jackson, 2004). Additionally, deposition and smothering will likely prevent feeding, growth and reproduction in bryozoans (Tyler-Walters, 2005). However, species such as *F. foliacea* and many encrusting sponges are tolerant of increased turbidity and are able to survive increased suspended sedimented concentrations (Tyler-Walters and Ballerstedt, 2007; Schönberg, 2015; Bell and Barnes, 2000; Bell and Smith, 2004). Similarly, venerid bivalves characterising the biotope '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) are

active suspension feeders and increases in suspended sediments will likely affect both feeding and respiration (Tillin & Watson, 2023). Consequently, the 'Subtidal Coarse and Mixed Sediments' IEF has a reasonable capacity to avoid or adapt to the impact with recovery taking up to two years and it is of local importance. Therefore, the 'Subtidal Coarse and Mixed Sediments' IEF is considered to have Low sensitivity to increased suspended sediment concentrations and associated deposition.

9.9.2.7. The MarESA assessment for the '*Sabellaria* on Stable Sediments' IEF indicates that representative biotopes have a high tolerance (resistance) and recoverability (resilience) to 'Changes in suspended solids (water clarity)' and 'Smothering and siltation rate changes' (Tillin *et al.*, 2023b; Tillin *et al.*, 2023c). *S. spinulosa* does not rely on light penetration for photosynthesis and requires a supply of suspended solids and organic matter to filter feed and build protective tubes (Tillin *et al.*, 2023b). Additionally, the tolerance of *S. spinulosa* for changes in turbidity is evident based on the persistence of reefs on the outskirts of aggregate dredging areas (Pearce *et al.*, 2007; Pearce *et al.*, 2011). When subject to smothering, Last *et al.* (2011), found that *S. spinulosa* was sensitive to damage from siltation events (Hendrick *et al.*, 2011). However, depth of burial is likely to be similar to that experienced during natural storm events and deposits of fine sediments are likely to be remobilised and moved. Consequently, the '*Sabellaria* on Stable Sediments' IEF has a high capacity to avoid or adapt to the impact with recovery taking up to two years. The '*Sabellaria* on stable sediments' IEF is of local importance. There was no evidence of Annex I *Sabellaria* reef during surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site).. Overall, the '*Sabellaria* on Stable Sediments' IEF and 'Reef' IEF (if present) are both considered to have Negligible sensitivity to increased suspended sediment concentrations and associated deposition. As highlighted in Table 9.13, confirmatory surveys (geophysical and underwater video surveys) prior to construction, to confirm the presence or absence of Annex I *Sabellaria* reef habitat will be conducted, and any Annex I habitat would be avoided via micro-routing and micro-siting of infrastructure.

9.9.2.8. Representative biotopes for the 'Moderate Energy Subtidal Rock' IEF have a high tolerance (resistance) and recoverability (resilience) to 'Changes in suspended solids (water clarity)' and a medium tolerance (resistance) and high recoverability (resilience) to 'Smothering and siltation rate changes' (Readman *et al.*, 2023c). Changes in suspended solids affecting water clarity will have a direct impact on the photosynthesising capabilities of characterising species (Kõuts *et al.*, 2006). However, characterising species of the biotope '*Flustra foliacea* on slight adversely scoured silty circalittoral rock' (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241), such as *F. foliacea*, are reported to be tolerant to suspended sediment based on their occurrence in turbid and fast flowing areas (Tyler-Walters & Ballerstedt, 2007). Filter feeding organisms may have increased mortality due to direct smothering and as their feeding apparatus becomes clogged with suspended particles this would lead to a reduction in feeding (e.g. the common limpet *Patella vulgata* and the barnacle *Semibalanus balanoides*), (Perry, 2015). Although, once suspended sediments return to background levels, rapid recovery would be expected (Perry, 2015). Consequently, the 'Moderate energy sublittoral rock' IEF has a reasonable capacity to avoid or adapt to the impact with recovery taking up to two years and is of local importance. Therefore, the 'Moderate Energy Subtidal Rock' IEF is considered to have Low sensitivity to increased suspended sediment concentrations and associated deposition.

9.9.2.9. The MarESA assessment for the 'Barren Coarse Intertidal Sediment' IEF indicates that representative biotopes have a high tolerance (resistance) and recoverability (resilience) to both 'Changes in suspended solids (water clarity)' and 'Smothering and siltation rate changes' (Tillin *et al.*, 2019; Tillin and Budd, 2016). Representative biotopes occur within scoured habitats and are likely to be exposed to chronic or intermittent episodes of high levels of suspended solids due to wave action (Tilin *et al.*, 2019; Tilin and Budd, 2016). Additionally, representative biotopes are characterised by the absence of species and changes in suspended solids or smothering will therefore not alter the biotopes present. Consequently, the 'Barren Coarse Intertidal Sediment'

IEF has a high capacity to avoid or adapt to the impact with recovery taking up to two years and is of local importance. Therefore, the 'Barren Coarse Intertidal Sediment' IEF is considered to have Negligible sensitivity to increased suspended sediment concentrations and associated deposition.

9.9.2.10. The representative biotopes of the 'Moderately Exposed Intertidal Rock' IEF have a medium tolerance (resistance) and medium to high recoverability (resilience) to 'Changes in suspended solids (water clarity)', and a low to medium tolerance (resistance) and 'Smothering and siltation rate changes' (Perry and Hill, 2015; Tillin and Hill, 2018). Changes in suspended solids affecting water clarity and smothering will have a direct impact on the photosynthesising capabilities of *Fucus vesiculosus* and increased suspended sediment can also cover the frond surface, further reducing photosynthesis and growth rate (Perry and Hill, 2015; Tilin and Hill, 2018). Other characterising species such as *S. balanoides* may also be affected as their feeding apparatus can become clogged with suspended particles leading to a reduction in total ingestion (Perry and Hill, 2015; Tilin and Hill, 2018). Representative biotopes are found in moderately exposed to exposed conditions and wave action will allow sediment to be removed relatively quickly from these areas (Perry and Hill, 2015; Tilin and Hill, 2018). Consequently, the moderately exposed intertidal rock IEF has a limited ability to avoid or adapt to an impact and a low capacity to accommodate the proposed form of change. However, based on the IEFs exposure to wave action, the receptor is anticipated to recover rapidly (i.e. within two years). In terms of value, the IEF is also of local importance. Therefore, the 'Moderately Exposed Intertidal Rock' IEF is considered to have Medium sensitivity to increased suspended sediment concentrations and associated deposition.

9.9.2.11. In summary, temporary increases in suspended sediment concentrations and sediment deposition are likely to be very localised and would occur within one tidal excursion of the construction, operational and maintenance and decommissioning activities, with the majority of any effects occurring within the Array Area and Cable Corridor and Working Area. Following completion of construction, operational and maintenance and decommissioning activities, it is anticipated that benthic communities would rapidly recover (if displacement has occurred). Benthic subtidal and intertidal IEFs have therefore been assessed as having Negligible to Medium sensitivity to increased suspended sediments and associated deposition.

Table 9.15: Sensitivity of Benthic Subtidal and Intertidal Ecology IEFs to increased suspended sediment concentrations and associated deposition.

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Changes in suspended solids (water clarity)'	'Smothering and siltation rate changes'
Reefs	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261)	Medium (based on Low resistance and Medium resilience)	Not sensitive (based on High resistance and High resilience)
Sandbanks which are slight adversely covered by sea water all the time	Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (JNCC code: SS.SSa.IFiSa.NcirBat; EUNIS code: MB5233)	Low (based on Medium resistance and High resilience)	Not sensitive (based on High resistance and High resilience)
Subtidal Sands Sediment	Infralittoral fine sand (JNCC code: SS.SSa.IFISa; EUNIS code: MB5 Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) Infralittoral muddy sand (JNCC code: SS.SSa.IMuSa; EUNIS code: MB5) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232)	Not Sensitive to Low (based on Medium to High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Changes in suspended solids (water clarity)'	'Smothering and siltation rate changes'
Subtidal Coarse and Mixed Sediments	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (JNCC code: MCR.SNemAdia; EUNIS code: MC1217) *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214)	Not Sensitive to Low (based on Medium to High resistance and Medium to High resilience)	Not Sensitive to Low (based on Medium to High resistance and Medium to High resilience)
Sabellaria on Stable Sediments	*Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock (JNCC code: CR.MCR.CSab.Sspi.As; EUNIS code: MC12812) *Sabellaria spinulosa* on stable circalittoral mixed sediment (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)
Moderate Energy Subtidal Rock	Moderate Energy Circalittoral rock (JNCC code: CR.MCR; EUNIS code: MC12)	Not Sensitive (based on High resistance and High resilience)	Low (based on Medium resistance and High resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure 'Changes in suspended solids (water clarity)'	'Smothering and siltation rate changes'
	Flustra foliacea on slight adversely scoured silty circalittoral rock (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241) Moderate Energy Infralittoral Rock (JNCC code: IR.MIR; ENIS code: MB12)		
Barren Coarse Intertidal Sediment	Barren littoral shingle (JNCC code: LS.LCS.Sh.BarSh; EUNIS code: MA3211) Barren littoral coarse sand (JNCC code: LS.LSa.MoSa.BarSa; EUNIS code: MA5231)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)
Moderately Exposed Intertidal Rock	Barnacles and fucoids on moderately exposed shores (JNCC code: LR.MLR.BF; EUNIS code: MA1245) *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock (JNCC code: LR.HLR.MusB.Sem.Sem; EUNIS code: MA12231)	Low to Medium (based on Medium resistance and Medium to High resilience)	Medium (based on Low to Medium resistance and Medium resilience)

Construction phase

MAGNITUDE OF THE IMPACT

9.9.2.12. The installation of Proposed Development infrastructure within the Array Area and Cable Corridor and Working Area will lead to increases in SSC above sediment baseline levels and associated sediment deposition. Full details of the modelling undertaken to inform this assessment is presented in Volume III, Appendix 6.1: Marine Physical Processes Numerical Modelling, including the individual scenarios considered, assumptions within these, and full modelling outputs for SSC and associated sediment deposition. A baseline for sedimentological conditions is presented in Volume II, Chapter 6: Coastal Processes. For the purposes of this assessment, site preparation activities, drilling for foundation installation and cable installation have been considered (Table 9.7).

9.9.2.13. A suite of site investigations (Array Area, Cable Corridor and Working Area) will be undertaken to confirm on the seabed and geological conditions prior to the installation of the Proposed Development. Complete details of the full suite of surveys proposed are provided in Volume II, Chapter 4: Description of Development. Site investigation activities include a range of methods which will disturb the seabed, on a short-term and localised basis, such as placement of an instrument and mooring system on the seabed or sediment removal (e.g. boreholes/grabs). Increased suspended sediment concentrations and associated deposition resulting from site investigation activities will typically be of lesser magnitude and more localised when compared to that resulting from site preparation, foundation and cable installation works.

9.9.2.14. Sand wave clearance may involve disturbance of seabed material along a corridor up to 70 m wide and to a depth of 10 m for inter-array, export and OSP interconnector cables. Sand wave clearance will also occur at 20% of OSP and WTG installations along a maximum diameter of 100 m. Modelling of suspended sediment associated with sandwave clearance in the Array Area indicates SSC at a maximum of 2,000 mg/l within the first hour, however, after five hours SSC is less than 2.5 mg/l. Similarly, disposal south of the Array Area initially results in a plume with SSC at a maximum of 2,000 mg/l, which after five hours is reduced down to less than 2.5 mg/l. Suspended sediments will largely be limited to the Array Area and to the area to the north and south of this (i.e. along the dominant tidal axis), with the resultant plume not extending beyond 8 km from the Array Area and Cable Corridor and Working Area under all tidal flow simulations (speeds and direction). Sediment deposition to a depth of 100 to 500 mm is predicted to occur within 1 km of the disturbance event. At 10 km from the disturbance event sediment deposition is predicted to be 2.5 mm and beyond this sediment deposition becomes immeasurable.

9.9.2.15. Modelling of suspended sediment associated with sandwave clearance along the Cable Corridor and Working Area indicates SSC at a maximum of 2,000 mg/l within the first hour, however, after four hours SSC is less than 2.5 mg/l. Disposal south of the Array Area initially results in a plume with SSC at a maximum of 2,000 mg/l, which after five hours is reduced down to less than 5 mg/l. Suspended sediments will largely be limited to the Array Area and to the area to the north and south of this (i.e. along the dominant tidal axis), with the resultant plume not extending beyond 8 km from the Array Area and Cable Corridor and Working Area under all tidal flow simulations (speeds and direction). Sediment deposition to a depth of 250 mm is predicted to occur within 1 km of the sandwave disturbance along the Cable Corridor and Working Area. At 10 km from the disturbance event, sediment deposition is predicted to be 2.5 mm and beyond this sediment deposition becomes immeasurable.

9.9.2.16. The design scenario for foundation installation assumes the drilled installation of 25 WTG piles 11 m in diameter and 2 OSP piles 14 m in diameter, with a total volume of approximately 159,720 m^3 of drill arisings. Numerical modelling has simulated drilling at WTG for 88 hours, followed by a 12 hour pause and then another 88 hour drilling event at the Southern OSP. SSC and sediment plume extent progressively increase across the drilling event. After completion of WTG drilling

the greatest SSC is within the centre of the plume (approximately 25 mg/l). During OSP drilling, SSC of over 100 mg/l is modelled at the point of activity, reducing to <25 mg/l 18 km north of the drilling activity. Two days following cessation of drilling activities SSCs are undiscernible from background levels. Sediment deposition is expected to be approximately 15 mm following completion of drilling.

9.9.2.17. At the Landfall the use of HDD could also result in an increase in suspended sediments and sediment deposition at the exit point(s), including release of bentonite (drilling mud). Modelling of SSC at the HDD exit location (which is in the subtidal zone) indicates maximum concentrations of 50 mg/l with concentrations no greater than 2.5 mg/l outside the Proposed Development Boundary. In terms of sediment deposition, 6.5 days after cessation of installation works a maximum deposition of 7.5 mm is predicted within 0.3 km.

9.9.2.18. The design scenario assumes the installation of 110-122 km of inter array cables, 25-40 km of export cables and 25-28 km of interconnector cables. The impact of cable trenching using jetting tools has been modelled and numerical modelling has indicated that the greatest increase in SSC would be immediately adjacent to the works (approx. 500 mg/l), with levels above background (2.5 mg/l) being observed 8 km away from the disturbance event. Modelling indicated that sediment deposition of 25 mm would occur within 1 km with deposition of <2.5 mm at 10 km.

9.9.2.19. The impact is predicted to be restricted to the far-field, be of short-term duration, frequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. Baseline conditions are expected to resume following cessation of the construction activities. It is predicted that the impact will affect the receptor both directly and indirectly. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.9.2.20. The magnitude of the impact has been assessed as **Low.**

9.9.2.21. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Negligible** but this habitat would be avoided via micro-routing and micro-siting of infrastructure). Therefore, the significance of effect from increased suspended sediment and deposition is **Imperceptible**, which is not significant in EIA terms.

9.9.2.22. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

9.9.2.23. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.2.24. The effect of increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.2.25. The significance of effect from increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to increased suspended sediment and deposition.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.9.2.26. Operational and maintenance activities, such as the repair and re-burial of cables, will result in seabed sediment disturbance. The volumes of sediment disturbance are expected to be far less than that disturbed during construction. The design scenario considers the repair and re-burial, once every three years of 110-122 km of inter-array cables and 25-28 km of interconnector cables and repair and re-burial, once every five years of 30-40 km of export cables. The design scenario also considers 400,000 m^3 of sediment during operational dredging once every five years, with 300,000 m^3 every five years for inter-array cable maintenance and 100,000 m^3 every five years for combined interconnector and export cable maintenance.

9.9.2.27. The impact is predicted to be restricted to the near-field, be of short term duration (occurs across operation and maintenance period, however individual events will be short-term), infrequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.2.28. The magnitude of the impact has been assessed as **Low.**

9.9.2.29. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (as indicated above, the sensitivity of the 'Reef' IEF is also **Negligible**). Therefore, the significance of effect from increased suspended sediment and deposition is **Imperceptible**, which is not significant in EIA terms.

9.9.2.30. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

9.9.2.31. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.2.32. The effect of increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.2.33. The significance of effect from increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to increased suspended sediment and deposition.

Decommissioning phase

MAGNITUDE OF IMPACT

9.9.2.34. At the end of operational lifetime of the Proposed Development, piles will be cut 2 m below the seabed and lifted. However, the volumes of sediment disturbance are expected to be far less than that disturbed during construction due to scour protection, cables and cable protection being left *in-situ*.

9.9.2.35. The impact is predicted to be restricted to the near-field, be of short-term duration, frequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.2.36. The magnitude of the impact has been assessed as **Low.**

9.9.2.37. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (as indicated above, the sensitivity of the 'Reef' IEF is also **Negligible**). Therefore, the significance of effect from increased suspended sediment and deposition is **Imperceptible**, which is not significant in EIA terms.

9.9.2.38. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

9.9.2.39. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from temporary habitat loss is **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.2.40. The effect of increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.2.41. The significance of effect from increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to increased suspended sediment and deposition.

9.9.3 Impact 3 – Injury and/or disturbance from underwater noise and vibration

9.9.3.1. Underwater noise and vibration within the Array Area and Cable Corridor and Working Areas will occur during the construction phase as a result of a range of activities including impact piling, drilling and UXO clearance (via detonation or relocation/wet storage). This can cause injury and/or disturbance to Benthic Subtidal and Intertidal Ecology receptors.

9.9.3.2. The assessment has been informed by the Underwater Noise Assessment by Subacoustech (Volume III, Appendix 11.1: Underwater Noise Assessment) which includes the results of numerical modelling using the INSPIRE underwater noise model.

SENSITIVITY OF THE RECEPTOR

9.9.3.3. There is no MarESA pressure for underwater noise and vibration. As a result, sensitivity for IEFs to this impact have been discussed qualitatively below.

9.9.3.4. Benthic invertebrate species are unable to detect sound pressure but are likely to be able to detect particle motion through a variety of organs such as hairs on the body that respond to mechanical stimulation, chordotonal organs associated with joints, or vibrations transmitted through the exoskeleton from the substrate (Popper and Hawkins, 2018).

9.9.3.5. Underwater noise and vibration have been shown to have potential effects on benthic invertebrates that do not rely on acoustics for communication. Studies of invertebrates have

indicated that increased noise and vibration levels can result in increased mortality, injury to tissues, growth and reproductive rates, and food uptake in invertebrates (Popper and Hawkins, 2018; Hawkins and Popper, 2016; Solan *et al.*, 2016; Aguilar de Soto *et al.*, 2016; Spiga *et al.*, 2012).

9.9.3.6. Spiga *et al.* (2016) studied the effects of pile driving on bivalve molluscs. Results indicated that individuals subjected to pile driving exhibited increased feeding (filtering) rate than those in ambient conditions. This is a developing area of research, however, and currently there are insufficient data on the effects of underwater noise and vibration on invertebrates to establish noise criteria (Popper *et al.*, 2014). There is little evidence available for the effects of other sources of underwater noise and vibration on benthic species such as cable laying, dredging, drilling, rock placement, vessel movements, operational WTG noise, and UXO clearance (via detonation or relocation/wet storage). In taking a precautionary approach, it is assumed some individuals in the immediate vicinity of sources of underwater noise and vibration could suffer injury or mortality (with lesser effects associated with noise and vibration generated by vessels). However, noise and vibration from sources such as piling activity will rapidly attenuate with increased distance from the source.

9.9.3.7. In summary, benthic IEFs will be unable to avoid the impact but have a high tolerance to the proposed form of change. Recoverability will be high (i.e. recovery within days or months) due to the intermittent and relatively short-term duration of effects at any given location and therefore any effects will not be detectable at the population level. Additionally, the value of IEFs are of local importance. There was no evidence of Annex I *Sabellaria* reef during surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site). The sensitivity of benthic subtidal IEFs and 'Reef' IEF (if present) to injury and/or disturbance from underwater noise and vibration is therefore considered to be Low.

Construction phase

MAGNITUDE OF THE IMPACT

9.9.3.8. The main source of underwater noise and vibration during the construction phase of the Proposed Development will be from impact piling for WTG and OSP foundations. Other sources of noise including cable laying, dredging, drilling, rock placement and UXO clearance, but only piling, drilling and UXO clearance have been considered to potentially generate noise levels sufficient to require assessment for benthic ecology.

9.9.3.9. Impact piling for the WTG and OSP foundations was modelled at a total of five representative locations covering the extent of the Array Area. The locations were chosen to give the greatest geographical spread to maximise the potential impact ranges to the north and the south of the site. The monopile foundations may be 7-11 m in diameter for Project Design Option 1 and so installation of both 7 m and the 11 m diameter foundations was modelled (taking into account potential noise levels from the smallest and largest pile diameters that could be used, which is anticipated to encompass potential impact of any pile diameters within this range). The OSP foundations will have a diameter of 7-14 m and were also modelled and a soft start and ramp up scenario was modelled for all foundation types (Volume III, Appendix 25.2: Marine Mammal Mitigation Plan). For further details of the modelled locations and foundation design details modelled see Volume III, Appendix 11.1: Underwater Noise Assessment. One pile will be installed at any one time and the total duration of piling will be four days.

9.9.3.10. Source level noise was estimated for both WTG and OSP foundations based on the pile diameter and the blow energy imparted on the pile by the hammer. This was adjusted depending on the water depth at the modelling location to allow for the length of pile (and effective surface area) in contact with the water, which can affect the amount of noise that is transmitted from the pile into its surroundings. The unweighted, single strike SPL_{peak} and SEL_{ss} source levels estimated for this study are provided in Table 9.16, based on the maximum blow energy.

Table 9.16: Summary of the unweighted source levels used for modelling, maximum blow energy

Source levels	Location	Large monopile foundation 11 m / 4,000 kJ (NW and C WTG) 11 m / 6,600 kJ (SW WTG) 14 m / 4,000 kJ (North OSP) 14 m / 6,600 kJ (South OSP)	Smaller monopile foundation 7 m / 4,000 kJ (NW, C WTG and North OSP) 7 m / 6,600 kJ (SW WTG and South OSP)
Unweighted SPL_{peak}	NW WTG	242.4 dB re 1 µPa @ 1 m	242.2 dB re 1 µPa @ 1 m
	C WTG	242.4 dB re 1 µPa @ 1 m	242.4 dB re 1 µPa @ 1 m
	SW WTG	243.1 dB re 1 µPa @ 1 m	243.1 dB re 1 µPa @ 1 m
	North OSP	242.4 dB re 1 µPa @ 1 m	242.4 dB re 1 µPa @ 1 m
	South OSP	243.1 dB re 1 µPa @ 1 m	243.0 dB re 1 µPa @ 1 m
Unweighted SEL_{ss}	NW WTG	223.5 dB re 1 μPa^2s @ 1 m	223.1 dB re 1 μPa^2s @ 1 m
	C WTG	223.5 dB re 1 μPa^2s @ 1 m	223.4 dB re 1 μPa^2s @ 1 m
	SW WTG	224.3 dB re 1 μPa^2s @ 1 m	224.3 dB re 1 μPa^2s @ 1 m
	North OSP	223.5 dB re 1 μPa^2s @ 1 m	223.4 dB re 1 μPa^2s @ 1 m
	South OSP	224.3 dB re 1 μPa^2s @ 1 m	224.3 dB re 1 μPa^2s @ 1 m

9.9.3.11. A review by Solé *et al.* (2023) highlights that data on the sound perception in invertebrates is scarce. Despite this, there is increasing evidence that some types of anthropogenic noise can negatively impact a variety of marine invertebrate taxa via changes in behaviour, physiology and rate of mortality. Much of the damage from exposure to noise comes from vibration of the invertebrate body (André *et al.*, 2016) caused by the passing of sound. However, studies described by Solé *et al.* (2023) show a general inconsistency in the way noise impacts have been quantified for marine invertebrates. For instance, Hubert *et al.* (2021) notes behavioural changes in blue mussels to 150 and 300 Hz tones, whereas Spiga *et al.* (2016) describes behavioural changes in the same species at SEL_{ss} 153.5 dB re 1 μPa^2s. These inconsistencies in terms of units of measurement make it difficult to generate accurate thresholds for the onset of any impact for species (Solé *et al.*, 2023). The unweighted SEL_{ss} indicated in Table 9.16 could be greater than noise levels which could cause behavioural changes in some invertebrate species (e.g. see Spiga *et al.*, (2016)). However, it is mainly behavioural changes that have been described in studies to date rather than an indication of injury or mortality at certain noise levels..

9.9.3.12. The extent of the impact will be restricted to the near-field and immediately adjacent far-field areas in the vicinity of the noise source. The duration of the impact is anticipated to be short-term (i.e. days), taking place during the five-year construction period of the project. The impact will occur frequently throughout the five-year construction phase and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.9.3.13. The magnitude of the impact has been assessed as **Low**, with the sensitivity of IEFs being assessed as **Low** (as indicated above, the sensitivity of the 'Reef' IEF is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.3.14. The effects of underwater noise and vibration is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.3.15. The significance of effect from underwater noise and vibration is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered to be necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to Benthic Subtidal and Intertidal Ecology.

9.9.4 Impact 4 – Long-term subtidal habitat loss/change

9.9.4.1. Long-term subtidal habitat loss/change will occur where there is placement of all foundation structures, associated scour protection and cable protection (including at crossings). This impact will occur during the operational and maintenance phase.

9.9.4.2. Representative biotopes of IEFs associated with SACs within the Benthic Subtidal and Intertidal Study Area, are located beyond the Array Area and Cable Corridor and Working Area. Therefore, there is no potential for interaction between the activities associated with long-term subtidal habitat loss/change, and these IEFs.

SENSITIVITY OF THE RECEPTOR

9.9.4.3. The key IEFs which may be affected by long-term subtidal habitat loss/change are presented in Table 9.15.

9.9.4.4. MarESA assessments for the 'Subtidal Sands Sediment', 'Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment', and 'Moderate Energy Subtidal Rock' IEFs indicated that representative biotopes have no tolerance (resistance) and very low recoverability (resilience) to 'Physical change (to another seabed type)' (there is no MarESA assessment for habitat loss per se, and this assessment has focussed on the 'Physical change (to another seabed type)' impact).

9.9.4.5. Representative biotopes of the 'Subtidal Sands Sediment' IEF are characterised by sedimentary habitat. Therefore, a change to artificial hard substratum would alter the character of the biotope leading to reclassification and the loss of the sedimentary community including the characterising polychaetes, amphipods and isopods (Tillin *et al.*, 2023a). Consequently, the 'Subtidal Sands Sediment' IEF will be unable to avoid or adapt to the impact, have no or very low capacity to accommodate the proposed form of change, with negligible recovery possible and this impact is considered to be of local importance. Therefore, the 'Subtidal Sands Sediment' IEF is considered to have High sensitivity to long-term subtidal habitat loss/change.

9.9.4.6. Representative biotopes of the 'Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment', and 'Moderate Energy Subtidal Rock' IEFs are characterised by hard substrata. Installation of artificial hard substrata on top of these IEFs would likely result in the loss of characterising benthic communities and would significantly alter the character of representative biotopes (Tillin and Watson, 2023; Readman *et al.*, 2023b). However, over time, introduced hard substrata could potentially be colonised by characterising species of representative biotopes. For instance, representative biotopes of the 'Subtidal Coarse and Mixed Sediment' IEF are characterised by epifaunal species such as *F. foliacea* and *S. spinulosa* which have the potential

to colonise hard substrates (Readman and Watson, 2024; Tillin *et al.*, 2023b; Tillin *et al.* 2023c). Overall, it is considered that the 'Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment', and 'Moderate Energy Subtidal Rock' IEFs will be unable to avoid or adapt to the impact, have no or very low capacity to accommodate the proposed form of change, however, potential recovery will be possible (i.e. within two-10 years). In terms of value, these IEFs are of local importance. There was no evidence of Annex I *Sabellaria* reef during surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site). Overall, IEFs (including *'Sabellaria* on Stable Sediments' IEF) and 'Reef' IEF (if present) are considered to have High sensitivity to long-term habitat loss/change. As highlighted in Table 9.13, confirmatory surveys (geophysical and underwater video surveys) prior to construction, to confirm the presence or absence of Annex I *Sabellaria* reef habitat will be conducted, and any Annex I habitat would be avoided via micro-routing and micro-siting of infrastructure.

9.9.4.7. In summary, the sensitivity of the benthic subtidal IEFs to long-term subtidal habitat loss/change has been assessed as High (although for some IEFs the change may be less notable, with potential for colonisation of hard substrates by characterising species/communities).

Table 9.17: Sensitivity of Benthic Subtidal Ecology IEFs to long-term subtidal habitat loss/change.

IEF	Representative biotopes	Sensitivity to defined MarESA pressure 'Physical change (to another seabed type)'
Reefs	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261)	High (based on No resistance and Very Low resilience)
Sandbanks which are slight adversely covered by sea water all the time	Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (JNCC code: SS.SSa.IFiSa.NcirBat; EUNIS code: MB5233)	High (based on No resistance and Very Low resilience)
Subtidal Sands Sediment	Infralittoral fine sand (JNCC code: SS.SSa.IFISa; EUNIS code: MB5 Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) Infralittoral muddy sand (JNCC code: SS.SSa.IMuSa; EUNIS code: MB5) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232)	High (based on No resistance and Very Low resilience)
Subtidal Coarse and Mixed Sediments	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (JNCC code: MCR.SNemAdia; EUNIS code: MC1217) *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214)	High (based on No resistance and Very Low resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure 'Physical change (to another seabed type)'
Sabellaria on Stable Sediments	*Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock (JNCC code: CR.MCR.CSab.Sspi.As; EUNIS code: MC12812) *Sabellaria spinulosa* on stable circalittoral mixed sediment (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211)	High (based on No resistance and Very Low resilience)
Moderate Energy Subtidal Rock	Moderate Energy Circalittoral rock (JNCC code: CR.MCR; EUNIS code: MC12) *Flustra foliacea* on slight adversely scoured silty circalittoral rock (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241) Moderate Energy Infralittoral Rock (JNCC code: IR.MIR; ENIS code: MB12)	High (based on No resistance and Very Low resilience)

Operational and maintenance phase

MAGNITUDE OF THE IMPACT

9.9.4.8. During the operational and maintenance phase, long-term subtidal habitat loss/change will occur due to the presence of 56 WTG and two OSPs foundations, inter-array, export and interconnector cables, associated scour protection and cable protection (Table 9.7). The total area of long-term subtidal habitat loss/change is 662,800 m^2. However, this only covers a small proportion (0.06%) of the 1,031.67 km^2 Benthic Subtidal and Intertidal Ecology Study Area.

9.9.4.9. The impact of long-term subtidal habitat loss/change will directly affect IEFs through the loss of characterising benthic communities and significant alteration of the character of representative biotopes.

9.9.4.10. Long-term subtidal habitat loss/change is predicted to have long-term duration and continuous throughout the operational and maintenance phase. However, a key consideration is that effects are expected to have a highly localised spatial extent (restricted to discrete areas within the Array Area and Cable Corridor and Working Area). It is predicted that the impact will affect benthic subtidal IEFs directly, with the potential for some IEFs to recover following the introduction of hard substrata and overall the magnitude of impact is considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.9.4.11. The magnitude of the impact has been assessed as **Low**, with the sensitivity of IEFs being assessed as **High** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **High**). Therefore, the significance of effect is considered to be **Moderate**. This has been deemed not significant in EIA terms based on professional judgement due to the small proportion of the Benthic Subtidal and Intertidal Ecology Study Area potentially affected by long-term subtidal habitat loss/change, and the extent of potentially affected biotopes in the wider area.

PROPOSED MITIGATION

9.9.4.12. The effects of long-term subtidal habitat loss/change are not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.4.13. The significance of effect due to long-term subtidal habitat loss/change is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to Benthic Subtidal and Intertidal Ecology.

9.9.5 Impact 5 – Colonisation of hard structures

9.9.5.1. The presence of WTG and OSP foundations, associated scour protection and cable protection within the Array Area and Cable Corridor and Working Area may result in the colonisation of these hard structures by organisms during the construction and operational and maintenance phase of the Proposed Development. Sediments within the Proposed Development are dominated by sand and mixed sediments within the Array Area and coarse sediments within the Cable Corridor and Working Area. Therefore, any long-term introduction and colonisation of hard substrate will directly alter the type of available habitats within the Benthic Subtidal and Intertidal Ecology Study Area. The impact of any long-term subtidal habitat loss/change to benthic ecology has been assessed in section 9.9.4.

9.9.5.2. Representative biotopes of IEFs associated with SACs within the Benthic Subtidal and Intertidal Study Area, are located beyond the Array Area and Cable Corridor and Working Area. Therefore,

there is no potential for interaction between the activities associated with colonisation of hard structures, and these IEFs within SACs.

SENSITIVITY OF THE RECEPTOR

9.9.5.3. There is no MarESA pressure for colonisation of hard structures. As a result, sensitivity of IEFs to this impact has been discussed qualitatively below.

9.9.5.4. The introduction of hard substrates from foundations, scour protection and cable protection will cause a shift from soft and coarse substrate areas (i.e. sand and mixed sediment) to hard and artificial substrate in areas where infrastructure is installed.

9.9.5.5. Colonisation of hard structures may result in an increase of biodiversity and biomass. It should be noted that the increase in biodiversity and biomass is largely associated with epibenthic species as opposed to infauna. This has been observed at the Egmond aan Zee offshore windfarm in the Netherlands, where post-construction monitoring observed an increase in biodiversity of the upper (7-10 m) and lower (10 m to seabed) zones. The upper zone was dominated by *M. edulis* and other fauna including barnacles and starfish, whilst the lower zone was dominated by anemones and the small crustacean *Jassa* spp. (Lindeboom *et al*., 2011). Additionally, the presence of scour protection may increase the structural complexity of available substrata, providing niche habitats whilst also increasing feeding opportunities for larger and more mobile species. Nursery habitats for the edible crab *Cancer pagurus* has been observed at the Horns Rev offshore windfarm in Denmark (BioConsult, 2006).

9.9.5.6. In summary, colonisation of hard structures represents a long-term change from the baseline environment but will be highly localised to the areas where hard structures will be present. It is anticipated that hard structures will be colonised by characterising species of hard/mixed substrate IEFs and other species already occurring within the baseline environment of the Benthic Subtidal and Intertidal Ecology Study Area. Overall, it is considered that IEFs will have a reasonable capacity to avoid or adapt to the impact and it is anticipated that any adjacent soft, mixed or hard substrate habitats and benthic communities adjacent to introduced structures will generally have high capacity to accommodate the proposed form of change. Additionally, it is anticipated that recoverability of IEFs will be short-term (i.e. within two-10 years) and IEFs associated with this effect are of local importance. There was no evidence of Annex I *Sabellaria* reef during surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site) and *Sabellaria* spp. would have capacity to colonise introduced hard substrates. Benthic subtidal and intertidal IEFs and 'Reef' IEF (if present) have therefore been assessed as having Low sensitivity to colonisation of hard structures.

Construction phase

MAGNITUDE OF THE IMPACT

9.9.5.7. The installation of the Proposed Development within the Array Area and Cable Corridor and Working Area may result in the colonisation of hard structures as they are gradually introduced with final areas of up to 662,800 m^2 and 1,460,644 m^3 of hard substrate habitat introduced due to the presence of WTG and OSP foundations, associated scour protection, cable protection and cable crossings. Additionally, the hulls of slow moving or stationary vessels (e.g. jack-up vessels) may also be colonised by benthic species.

9.9.5.8. The extent of the impact will be restricted to the locations where there is placement of infrastructure and the location of vessels which will be within the near-field. The duration of the impact is anticipated to persist for the duration of the construction phase. The frequency of the impact will occur continuously throughout the construction phase of the project. The impact will result in a barely discernible to noticeable change to key characteristics or features, as it is anticipated that hard structures will be colonised by characterising species of hard or mixed

substrate IEFs and other species already occurring within the baseline environment. Overall, the magnitude is considered to be Medium.

SIGNIFICANCE OF THE EFFECT

9.9.5.9. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (as indicated above, the sensitivity of the 'Reef' IEF is also **Low**). Therefore, the significance of effect will be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.5.10. The effects of colonisation of hard structures is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.5.11. The significance of effect due to colonisation of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to Benthic Subtidal and Intertidal Ecology.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.9.5.12. The presence of the Proposed Development within the Array Area and Cable Corridor and Working Area may result in the colonisation of hard structures with up to 662,800 m^2 and 1,465,796 m^3 of hard substrate habitat created from the presence of WTG and OSP foundations, associated scour protection, cable protection and cable crossings.

9.9.5.13. The extent of the impact will be restricted to the placement of infrastructure which will be within the near-field. The duration of the impact is anticipated to persist for the duration of the operational and maintenance phase and therefore, is considered to be long term. The frequency of the impact will occur continuously throughout the operational and maintenance phase. The impact will result in a barely discernible to noticeable change to key characteristics or features, as it is anticipated that hard structures will be colonised by characterising species of hard or mixed substrate IEFs and other species already occurring within the baseline environment. The magnitude of impact is therefore, considered to be Medium.

SIGNIFICANCE OF EFFECT

9.9.5.14. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (as indicated above, the sensitivity of the 'Reef' IEF is also **Low**). Therefore, the significance of effect will be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.5.15. The effects of colonisation of hard structures is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.5.16. The significance of effect due to colonisation of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to Benthic Subtidal and Intertidal Ecology.

Decommissioning phase

MAGNITUDE OF THE IMPACT

9.9.5.17. The presence of the Proposed Development within the Array Area and Cable Corridor and Working Area which is to be left *in situ* following decommissioning may result in the colonisation of hard structures with up to 657,110 m^2 and 1,460,644 m^3 of hard substrate habitat created from the presence of scour protection, cable protection and cable crossings. Additionally, slow moving or stationary vessels (e.g. jack-up vessels) may also be colonised by benthic species.

9.9.5.18. The extent of the impact will be restricted to the placement of infrastructure and the location of vessels which will be within the near-field. The duration of the impact is anticipated to persist beyond the decommissioning phase due to infrastructure that will remain *in situ* following decommissioning and therefore is considered to be long-term. The frequency of the impact will occur continuously throughout the decommissioning phase of the project and beyond in respect of elements that will remain *in situ* following decommissioning. The impact will result in a barely discernible to noticeable change to key characteristics or features, as it is anticipated that hard structures will be colonised by characterising species of hard or mixed substrate IEFs and other species already occurring within the baseline environment. The magnitude is therefore, considered to be Medium.

SIGNIFICANCE OF THE EFFECT

9.9.5.19. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect will be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.5.20. The effects of colonisation of hard structures is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.5.21. The significance of effect due to colonisation of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted with respect to Benthic Subtidal and Intertidal Ecology.

9.9.6 Impact 6 – Alteration of seabed habitat arising from effects on physical processes

9.9.6.1. The presence of the WTG and OSP foundations, associated scour protection and other installed structures such as cable protection may lead to changes in the physical processes within the Array Area and Cable Corridor and Working Area and potentially further afield which could subsequently affect seabed habitats through changes to locations of sediment scour, sediment deposition and grain size distribution. Volume III, Appendix 6.1: Marine Physical Processes Numerical Modelling, describes in detail the changes that could occur as a result of the presence of foundation structures and associated scour and cable protection. It should be noted that as structures are introduced to the marine environment during construction, there could be effects on physical processes during the construction phase. In line with standard practice, however, it has been assessed as an operational and maintenance phase and decommissioning phase impact, with the effects during operation being assessed based on all infrastructure being in place. Taking this approach it can be assumed that the effects determined for the operational and maintenance phase will be greater than any effects during the construction phase.

SENSITIVITY OF THE RECEPTOR

9.9.6.2. The key IEFs which may be affected by alteration of seabed habitat arising from effects on physical processes are presented in Table 9.18.

9.9.6.3. The representative biotope of the 'Reefs' IEF, is '*Sabellaria alveolata* reefs on sand-abraded eulittoral rock' (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261), and is characteristic of the Annex I reef habitat feature of the Wicklow Reef SAC (DCHG, 2014a). Impacts associated with alteration of seabed habitat arising from effects on physical processes are predicted be low with the largest changes of between 0.05 and 0.1 m/s within the Array Area and immediately downstream of foundations (see Chapter 6: Coastal Processes). However, Wicklow Reef SAC is located approximately 4.5 km and 3.6 km from the Array Area and Cable Corridor and Working Area. Therefore, there is no potential for Interaction between the activities associated with increased suspended sediment and deposition, and the 'Reef' IEF in the Wicklow Reef SAC.

9.9.6.4. Similarly, the representative biotopes of the 'Sandbanks' IEF is characteristic of the Annex I 'Sandbanks which are slight adversely covered by sea water all the time' feature of the Blackwater Bank SAC (DCHG, 2014b) which is located approximately 19.7 km and 19.1 km from the Array Area and Cable Corridor and Working Area respectively, and therefore beyond the potential distance of alteration of seabed habitat arising from effects on physical processes. Consequently, there is no potential for interaction between the activities associated with increased suspended sediment and deposition, and the Sandbanks IEF of the Blackwater Bank SAC.

9.9.6.5. The MarESA assessments for the 'Subtidal Sands Sediment', 'Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' (and 'Reef' IEF (if present)), and 'Moderate Energy Subtidal Rock' IEFs indicate that representative biotopes have a high tolerance (resistance) and high recoverability (resilience) to both 'Water flow (tidal current) changes (local)' (a change in peak mean spring bed flow velocity of between 0.1 m/s to 0.2 m/s for more than one year) and 'Wave exposure changes' (change in near shore significant wave height of >3% but <5% for more than one year).

9.9.6.6. The physical processes modelling indicates that any changes to water flow and wave height would be minimal, not exceeding the MarESA benchmarks mentioned above, and largely localised around the foundation structures (Volume II, Chapter 6: Coastal Processes). Benthic subtidal and intertidal IEFs have therefore been assessed as having Negligible sensitivity to alteration of seabed habitat arising from effects on physical processes.

Table 9.18: Sensitivity of Benthic Subtidal Ecology IEFs to alteration of seabed habitat arising from effects on physical processes.

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Changes in suspended solids (water clarity)'	'Water Flow (tidal current) changes (local)'
Reefs	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)
Sandbanks which are slight adversely covered by sea water all the time	Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (JNCC code: SS.SSa.IFiSa.NcirBat; EUNIS code: MB5233)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)
Subtidal Sands Sediment	Infralittoral fine sand (JNCC code: SS.SSa.IFISa; EUNIS code: MB5 Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) Infralittoral muddy sand (JNCC code: SS.SSa.IMuSa; EUNIS code: MB5) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Changes in suspended solids (water clarity)'	'Water Flow (tidal current) changes (local)'
Subtidal Coarse and Mixed Sediments	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (JNCC code: MCR.SNemAdia; EUNIS code: MC1217) *Moerella* spp. with venerid bivalves in infralittoral gravelly sand (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)
Sabellaria on Stable Sediments	*Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock (JNCC code: CR.MCR.CSab.Sspi.As; EUNIS code: MC12812) *Sabellaria spinulosa* on stable circalittoral mixed sediment (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)
Moderate Energy Subtidal Rock	Moderate Energy Circalittoral rock (JNCC code: CR.MCR; EUNIS code: MC12)	Not Sensitive (based on High resistance and High resilience)	Not Sensitive (based on High resistance and High resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure	
		'Changes in suspended solids (water clarity)'	'Water Flow (tidal current) changes (local)'
	Flustra foliacea on slight adversely scoured silty circalittoral rock (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241)		
	Moderate Energy Infralittoral Rock (JNCC code: IR.MIR; ENIS code: MB12)		

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.9.6.7. The presence of Proposed Development infrastructure may lead to changes in physical processes within the Array Area, Cable Corridor and Working Area and potentially further afield, potentially affecting seabed habitats. The scenario for Design Option 1 includes 56 WTG monopile foundations and two OSP foundations with a diameter of 7-11 m or 7-14 m, associated scour protection at a height of 0.5-3 m, cable protection and cable crossings covering a total area of 662,800 m^2.

9.9.6.8. Modelling was undertaken to determine changes in hydrodynamic flow during peak spring and neap, flood and ebb tidal conditions. Changes to tidal flow are expected to be low with the largest changes of between 0.05 and 0.1 m/s within the Array Area and immediately downstream of foundations. Modelling of effects on waves was undertaken for several scenarios, with a slight adverse reduction in wave conditions predicted.

9.9.6.9. Based on coastal processes modelling, the potential for alteration to seabed habitats due to changes in physical processes is predicted to be of near-field spatial extent, long term duration, continuous and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude of impact is therefore considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.6.10. The magnitude of the impact has been assessed as **Low**, with the sensitivity of the receptors being **Negligible** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from alteration of seabed habitat arising from effects on physical processes is **Imperceptible**, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.6.11. The effect of alteration of seabed habitats arising from changes in physical processes is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.6.12. The significance of effect from alteration of seabed habitats arising from changes in physical processes is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Consequently, no ecologically significant adverse residual effects have been predicted with respect to alteration of seabed habitats arising from changes in physical processes.

9.9.7 Impact 7 – Removal of hard substrates resulting in loss of colonising communities

9.9.7.1. The removal of some of the hard structures following the decommissioning of the Proposed Development will result in the removal of benthic communities that have colonised hard structures and will therefore have a direct effect on benthic ecology IEFs.

9.9.7.2. Representative biotopes of IEFs associated with SACs within the Benthic Subtidal and Intertidal Study Area, are located beyond the Array Area and Cable Corridor and Working Area. Therefore, there is no potential for interaction between the activities associated with removal of hard substrates and habitat features of these SACs.

SENSITIVITY OF THE RECEPTOR

9.9.7.3. There is no MarESA pressure for removal of hard substrates. As a result, sensitivity of IEFs to this impact has been discussed qualitatively below.

9.9.7.4. The removal of hard substrates will result in the removal of any organisms which have colonised them over time, resulting in a likely localised reduction in epifaunal biodiversity. However, where these hard substrates are in soft sediment locations, the abundance and diversity of epifaunal species would have likely been greater than the assemblages present pre-construction and removal would represent a change back to more natural conditions. In addition, areas of seabed where infrastructure was present prior to decommissioning will then be available for recolonisation. It is expected that the baseline benthic communities will recover rapidly to their pre-construction state due to recruitment from surrounding unaffected areas, adult migration and larval dispersal.

9.9.7.5. IEFs which have colonised hard structures prior to decommissioning will be unable to avoid the impact. However, it is anticipated that these areas will be recolonised rapidly. As a result, IEFs will have a high capacity to accommodate the proposed form of change and recoverability will be short-term (i.e. within two to 10 years). Additionally, IEFs are of local importance. There was no evidence of Annex I *Sabellaria* reef during surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site). Benthic subtidal and intertidal IEFs have therefore been assessed as having Low sensitivity to removal of hard structures resulting in loss of colonising communities.

Decommissioning phase

MAGNITUDE OF IMPACT

9.9.7.6. The decommissioning of Proposed Development infrastructure from the Array Area will result in the loss of 5,690 m^2 of colonised hard substrate due to the removal of monopile foundations which will be cut 2 m below the seabed. Cables, associated scour protection and cable protection will not be removed and remain *in situ*.

9.9.7.7. The removal of hard substrate will be restricted to the near-field, duration will be long term and the frequency of the impact will be constant throughout the decommissioning phase. Additionally, the consequence will result in noticeable change to key characteristics or features due to the complete removal of colonised hard structures. The magnitude of impact is therefore, considered to be Medium.

SIGNIFICANCE OF EFFECT

9.9.7.8. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect will be **Slight** adverse significance, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.7.9. The effects of removal of hard structures is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.7.10. The significance of effect from removal of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.9.8 Impact 8 – Increased risk of introduction and spread of invasive and non-native species

9.9.8.1. The introduction and spread of invasive and non-native species may occur during the construction, operational and maintenance, and decommissioning phases of the Proposed Development due to the introduction of hard structures (allowing for colonisation) and the presence and movement of vessels (due to colonisation of vessel hulls and structures and ballast water discharge). There is therefore potential for an impact on benthic ecology IEFs.

SENSITIVITY OF THE RECEPTOR

9.9.8.2. The key IEFs which may be affected by increased risk of introduction and spread of invasive non-native species are presented in Table 9.19.

9.9.8.3. Invasive non-native benthic species can include broad groups including molluscs, crustaceans, sea squirts, bryozoans and macroalgae. However, for the purposes of this assessment only key species are mentioned. It should be noted that similar considerations apply to a wide range of invasive and non-native species.

9.9.8.4. The representative biotope of the 'Reefs' IEF has a medium tolerance (resistance) and very low recoverability (resilience) to the introduction or spread of invasive non-native species. The slipper limpet *Crepidula fornicata* and pacific oyster *Magallana gigas* have the potential to colonise *S. alveolata* reefs. *M. gigas* can smother *S. alveolata* by growing over the tube ends and could out-compete the larvae, juveniles, and adults for space. Additionally, due to the high filtration rates of oysters like *M. gigas*, the species may directly outcompete *S. alveolata* for food (Dubois *et al.* 2006; Tillin *et al.*, 2023d). There is no evidence to suggest that *C. fornicata* has a detrimental effect on *S. alveolata* (Tillin *et al.*, 2023d). However, due to the distance of the Wicklow Reef SAC to the Array Area (4.5 km) and Cable Corridor and Working Area (3.6 km), and the potential for only localised increases in invasive and non-native species on the hard substrates within the Array Area and Cable Corridor and Working Area, the risk to the 'Reef' IEF habitat feature of the Wicklow Reef SAC is low.

9.9.8.5. Representative biotopes for the sandbanks which are slight adversely covered by sea water all the time IEF have a high tolerance (resistance) and high recoverability (resilience) to the introduction or spread of invasive non-native species. Representative biotopes are characterised by highly mobile sediment and high energy environments which are unsuitable for invasive species such as *C. fornicata* (Bohn *et al.* 2015; Blanchard, 2009). Unsuitable habitat conditions are also exemplified by the low species richness which characterises representative biotopes (Tillin *et al.*, 2023a). Additionally, due to the distance of the Blackwater Bank SAC to the Array Area (19.7 km) and Cable Corridor and Working Area (19.1 km), and the potential for only localised increase in invasive and non-native species on the hard substrates within the Array Area and Cable Corridor and Working Area, the risk to IEFs in the Blackwater Bank SAC is low.

9.9.8.6. The MarESA assessment for the 'Subtidal Sands Sediment' IEF indicates that representative biotopes have a medium to high tolerance (resistance) and very low to high recoverability (resilience) to the 'Introduction or spread of invasive non-native species'. The representative biotope 'Infralittoral mobile clean sand with sparse fauna' (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) is characterised by unsuitable habitat conditions and low species richness, limiting the establishment of invasive species (Bohn *et al.* 2015; Blanchard, 2009). However, *C. fornicata* could colonise the biotope '*Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles' (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232) due to the presence of pebbles, cobbles, or any other hard substrata that can be used for larvae settlement (Tillin *et al.*, 2020), modifying the habitat and its associated community. Wave action and storm events, however, could hinder the colonisation of *C. fornicata* (Readman *et al.*, 2023a). Consequently, the 'Subtidal Sands Sediment' IEF has a reasonable

capacity to avoid the impact, but a low to moderate capacity to accommodate the proposed form of change if colonisation were to occur. It is anticipated that the recoverability of IEFs will be low if colonised by invasive species such as *C. fornicata* and the value of the IEF is of local importance. Therefore, 'Subtidal Sands Sediment' IEF is considered to have Medium sensitivity to the introduction or spread of invasive non-native species.

9.9.8.7. Representative biotopes of the 'Subtidal Coarse and Mixed Sediments' IEF have a medium tolerance (resistance) and a very low recoverability (resilience) to the introduction or spread of invasive non-native species. Sediments characterising the representative biotopes for this IEF may be too mobile for colonisation of most invasive species. However, *C. fornicata* could colonise the coarse sediment and mixed sediment habitats of the biotopes '*Moerella* spp. with venerid bivalves in infralittoral gravelly sand' (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233) and '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214), modifying the biotopes and associated communities (Blanchard, 2009; Tillin *et al.*, 2020). However, exposure to wave action and storm events may prevent colonisation at higher densities. For the biotope '*Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment' (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214), colonisation of invasive bryozoans such as *Schizoporella japonica* and *Tricellaria inopinata* may be of concern, but high levels of scour in this biotope will likely limit establishment. Insufficient evidence is available for the representative biotope 'Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata' (JNCC code: MCR.SNemAdia; EUNIS code: MC1217), however, the biotope is likely to be unsuitable for colonisation by *C. fornicata* due to the moderate wave exposure, as wave action, scour, and storms may inhibit or prevent colonisation (Readman *et al.*, 2023b). Consequently, the 'Subtidal Coarse and Mixed Sediments' IEF has a reasonable capacity to avoid the impact, but a low to moderate capacity to accommodate the proposed form of change if colonisation were to occur. It is anticipated that the recoverability of IEFs will be low if colonised by invasive species such as *C. fornicata*, *Schizoporella japonica* and *Tricellaria inopinata* and the value of the IEF is of local importance. Therefore, 'Subtidal Coarse and Mixed Sediments' IEF is considered to have Medium sensitivity to the introduction or spread of invasive non-native species.

9.9.8.8. The MarESA assessment for the *'Sabellaria* on Stable Sediments' IEF indicates that there is either no direct evidence or insufficient evidence for effect of the introduction or spread of invasive non-native species on representative biotopes. As indicated above *M. gigas* and *C. fornicata* can colonise *Sabellaria* reef and compete for food and space. However, there is no evidence that this is significantly affecting *S. spinulosa* biotopes, but invasive species including *C. fornicata* and *M. gigas* have been observed colonising *S. spinulosa* reefs (Dubois *et al.* 2006; Tillin *et al.*, 2023b). *C. fornicata* and *M. gigas* may pose a potential threat in terms of competition for food and space (Tillin *et al.*, 2023b; Tillin *et al.,* 2023c). However, characterising sediments of representative biotopes are likely to be unsuitable for the colonisation of these species due to wave exposed conditions and storm events (Tillin *et al.,* 2023b). Consequently, the *'Sabellaria* on Stable Sediments' IEF has a reasonable capacity to avoid the impact but may have low to moderate capacity to accommodate the proposed form of change if colonisation were to occur and recoverability of IEFs will be low. The '*Sabellaria* on stable sediments' IEF is of local importance. There was no evidence of Annex I *Sabellaria* reef during site characterisation surveys, but if present, it would be of national importance (i.e. where it is not a feature of a protected site). Overall, the *'Sabellaria* on Stable Sediments' IEF and 'Reef' IEF (if present) are both considered to have Medium sensitivity to increased risk of introduction and spread of invasive and non-native species. As highlighted in Table 9.13, confirmatory surveys will include a geophysical survey carried out prior to construction which will confirm the location and extent of any potential areas of Annex I *Sabellaria* reef habitat which will then be ground truthed via underwater video. Any areas of Annex I Sabellaria reef habitat identified will be avoided via micro-routing and micro-siting of infrastructure.

9.9.8.9. The MarESA assessment for the 'Moderate Energy Subtidal Rock' IEF indicates that there is insufficient evidence for effects of the introduction or spread of invasive non-native species on representative biotopes. The circalittoral rock characterising the representative biotope '*Flustra foliacea* on slight adversely scoured silty circalittoral rock' (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241) is likely to be unsuitable for the colonisation by invasive species such as *C. fornicata* due to wave exposed conditions and storm events which may inhibit or prevent colonisation at high densities (Readman *et al.*, 2023c). Although no evidence is available for the effect of the introduction or spread of invasive non-native species, the biotope is characterised by fast growing and opportunistic suspension feeders which may prevent colonisation due to larval predation and out competing non-native species for space (Readman *et al.*, 2023c). Consequently, the 'Moderate Energy Subtidal Rock' IEF has a reasonable capacity to avoid the impact, high capacity to accommodate the proposed form of change and high recoverability. The value of the 'Moderate Energy Subtidal Rock' IEF is also of local importance. Therefore, 'Moderate Energy Subtidal Rock' IEF is considered to have Low sensitivity to the introduction or spread of invasive non-native species.

9.9.8.10. The MarESA assessment for the 'Barren Coarse Intertidal Sediment' IEF indicates that there is no evidence of the effect of introduction or spread of invasive non-native species on representative biotopes and a high tolerance (resistance) and recoverability (resilience) is applied. High levels of abrasion as a result of movement of coarse sands and sediment instability will limit the colonisation of invasive species (Tillin *et al.*, 2019; Tillin and Budd, 2016). Additionally, low levels of water and organic matter retained by representative biotopes will inhibit permanent colonisation (Tillin *et al.*, 2019; Tillin and Budd, 2016). Consequently, the 'Barren Coarse Intertidal Sediment' IEF has a high capacity to avoid the impact and accommodate the proposed form of change, and has high recoverability. The value of the 'Barren Coarse Intertidal Sediment' IEF is also of local importance. Therefore, the 'Barren Coarse Intertidal Sediment' IEF is considered to have Negligible sensitivity to the introduction or spread of invasive non-native species.

9.9.8.11. The representative biotopes of the 'Moderately Exposed Intertidal Rock' IEF have a high tolerance (resistance) and recoverability (resilience) to the introduction or spread of invasive non-native species. Native fucoid species show high resistance to invasions by some non-native species such as the Japanese kelp *Undaria pinnatifida* (Thompson and Schiel, 2012). However, whilst other evidence suggests *Fucus vesiculosus* is impacted by the invasive *Sargassum muticum* which competes for both light and space (Stæhr *et al.*, 2000). The invasive barnacle *Austrominius modestus* has only had a small effect on the dynamics of rocky shore habitats. Little to no specific evidence is available for the impacts of invasive species on the characterising species of the representative biotopes 'Barnacles and fucoids on moderately exposed shores' (JNCC code: LR.MLR.BF; EUNIS code: MA1245) and '*Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock' (JNCC code: LR.HLR.MusB.Sem.Sem; EUNIS code: MA12231). Consequently, the 'Moderately Exposed Intertidal Rock' IEF has a high capacity to avoid the impact and accommodate the proposed form of change, and has high recoverability. The value of the 'Moderately Exposed Intertidal Rock' IEF is also of local importance. Therefore, the 'Moderately Exposed Intertidal Rock' IEF is considered to have Negligible sensitivity to the introduction or spread of invasive non-native species.

9.9.8.12. In summary, the introduction or spread of invasive non-native species would represent a long-term change from the baseline environment but is anticipated to be highly localised to the areas where hard structures will be present. The effect of colonisation of invasive species will vary for the IEFs assessed above. For instance, subtidal IEFs will have a reasonable capacity to avoid the impact due to exposure to wave action and storm events that will limit colonisation. However, the tolerance of representative biotopes would be low and if colonised, recoverability would be prolonged. Intertidal IEFs however, would have high capacity to avoid the impact, accommodate the proposed form of change and would have high recoverability. Benthic subtidal and intertidal

IEFs have therefore been assessed as having Negligible to Medium sensitivity to the introduction or spread of invasive non-native species.

Table 9.19: Sensitivity of Benthic Subtidal and Intertidal Ecology IEFs to increased risk of introduction and spread of invasive and non-native species

IEF	Representative biotopes	Sensitivity to defined MarESA pressure 'Introduction or spread of invasive non-indigenous species'
Reefs	*Sabellaria alveolata* reefs on sand-abraded eulittoral rock (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261)	Medium (based on Medium resistance and Very Low resilience)
Sandbanks which are slight adversely covered by sea water all the time	Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) *Nephtys cirrosa* and *Bathyporeia* spp. in infralittoral sand (JNCC code: SS.SSa.IFiSa.NcirBat; EUNIS code: MB5233)	Not Sensitive (based on High resistance and High resilience)
Subtidal Sands Sediment	Infralittoral fine sand (JNCC code: SS.SSa.IFISa; EUNIS code: MB5 Infralittoral mobile clean sand with sparse fauna (JNCC code: SS.SSa.IFiSa.IMoSa; EUNIS code: MB5231) Infralittoral muddy sand (JNCC code: SS.SSa.IMuSa; EUNIS code: MB5) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles (JNCC code: SS.SSa.IFiSa.ScupHyd; EUNIS code: MB5232)	Not Sensitive to Medium (based on Medium to High resistance and Very Low to High resilience)
Subtidal Coarse and Mixed Sediments	Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata (JNCC code: MCR.SNemAdia; EUNIS code: MC1217)	Medium to High (based on Low to Medium resistance and Very Low resilience)

IEF	Representative biotopes	Sensitivity to defined MarESA pressure 'Introduction or spread of invasive non-indigenous species'
	Moerella spp. with venerid bivalves in infralittoral gravelly sand (JNCC code: SS.SCS.ICS.MoeVen; EUNIS code: MB3233)	
	Flustra foliacea and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment (JNCC code: SS.SMx.CMx.FluHyd; EUNIS code: MC4214)	
Sabellaria on Stable Sediments	*Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock (JNCC code: CR.MCR.CSab.Sspi.As; EUNIS code: MC12812)	No Evidence or Insufficient Evidence indicated in MarESA assessment
	Sabellaria spinulosa on stable circalittoral mixed sediment (JNCC code: SS.SBR.PoR.SspiMx; EUNIS code: MC2211)	
Moderate Energy Subtidal Rock	Moderate Energy Circalittoral rock (JNCC code: CR.MCR; EUNIS code: MC12)	Insufficient Evidence indicated in MarESA assessment
	Flustra foliacea on slight adversely scoured silty circalittoral rock (JNCC code: CR.MCR.EcCr.FaAlCr.Flu: EUNIS code: MC12241)	
	Moderate Energy Infralittoral Rock (JNCC code: IR.MIR; ENIS code: MB12)	

IEF	Representative biotopes	Sensitivity to defined MarESA pressure 'Introduction or spread of invasive non-indigenous species'
Barren Coarse Intertidal Sediment	Barren littoral shingle (JNCC code: LS.LCS.Sh.BarSh; EUNIS code: MA3211) Barren littoral coarse sand (JNCC code: LS.LSa.MoSa.BarSa; EUNIS code: MA5231)	No Evidence or Not Relevant indicated in MarESA assessment
Moderately Exposed Intertidal Rock	Barnacles and fucoids on moderately exposed shores (JNCC code: LR.MLR.BF; EUNIS code: MA1245) *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock (JNCC code: LR.HLR.MusB.Sem.Sem; EUNIS code: MA12231)	Not Sensitive (based on High resistance and High resilience)

Construction phase

MAGNITUDE OF THE IMPACT

9.9.8.13. The presence of construction vessels may lead to the increased risk of introduction and spread of invasive and non-native species within the Benthic Subtidal and Intertidal Ecology Study Area. During the construction phase, a maximum of 66 installation vessels will be present within the Array Area at any one time, resulting in a maximum of 4,150 vessel return trips over the five-year construction period, and a maximum of 1,797 vessel return trips per year.

9.9.8.14. Several already established invasive species have the potential to colonise hard structures within the Array Area and Cable Corridor and Working Area including the carpet sea squirt *Didemnum vexillum*, devil's tongue weed *Grateloupia turuturu*, Japanese skeleton shrimp *Caprella mutica*, leathery sea squirt *Styela clava*, Pacific oyster *M. gigas*, slipper limpet *C. fornicata*, wakame *Undaria pinnatifida* and wire weed *Sargassum muticum* (Invasive Species Ireland, 2020). Additionally, several other species are of concern as potentially invasive for Ireland including, Asian rapa whelk *Rapana venosa*, oyster drill *Ceratostoma inornatum* and *Urosalpinx cinereal* and red king crab *Paralithodes camtschaticus* (Invasive Species Ireland, 2020). Of these species that are not yet established within Ireland, *R. venosa* is thought to have a potential pathway for introduction through ballast water (Invasive Species Ireland, 2020).

9.9.8.15. As set out in Table 9.13, an Invasive Non-Indigenous Species Management Plan and Vessel Management Plan (VMP) will be implemented (Volume III, Appendix 25.7). The plans outline various measures to ensure that vessels comply with (IMO) ballast water management guidelines and legislation including consideration for vessel origin and standard housekeeping measures for vessels such as checks for invasive species. Overall this will ensure that the risk of introduction and spread of invasive and non-native species will be minimised.

9.9.8.16. The increased risk of introduction and spread of invasive and non-native species is considered to be restricted to the near-field and adjacent far field-areas, long-term and will occur constantly throughout the construction phase and future phases. The consequence of introduction and spread of invasive and non-native species would be permanent changes to key characteristics or features of benthic habitats. However, given the implementation of an Invasive Non-Indigenous Species Management Plan, it is anticipated that any impact would be indirect. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.9.8.17. The magnitude of the impact has been assessed as **Low.**

9.9.8.18. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible**, which is not significant in EIA terms.

9.9.8.19. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.9.8.20. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Medium** but this habitat would be avoided via micro-routing and micro-siting of infrastructure). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.8.21. The effects of increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.8.22. The significance of effect from increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.9.8.23. The presence of hard substrates and the presence of operational and maintenance vessels may lead to the increased risk of introduction and spread of invasive and non-native species within the Benthic Subtidal and Intertidal Ecology Study Area. During the operational and maintenance phase, a maximum of 30 installation vessels will be present within the Array Area at any one time, resulting in a maximum of 1,359 vessel return trips per year. The risk of introduction and spread of invasive and non-native species will also be increased due to the presence of 573,385 m^2 and 938,540 m^3 of new hard structures within the Array Area and Cable Corridor and Working Area from the installation of WTG and OSP foundations, associated scour protection and cable protection.

9.9.8.24. As mentioned above, several species are either already established or are of concern as potentially invasive for Ireland (Invasive Species Ireland, 2020).

9.9.8.25. As set out in Table 9.13, an Invasive Non-Indigenous Species Management Plan and VMP will be implemented (Volume III, Appendix 25.7). The plan outlines various measures to ensure that vessels comply with (IMO) ballast water management guidelines and legislation including consideration for vessel origin and standard housekeeping measures for vessels. Overall this will ensure that the risk of introduction and spread of invasive and non-native species due to vessel activity will be minimised. Additionally, post-installation cable burial surveys will take place during the operational and maintenance phase. This will allow for periodic monitoring to determine the extent of colonisation of invasive species on the hard structures associated with cables.

9.9.8.26. The increased risk of introduction and spread of invasive and non-native species is considered to be restricted to the near-field and adjacent far field-areas, will be long-term and will occur constantly throughout the operation and maintenance phase and future phases. The consequence of introduction and spread of invasive and non-native species would be permanent with changes to key characteristics or features of benthic habitats. However, given the implementation of an Invasive Non-Indigenous Species Management Plan and VMP it is anticipated that any impact would be indirect. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.8.27. The magnitude of the impact has been assessed as **Low.**

9.9.8.28. The sensitivity of the ‘Barren Coarse Intertidal Sediment’ and ‘Moderately Exposed Intertidal Rock’ IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible**, which is not significant in EIA terms.

9.9.8.29. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.9.8.30. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.8.31. The effects of increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.8.32. The significance of effect from increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

Decommissioning phase

MAGNITUDE OF IMPACT

9.9.8.33. The presence of decommissioning vessels may lead to the increased risk of introduction and spread of invasive and non-native species within the Benthic Subtidal and Intertidal Ecology Study Area. During the decommissioning phase, similar types of vessels used for the construction phase are anticipated to be present but to a lesser extent (Volume III, Appendix 4.1: Rehabilitation Schedule). Scour protection, cables and cable protection would be left *in situ* following decommissioning allowing any invasive species which colonised during the operational and maintenance phase to remain in place.

9.9.8.34. As set out in Table 9.13, an Invasive Non-Indigenous Species Management Plan (Volume III, Appendix 25.4) and VMP (Volume III, Appendix 25.7). The plan outlines various measures to ensure that vessels comply with (IMO) ballast water management guidelines and legislation including consideration for vessel origin and standard housekeeping measures for vessels. Overall this will ensure that the risk of introduction and spread of invasive and non-native species will be minimised.

9.9.8.35. The increased risk of introduction and spread of invasive and non-native species is considered to be restricted to the near-field and adjacent far field-areas, long-term and will occur constantly throughout the decommissioning phase. The consequence of introduction and spread of invasive and non-native species would be permanent changes to key characteristics or features of benthic habitats. However, given the implementation of an Invasive Non-Indigenous Species Management Plan, VMP and post-installation cable burial surveys it is anticipated that any impact would be indirect. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.8.36. The magnitude of the impact has been assessed as **Low.**

9.9.8.37. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible**, which is not significant in EIA terms.

9.9.8.38. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.9.8.39. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.8.40. The effects of increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.8.41. The significance of effect from increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.9.9 Impact 9 – Accidental Pollution

9.9.9.1. Accidental release of pollutants (such as fuel, lubricants, and anti-fouling biocides) from vessels or equipment associated with the Proposed Development has the potential to occur during the construction, operational and maintenance and decommissioning phases, as a result of the installation/removal of foundations, presence of operational equipment, confirmatory survey activities, maintenance activities, and the installation of inter-array cables, interconnector cables and offshore export cables.

SENSITIVITY OF THE RECEPTOR

9.9.9.2. MarESA does not provide an assessment for the relevant chemical pressures for the identified IEFs due to limited evidence. The MarESA evidence base considers the effects of pollutants and chemicals, should they be accidentally released at concentrations that exceed environmental protection standards. It is anticipated that any accidental pollution released from the Proposed Development will be less than environmental protection standards, and is detailed further in the magnitude for construction, operation and maintenance and decommissioning sections below.

9.9.9.3. The representative biotope of the 'Reefs' IEF, is '*Sabellaria alveolata* reefs on sand-abraded eulittoral rock' (JNCC code: LS.LBR.Sab.Salv; EUNIS code: MA2261) is characteristic of the Annex I reef habitat feature of the Wicklow Reef SAC (DCHG, 2014a). However, Wicklow Reef SAC is located approximately 4.5 km and 3.6 km from the Array Area and Cable Corridor and Working Area. Therefore, there is no potential for interaction between the activities associated with accidental pollution, and the IEF.

9.9.9.4. Similarly, the representative biotopes of the 'Sandbanks' IEF is characteristic of the Annex I 'Sandbanks which are slight adversely covered by sea water all the time' feature of the Blackwater Bank SAC (DCHG, 2014b) and is located approximately 19.7 km and 19.1 km from the Array Area and Cable Corridor and Working Area respectively and beyond the potential distance of impact for accidental pollution. Therefore, there is no potential for interaction between the activities associated with accidental pollution, and the IEF.

9.9.9.5. For the 'subtidal sands sediment', 'subtidal coarse and mixed sediment' and 'Moderate Energy Subtidal Rock' IEFs, evidence indicates that sub-lethal effects, morphological changes and

reduced growth may occur due to heavy metal contamination (Bryan, 1984; Stebbing, 1981). Characterising species such as bivalves are able to accumulate heavy metals into their tissues and sublethal levels of heavy metals may cause a range of effects including siphon retraction, valve closure, inhibition of byssal thread production, disruption of burrowing behaviour, inhibition of respiration, inhibition of filtration rate and suppressed growth (Aberkali & Trueman, 1985). Echinoderms are considered to be intolerant of heavy metals, whilst polychaetes are more tolerant (Bryan, 1984; Kinne, 1984). Hydrocarbon and Polycyclic Aromatic Hydrocarbons (PAHs) contamination may occur as a result of oil spills from vessels which mix with seawater and impact sublittoral habitats (Castège *et al.*, 2014). The most sensitive species to oil pollution are bottom dwelling filter feeders in areas where oil components are deposited by sedimentation (Zahn *et al.*, 1981) and limited evidence is available for the effects of oil pollution on hydroids. Houghton *et al.* (1996) found a reduction in abundance of encrusting bryozoa following an oil spill, however, Soule & Soule (1979) found that bryozoa returned to an area close to an oil spill within 5 months of the incident, suggesting that recoverability is high. Bivalves will display increases in energy expenditure and decreases in feeding rate, resulting in reduced growth and reproduction when in contact with oil (Suchanek, 1993). Echinoderms and amphipods are also regarded as being intolerant of hydrocarbons while polychaetes are considered to be tolerant of elevated hydrocarbon levels (Suchanek, 1993; Cabioch *et al.*, 1978). The recoverability of these communities to contaminants of this nature is likely to be medium to high as a result of the life history characteristics of the component species (Readman *et al.*, 2023c; Tillin *et al.*, 2023a), and would facilitate rapid re-colonisation of affected areas via adult migration and larval settlement following a return to ecological baseline conditions and baseline levels of contaminants. Consequently, the 'Subtidal Sands Sediment', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs will have a limited ability to avoid or adapt to the impact, with recovery taking up to two years and they have a value of local importance. Therefore, the subtidal sands sediment, subtidal coarse and mixed sediment and 'Moderate Energy Subtidal Rock' IEFs are considered to have Medium sensitivity to accidental pollution.

9.9.9.6. No evidence is available on which to assess the sensitivity of representative biotopes for the *'Sabellaria* on Stable Sediments' and 'Reef' IEF (if present). However, it is likely to be similar to 'Subtidal Sands Sediment', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs and is therefore considered to have Medium sensitivity to accidental pollution.

9.9.9.7. The 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs are characterised by a lack of species and exposure to contaminants will not result in significant impacts (Tillin, 2019; Tillin and Budd, 2016). Therefore, representative habitats are considered to have Low sensitivity to accidental pollution.

9.9.9.8. In summary, subtidal benthic habitats are unlikely to be able to avoid the impact of accidental pollution. However, evidence indicates that they will be expected to recover within the short term and are of local importance. There was no evidence of Annex I *Sabellaria* reef during surveys, but if present, would be of national importance. Benthic subtidal and intertidal IEFs have therefore been assessed as having Low to Medium sensitivity to accidental pollution.

Construction phase

MAGNITUDE OF THE IMPACT

9.9.9.9. The installation of the Proposed Development may lead to the accidental release of pollutants through spills and leaks from vessels and equipment. The design scenario assumes the installation of 56 WTGs, two OSPs, inter-array, interconnector and offshore export cables. The Project Design Option also considers total vessel and helicopter movements throughout the construction phases. The magnitude of the impact will be dependent on the quantities of potential pollutants carried by vessels, helicopters and equipment. Although many of the large vessels (e.g. installation vessels) may contain large quantities of diesel oil, any accidental spill from vessels, vehicles, machinery from construction activities would be subject to immediate dilution and rapid dispersal.

9.9.9.10. The factored in measures include an Environmental Management Plan (EMP) and marine pollution contingency plan. Adherence to the factored-in measures outlined in Table 9.13 and good working practices will significantly reduce the likelihood of an accidental pollution incident occurring and the magnitude of its impact. Given the factored-in measures, the likelihood of accidental release is considered to be extremely low.

9.9.9.11. There is also a risk to benthic subtidal and intertidal IEFs from water based drilling mud, including bentonite, which is used as a lubricant during trenchless techniques. Trenchless techniques will be undertaken to install the offshore export cables at the Landfall and potentially across the sandbank for inter-array cable installation. Drilling muds are used in a closed system to minimise loss to the environment, however it is possible that muds (including bentonite) can break out during drilling operations, which may occur in intertidal or subtidal areas. Bentonite is a low toxicity drilling mud and therefore the risk to benthic subtidal and intertidal IEFs is minimal, particularly when considering that any break outs will be quickly diluted (seawater degrades the bentonite fluid, causing it to flocculate allowing faster dispersal). However, any potential break outs or accidental spills of bentonite will be managed via good working practices (e.g. monitoring of mud volumes and pressure, detection of break outs and pausing drilling, plugging fissures and ongoing monitoring) such that any loss of bentonite to the environment is minimal. Suspended sediment and deposition associated with bentonite from the HDD have been assessed within section 9.9.2.

9.9.9.12. Accidental release of pollutants during the construction phase is predicted to extend to the near-field and adjacent far field, would have short-term duration (any chemicals released to the water column will be quickly dispersed and diluted via currents and other water movement) (Tarr *et al.*, 2016), and would be infrequent and of low consequence. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.9.9.13. The magnitude of the impact has been assessed as **Low.**

9.9.9.14. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.9.9.15. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.9.16. The effect of accidental pollution is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.9.17. The significance of effect from accidental pollution is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of accidental pollution.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.9.9.18. Operational and maintenance tasks within the Proposed Development may lead to the accidental release of pollutants through spills and leaks from vessels and equipment. The project design parameters include the release of synthetic compounds, for example from antifouling biocides, heavy metal, and hydrocarbon contamination as a result of the presence of 56 WTGs and two OSPs as well as from maintenance activities. The project design parameters also include a maximum of 22 vessels within the Proposed Development at any one time, a maximum of 1294 vessel return trips per year and 485 helicopter return trips per year.

9.9.9.19. The magnitude of the impact will be dependent on the quantities of potential pollutants carried by vessels, helicopters and equipment. Although many of the large vessels (e.g. installation vessels) may contain large quantities of diesel oil, any accidental spill from vessels, vehicles, machinery or from construction, operational and maintenance and decommissioning activities would be subject to immediate dilution and rapid dispersal.

9.9.9.20. Given the factored-in measures mentioned in paragraph 9.9.9.10, the likelihood of accidental release is considered to be extremely low. Adherence to the factored-in measures outlined in Table 9.13 and good working practices will significantly reduce the likelihood of an accidental pollution incident occurring and the magnitude of its impact.

9.9.9.21. Accidental release of pollutants during the operational and maintenance phase is predicted to be of near-field and adjacent far field extent, short-term duration (any chemicals released to the water column will be quickly dispersed and diluted via currents and other water movement) (Tarr *et al.*, 2016), infrequent and of low consequence. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.9.22. The magnitude of the impact has been assessed as **Low.**

9.9.9.23. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse , which is not significant in EIA terms.

9.9.9.24. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.9.25. The effects of accidental pollution is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.9.26. The significance of effect from accidental pollution is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of accidental pollution.

Decommissioning phase

MAGNITUDE OF IMPACT

9.9.9.27. The design scenario for the decommissioning phase of the project is anticipated to be similar in nature to that of the construction phase. As such, accidental release of pollutants during the decommissioning phase is predicted to be of near-field and adjacent far field extent, short-term duration (any chemicals released to the water column will be quickly dispersed and diluted via currents and other water movement) (Tarr *et al.*, 2016), infrequent and of low consequence. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.9.9.28. The magnitude of the impact has been assessed as **Low.**

9.9.9.29. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.9.9.30. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (as indicated above, the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.9.9.31. The effects of accidental pollution is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.9.9.32. The significance of effect from accidental pollution is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of accidental pollution.

9.10 Assessment of Project Design Option 2

9.10.1 Impact 1 – Temporary subtidal habitat loss/disturbance

9.10.1.1. Direct temporary subtidal habitat loss/disturbance within the Proposed Development will occur during the construction, operational and maintenance, and decommissioning phases as a result of a range of activities including installation and maintenance of inter-array, interconnector and

offshore export cables and associated seabed preparation, and use of jack-up vessels during installation/maintenance activities.

SENSITIVITY OF THE RECEPTOR

9.10.1.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.1).

Construction phase

MAGNITUDE OF THE IMPACT

9.10.1.3. Project Design Option 1 factored in a maximum of 9,929,060 m^2 of temporary habitat loss (section 9.9.1). For Project Design Option 2, sandwave clearance for scour protection and OSP/WTG installation is less than that for Project Design Option 1, equating to a maximum temporary habitat loss/disturbance (across all construction activities) of 9,892,260 m^2. Given the small degree of increase, the magnitude is the same as that for Project Design Option 1.

9.10.1.4. The extent of the impact would be restricted to the discrete areas within the Benthic Subtidal and Intertidal Study Area and is therefore regarded as near field.

9.10.1.5. The duration of the impact will be short-term (i.e. one to seven years). However, the duration of works in any given discrete location within the Benthic Subtidal and Intertidal Study Area will often be much shorter (i.e. less than one year). The impact is expected to occur frequently at discrete areas within the Benthic Subtidal and Intertidal Study Area throughout the construction phase. The consequence of construction activities will result in loss and/or disturbance of subtidal benthic habitat. However, this will be temporary, with habitats expected to recover following the cessation of construction activities. The overall magnitude of the impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.10.1.6. The magnitude of the impact has been assessed as **Low.**

9.10.1.7. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.1.8. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.1.9. The effect of temporary subtidal habitat loss/disturbance is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.1.10. The significance of effect from temporary subtidal habitat loss/disturbance is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of temporary subtidal habitat loss/disturbance.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.10.1.11. The design scenario is the same for both Project Design Options and therefore the magnitude of temporary habitat loss/disturbance for Project Design Option 1 is the same as that for Project Design Option 2.

9.10.1.12. The impact is predicted to be restricted to the near-field, short term duration, infrequent and of low consequence. Habitats are expected to recover following cessation of repair activities. The magnitude is therefore, considered to be Negligible.

SIGNIFICANCE OF EFFECT

9.10.1.13. The magnitude of the impact has been assessed as **Negligible.**

9.10.1.14. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is considered to be **Not Significant**, which is not significant in EIA terms.

9.10.1.15. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from temporary habitat loss is considered to be **Not Significant**, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.1.16. The effect of temporary subtidal habitat loss/disturbance is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.1.17. The significance of effect from temporary subtidal habitat loss/disturbance is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of temporary subtidal habitat loss/disturbance.

Decommissioning phase

MAGNITUDE OF IMPACT

9.10.1.18. The design scenario is the same for both Project Design Options and therefore the magnitude of temporary habitat loss/disturbance for Project Design Option 1 is the same as that for Project Design Option 2.

9.10.1.19. The impact is predicted to be restricted to the near-field, short term duration, frequent and of low consequence. Habitats are expected to recover following cessation of the decommissioning activities. It is predicted that the impact will affect the receptor both directly and indirectly. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.1.20. The magnitude of the impact has been assessed as **Low.**

9.10.1.21. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.1.22. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.1.23. The effect of temporary subtidal habitat loss/disturbance is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.1.24. The significance of effect from temporary subtidal habitat loss/disturbance is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of temporary subtidal habitat loss/disturbance.

9.10.2 Impact 2 – Increased suspended sediment concentrations and associated deposition

9.10.2.1. Increases in suspended sediment concentrations and associated sediment deposition are predicted to occur during the construction, operational and maintenance and decommissioning phases as a result of the installation and removal of foundations and the installation and maintenance (repair and reburial) of inter-array, interconnector and offshore export cables. Volume II, Chapter 6: Coastal Processes provides a full description of the physical assessment, including numerical modelling used to inform the predictions made with respect to increases in suspended sediment and subsequent deposition.

SENSITIVITY OF THE RECEPTOR

9.10.2.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.2).

Construction phase

MAGNITUDE OF THE IMPACT

9.10.2.3. The design scenarios for Project Design Option 1 and 2 are similar in nature with only small degrees of change (e.g. 3,139,200 m^3 of sandwave clearance for offshore infrastructure installation for Project Design Option 1 and 3,117,600 m^3 for Project Design Option 2). Therefore, the magnitude of increased suspended sediment concentrations and associated deposition for Project Design Option 2 is the same as that described for Project Design Option 1.

9.10.2.4. The impact is predicted to be restricted to the near-field, short term duration, frequent and of low consequence. Baseline conditions are expected to resume following cessation of the construction activities. It is predicted that the impact will affect the receptor both directly and indirectly. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.10.2.5. The magnitude of the impact has been assessed as **Low.**

9.10.2.6. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (the sensitivity of the 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from increased suspended sediment and deposition is considered to be **Imperceptible**, which is not significant in EIA terms.

9.10.2.7. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.2.8. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.2.9. The effect of increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.2.10. The significance of effect from increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of increased suspended sediment and deposition.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.10.2.11. The design scenario is the same for both Project Design Options and therefore the magnitude of temporary habitat loss/disturbance for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.2.12. The impact is predicted to be restricted to the near-field, short term duration (occurs across operation and maintenance period, however individual events will be short term), frequent and of low consequence. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.2.13. The magnitude of the impact has been assessed as **Low.**

9.10.2.14. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (the sensitivity of the 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from increased suspended sediment and deposition is considered to be **Imperceptible**, which is not significant in EIA terms.

9.10.2.15. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.2.16. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.2.17. The effect of increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.2.18. The significance of effect from increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no additional mitigation to that already

identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of increased suspended sediment and deposition.

Decommissioning phase

MAGNITUDE OF IMPACT

9.10.2.19. The design scenario is the same for both Project Design Options and therefore the magnitude of temporary habitat loss/disturbance for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.2.20. The impact is predicted to be restricted to the near-field, short term duration, frequent and of low consequence. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.2.21. The magnitude of the impact has been assessed as **Low.**

9.10.2.22. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (the sensitivity of the 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from increased suspended sediment and deposition is considered to be **Imperceptible**, which is not significant in EIA terms.

9.10.2.23. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.2.24. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from temporary habitat loss is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.2.25. The effect of increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.2.26. The significance of effect from increased suspended sediment concentrations and deposition is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of increased suspended sediment and deposition.

9.10.3 Impact 3 – Injury and/or disturbance from underwater noise and vibration

9.10.3.1. Underwater noise and vibration within the Array Area and Cable Corridor and Working Areas will occur during the construction phase as a result of a range of activities including impact piling, drilling and UXO clearance (via detonation or relocation/wet storage). This can cause injury and/or disturbance to Benthic Subtidal and Intertidal Ecology receptors.

9.10.3.2. The assessment has been informed by the Underwater Noise Assessment by Subacoustech (Volume III, Appendix 11.1: Underwater Noise Assessment) which includes the results of numerical modelling using the INSPIRE underwater noise model.

SENSITIVITY OF THE RECEPTOR

9.10.3.3. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.3).

Construction phase

MAGNITUDE OF THE IMPACT

9.10.3.4. The design scenarios for Project Design Option 1 and 2 are similar in nature with only small degrees of change. For example, the installation of 56 WTGs for Project Design Option 1 and the installation of 47 for Project Design option 2. This will result in a total of 75 days when piling may occur for Design Option 1 and 63 days when piling may occur for Design Option 2. Therefore, the magnitude of injury and/or disturbance from underwater noise and vibration for Project Design Option 2 is the same as that described for Project Design Option 1.

9.10.3.5. The extent of the impact will be restricted to the to the near-field and immediately adjacent far-field areas of where construction activity will take place. The duration of the impact is anticipated to be short-term (i.e. days), taking place during the five-year construction period of the project. The impact will occur frequently throughout the five-year construction phase and is anticipated to result in no discernible change to key characteristics or features of benthic habitats. The magnitude is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.10.3.6. The magnitude of the impact has been assessed as **Low**, with the sensitivity of IEFs being assessed as **Low** (the sensitivity of the 'Reef' IEF(if present) is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.3.7. The effects of underwater noise and vibration is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.3.8. The significance of effect from underwater noise and vibration is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.10.4 Impact 4 – Long-term subtidal habitat loss/change

9.10.4.1. Long-term subtidal habitat loss/change will occur directly under all foundation structures, associated scour protection and cable protection (including at crossings) where this is required. This impact will occur during the operational and maintenance phase.

SENSITIVITY OF THE RECEPTOR

9.10.4.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.4).

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.10.4.3. Project design option 1 factored in a maximum of 662,800 m^2 of long-term habitat loss/change (section 9.9.4). For Project Design option 2 the area of scour protection for WTG foundations is less than that for Project Design option 1 due to a smaller number of WTG foundations (47 for Design Option 2 compared to 56 for Design Option 1), equating to a maximum long-term subtidal habitat loss/change of 618,930 m^2. Given the small degree of increase, the magnitude is the same as that for Project Design Option 1.

9.10.4.4. The impact of long-term subtidal habitat loss/change will directly affect IEFs through the complete loss of characterising benthic communities and significantly altering the character of representative biotopes.

9.10.4.5. Long-term subtidal habitat loss/change is predicted to be of highly localised spatial extent (restricted to discrete areas within the Array Area and Cable Corridor and Working Area), of long-term duration and continuous throughout the operational and maintenance phase. It is predicted that the impact will affect benthic subtidal IEFs directly, with the potential for some IEFs to recover following the introduction of hard substrata. The magnitude is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.4.6. The magnitude of the impact has been assessed as **Low**, with the sensitivity of IEFs being assessed as **High** (as mentioned above, the sensitivity of the 'Reef' IEF is also **High**). Therefore, the significance of effect is considered to be **Moderate**. This has been deemed not significant in EIA terms based on professional judgement due to the small proportion of the Benthic Subtidal and Intertidal Ecology Study Area potentially affected by long-term subtidal habitat loss/change, and the extent of potentially affected biotopes in the wider area.

PROPOSED MITIGATION

9.10.4.7. The effects of long-term subtidal habitat loss/change are not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.4.8. The significance of effect from long-term subtidal habitat loss/change is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.10.5 Impact 5 – Colonisation of hard structures

9.10.5.1. The presence of WTG and OSP foundations, associated scour protection and cable protection within the Array Area and Cable Corridor and Working Area may result in the colonisation of hard structures by organisms during the operational and maintenance phase of the Proposed Development. Sediments within the Proposed Development are dominated by sand and mixed sediments within the Array Area and coarse sediments within the Cable Corridor and Working Area. Therefore, any long-term introduction and colonisation of hard substrate will directly alter the type of available habitats within the benthic subtidal ecology study area. The impact of any long-term subtidal habitat loss/change to Benthic Subtidal and Intertidal Ecology has been assessed in section 9.10.4.

SENSITIVITY OF THE RECEPTOR

9.10.5.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.5).

Construction phase

MAGNITUDE OF THE IMPACT

9.10.5.3. Project Design Option 1 factored in a maximum of 662,800 m^2 and 1,460,644 m^3 of colonisation of hard structures (section 9.9.5). For Project Design Option 2 the area of scour protection for WTG foundations is less than that for Project Design Option 1 due to a smaller number of WTG foundations (47 for Design Option 2 compared to 56 for Design Option 1), equating to a maximum of 618,930 m^2 and 1,335,935 m^3 of colonisation of hard structures. The presence of slow moving or stationary vessels (e.g. jack-up vessels) that may also enable colonisation benthic species will be similar to both Design Option 1 and 2. Given the small degree of increase, the magnitude is the same as that for Project Design Option 1.

9.10.5.4. The extent of the impact will be restricted to the placement of infrastructure which will be within the near-field. The duration of the impact is anticipated to persist for the lifetime of the Proposed Development and beyond as scour protection and cable protection will remain *in situ* following decommissioning and therefore is considered to be long term. The frequency of the impact will occur constantly throughout the operational and maintenance phase of the project and the impact will result in a barely discernible to noticeable change to key characteristics or features, as it is anticipated that hard structures will be colonised by characterising species of hard or mixed substrate IEFs and other species already occurring within the baseline environment. The magnitude of impact is therefore, considered to be Medium.

SIGNIFICANCE OF THE EFFECT

9.10.5.5. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (the sensitivity of the 'Reef' IEF is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.5.6. The effects of colonisation of hard structures is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.5.7. The significance of effect due to colonisation of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

Operational and maintenance phase

MAGNITUDE OF THE IMPACT

9.10.5.8. Project Design Option 1 factored in a maximum of 662,800 m^2 and 1,460,644 m^3 of colonisation of hard structures (section 9.9.5). For Project Design Option 2 the area of scour protection for WTG foundations is less than that for Project Design Option 1 due to a smaller number of WTG foundations (47 for Design Option 2 compared to 56 for Design Option 1), equating to a maximum of 618,930 m^2 and 1,335,935 m^3 of colonisation of hard structures. Given the small degree of increase, the magnitude is the same as that for Project Design Option 1.

9.10.5.9. The extent of the impact will be restricted to the placement of infrastructure which will be within the near-field. The duration of the impact is anticipated to persist for the lifetime of the Proposed Development and beyond as scour protection and cable protection will remain *in situ* following decommissioning and therefore is considered to be long term. The frequency of the impact will occur constantly throughout the operational and maintenance phase of the project and the impact will result in a barely discernible to noticeable change to key characteristics or features, as it is anticipated that hard structures will be colonised by characterising species of hard or mixed substrate IEFs and other species already occurring within the baseline environment. The magnitude of impact is therefore, considered to be Medium.

SIGNIFICANCE OF THE EFFECT

9.10.5.10. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (the sensitivity of the 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.5.11. The effects of colonisation of hard structures is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.5.12. The significance of effect due to colonisation of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

Decommissioning phase

MAGNITUDE OF THE IMPACT

9.10.5.13. Project Design Option 1 factored in a maximum of 657,110 m^2 and 1,460,644 m^3 of colonisation of hard structures (section 9.9.5). For Project Design Option 2 the area of scour protection for WTG foundations is less than that for Project Design Option 1 due to a smaller number of WTG foundations (47 for Design Option 2 compared to 56 for Design Option 1), equating to a maximum of 613,790 m^2 and 1,335,935 m^3 of colonisation of hard structures. The presence of slow moving or stationary vessels (e.g. jack-up vessels) that may also enable colonisation benthic species will be similar to both Design Option 1 and 2. Given the small degree of increase, the magnitude is the same as that for Project Design Option 1.

9.10.5.14. The extent of the impact will be restricted to the placement of infrastructure which will be within the near-field. The duration of the impact is anticipated to persist for the lifetime of the Proposed Development and beyond as scour protection and cable protection will remain *in situ* following decommissioning and therefore is considered to be long term. The frequency of the impact will occur constantly throughout the operational and maintenance phase of the project and the impact will result in a barely discernible to noticeable change to key characteristics or features, as it is anticipated that hard structures will be colonised by characterising species of hard or mixed substrate IEFs and other species already occurring within the baseline environment. The magnitude of impact is therefore, considered to be Medium.

SIGNIFICANCE OF THE EFFECT

9.10.5.15. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (the sensitivity of the 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.5.16. The effects of colonisation of hard structures is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.5.17. The significance of effect due to colonisation of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.10.6 Impact 6 – Alteration of seabed habitat arising from effects on physical processes

9.10.6.1. The presence of the WTG and OSP foundations, associated scour protection and other installed structures such as cable protection may lead to changes in the physical processes within the Array Area and Cable Corridor and Working Area and potentially further afield which could subsequently affect seabed habitats through changes to locations of sediment scour, sediment deposition and grain size distribution. Volume III, Appendix 6.1: Marine Physical Processes Numerical Modelling, describes in detail the changes that could occur as a result of the presence of foundation structures and associated scour and cable protection.

SENSITIVITY OF THE RECEPTOR

9.10.6.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.6).

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.10.6.3. The magnitude will be of a similar nature to that of Project Design Option 1, with the only difference being Project Design Option 2 having fewer WTGs and therefore a smaller scour protection footprint. Given the small degree of difference, the magnitude is the same as that for Project Design Option 1.

9.10.6.4. Based on coastal processes modelling, the potential for alteration to seabed habitats due to changes in physical processes is predicted to be of near-field spatial extent, long term duration, continuous and of low consequence. The magnitude of impact is therefore considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.6.5. The magnitude of the impact has been assessed as **Low**, with the sensitivity of the receptors being **Negligible** (the sensitivity of the 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect from alteration of seabed habitat arising from effects on physical processes is considered to be **Imperceptible**, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.6.6. The effect of alteration of seabed habitats arising from changes in physical processes is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.6.7. The significance of effect from alteration of seabed habitats arising from changes in physical processes is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Consequently, no ecologically significant adverse residual effects have been predicted in respect of alteration of seabed habitats arising from changes in physical processes.

9.10.7 Impact 7 – Removal of hard substrates resulting in loss of colonising communities

9.10.7.1. The removal of some of the hard structures following the decommissioning of the Proposed Development will result in the removal of benthic communities that have colonised hard structures and will therefore have a direct effect on benthic ecology IEFs.

SENSITIVITY OF THE RECEPTOR

9.10.7.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.7).

Decommissioning phase

MAGNITUDE OF IMPACT

9.10.7.3. Project Design Option 1 factored in a maximum of 5,690 m^2 of removal of hard substrate (section 9.9.7). For Project Design Option 2 the volume of hard substate for WTG foundations is less than that for Project Design Option 1 due to a smaller number of WTG foundations (47 for Design Option 2 compared to 56 for Design Option 1), equating to a maximum of 4,822 m^2 of colonisation of hard structures. Given the small degree of increase, the magnitude is the same as that for Project Design Option 1.

9.10.7.4. The removal of hard substrate will be restricted to the near-field, duration will be long term and the frequency of the impact will be constant throughout the decommissioning phase. Additionally, the consequence will result in noticeable change to key characteristics or features due to the complete removal of colonised hard structures. The magnitude is therefore, considered to be Medium.

SIGNIFICANCE OF EFFECT

9.10.7.5. The magnitude of the impact has been assessed as **Medium**, with the sensitivity of IEFs being assessed as **Low** (the sensitivity of the 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.7.6. The effects of removal of hard structures is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.7.7. The significance of effect from removal of hard structures is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary.

Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.10.8 Impact 8 – Increased risk of introduction and spread of invasive and non-native species

9.10.8.1. The introduction and spread of invasive and non-native species may occur during the construction, operational and maintenance, and decommissioning phases of the Proposed Development due to the introduction of hard structures (allowing for colonisation) and the presence and movement of vessels (due to colonisation of vessel hulls and structures and ballast water discharge). There is therefore potential for an impact on benthic ecology IEFs.

SENSITIVITY OF THE RECEPTOR

9.10.8.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.8).

Construction phase

MAGNITUDE OF THE IMPACT

9.10.8.3. The design scenario is the similar for both Project Design options and therefore the magnitude of increased risk of introduction and spread of invasive and non-native species from vessels, for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.8.4. The increased risk of introduction and spread of invasive and non-native species is considered to be restricted to the near-field and adjacent far field-areas, long-term and will occur constantly throughout the construction phase and future phases. The consequence of introduction and spread of invasive and non-native species could result in permanent changes to key characteristics or features of benthic habitats. However, given the implementation of an Invasive Non-Indigenous Species Management Plan, it is anticipated that any impact would be indirect. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.10.8.5. The magnitude of the impact has been assessed as **Low.**

9.10.8.6. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible**, which is not significant in EIA terms.

9.10.8.7. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.8.8. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.8.9. The effects of increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.8.10. The significance of effect from increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.10.8.11. The design scenario is the similar for both Project Design options and therefore the magnitude of increased risk of introduction and spread of invasive and non-native species from vessels for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.8.12. The increased risk of introduction and spread of invasive and non-native species is considered to be restricted to the near-field and adjacent far field-areas, will be long-term and will occur constantly throughout the operation and maintenance phase and future phases. The consequence of introduction and spread of invasive and non-native species would be permanent with changes to key characteristics or features of benthic habitats. However, given the implementation of an Invasive Non-Indigenous Species Management Plan, VMP and post-construction monitoring surveys it is anticipated that any impact would be indirect. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.8.13. The magnitude of the impact has been assessed as **Low.**

9.10.8.14. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible,** which is not significant in EIA terms.

9.10.8.15. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.8.16. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.8.17. The effects of increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.8.18. The significance of effect from increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

Decommissioning phase

MAGNITUDE OF IMPACT

9.10.8.19. The design scenario is the similar for both Project Design options and therefore the magnitude of increased risk of introduction and spread of invasive and non-native species from vessels for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.8.20. The increased risk of introduction and spread of invasive and non-native species is considered to be restricted to the near-field and adjacent far field-areas, long-term and will occur constantly throughout the decommissioning phase. The consequence of introduction and spread of invasive and non-native species would be permanent changes to key characteristics or features of benthic habitats. However, given the implementation of an Invasive Non-Indigenous Species Management Plan, VMP and post-installation cable burial surveys it is anticipated that any impact would be indirect. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.8.21. The magnitude of the impact has been assessed as **Low.**

9.10.8.22. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible,** which is not significant in EIA terms.

9.10.8.23. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.8.24. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.8.25. The effects of increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms, Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.8.26. The significance of effect from increased risk of introduction and spread of invasive and non-native species is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect to Benthic Subtidal and Intertidal Ecology.

9.10.9 Impact 9 – Accidental Pollution

9.10.9.1. Accidental release of pollutants (such as fuel, lubricants, and anti-fouling biocides) from vessels or equipment associated with the Proposed Development has the potential to occur during the construction, operational and maintenance and decommissioning phases, as a result of the installation/removal of foundations, presence of operational equipment, confirmatory surveys, maintenance activities, and the installation of inter-array cables, interconnector cables and offshore export cables.

SENSITIVITY OF THE RECEPTOR

9.10.9.2. The sensitivity of the receptors is the same as that indicated for Project Design Option 1 (section 9.9.9).

Construction phase

MAGNITUDE OF THE IMPACT

9.10.9.3. The design scenario is the similar for both Project Design Options and therefore the magnitude of accidental pollution from vessels, vehicles, equipment and machinery for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.9.4. Accidental release of pollutants during the construction phase is predicted to extend to the near-field and adjacent far field, would have short-term duration (any chemicals released to the water column will be quickly dispersed and diluted via currents and other water movement), and would be infrequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF THE EFFECT

9.10.9.5. The magnitude of the impact has been assessed as **Low.**

9.10.9.6. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.9.7. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (the sensitivity of the 'Reef' IEF is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.9.8. The effect of accidental pollution is not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.9.9. The significance of effect from accidental pollution is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of accidental pollution.

Operational and maintenance phase

MAGNITUDE OF IMPACT

9.10.9.10. The design scenario is the similar for both Project Design Options and therefore the magnitude of accidental pollution from vessels, vehicles, equipment and machinery for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.9.11. Accidental release of pollutants during the operational and maintenance phase is predicted to be of near-field and adjacent far field extent, short-term duration (any chemicals released to the water column will be quickly dispersed and diluted via currents and other water movement), infrequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.9.12. The magnitude of the impact has been assessed as **Low.**

9.10.9.13. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.10.9.14. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (the sensitivity of the 'Reef' IEF(if present) is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.9.15. The effects of accidental pollution are not significant in EIA terms. Therefore, no mitigation measures are proposed.

RESIDUAL EFFECT ASSESSMENT

9.10.9.16. The significance of effect from accidental pollution is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of accidental pollution.

Decommissioning phase

MAGNITUDE OF IMPACT

9.10.9.17. The design scenario is the similar for both Project Design Options and therefore the magnitude of accidental pollution from vessels, vehicles, equipment and machinery for Project Design Option 2 is the same as that for Project Design Option 1.

9.10.9.18. Accidental release of pollutants during the decommissioning phase is predicted to extend to the near-field and adjacent far field, would have short-term duration (any chemicals released to the water column will be quickly dispersed and diluted via currents and other water movement), infrequent and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. The magnitude of impact is therefore, considered to be Low.

SIGNIFICANCE OF EFFECT

9.10.9.19. The magnitude of the impact has been assessed as **Low.**

9.10.9.20. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is **Slight** adverse, which is not significant in EIA terms.

9.10.9.21. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (the sensitivity of the 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect due to accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

PROPOSED MITIGATION

9.10.9.22. The effects of accidental pollution is not significant in EIA terms, Therefore, no mitigation measures are proposed.

9.10.9.23. The significance of effect from accidental pollution is not significant in EIA terms. Therefore, no additional mitigation to that already identified in Table 9.13 is considered necessary. Therefore, no ecologically significant adverse residual effects have been predicted in respect of accidental pollution.

9.11 Cumulative impacts assessment methodology

9.11.1 Methodology

9.11.1.1. The Cumulative Impact Assessment (CIA) takes into account the impacts associated with the Proposed Development together with other proposed and reasonably foreseeable projects, plans and existing and permitted projects. The projects and plans selected as relevant to the CIA presented within this chapter are based upon the results of a screening exercise (see Volume III, Appendix 3.2: CIA Screening). Each project and plan has been considered on a case-by-case basis for screening in or out of this chapter's assessment based upon effect-receptor pathways and the spatial/temporal scales involved.

9.11.1.2. When assessing the potential cumulative impacts of the Proposed Development, it is essential to consider that some projects, particularly those labelled as 'proposed' or outlined in development plans, may not materialise or may not fully manifest as described in their worst-case scenarios. Therefore, it is imperative to incorporate a degree of certainty (or uncertainty) regarding the potential impacts from such proposals. For example, projects under construction are likely to contribute to cumulative impacts (assuming effects or spatial pathways exist), whereas proposals awaiting approval are less likely to contribute, as some may not attain approval or may not be realised due to various factors.

9.11.1.3. In light of this, all projects and plans considered alongside the Proposed Development have been categorised into 'tiers', reflecting their current stage within the planning and development process. This enables the CIA to present various future development scenarios, each carrying different potential for actualisation. This approach facilitates assigning appropriate weight to each scenario (tier) when evaluating potential cumulative impacts. The proposed tier structure aims to provide clarity regarding the confidence level in the CIA. The tiering methodology is provided in Volume III, Appendix 3.2: CIA Screening.

9.11.1.4. Due to the commitments made by the Developer in respect of the Foreshore Licence FS007339 and Foreshore Licence Application FS007555 (Table 9.13), FS007339 and FS007555 have been screened out of the cumulative impact assessment.

Table 9.20: List of other projects and plans considered within the cumulative impact assessment

Project/Plan	Status	Distance from Array Area (km)	Distance from Export Cable Corridors	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Tier 1							
Arklow Bank Wind Park 1 Power Cable	Operational	0.0	0.0	Export cable from ABWP1 Array Area to the Irish mainland	Complete	2003/2004 - onwards	Potential for temporal overlap of operation with Proposed Development construction and operation and maintenance phases.
ABWP1	Operational	0	0.5	Initial foreshore licence granted in 2002	Complete	2003/04 onwards	Potential for temporal overlap of operation with *Proposed Development construction and operation and maintenance phases.*
Arklow Wastewater Treatment Plant	Construction	3.4	10.8	Relates to ABWP2. The project will comprise a new Wastewater Treatment Plant, associated infrastructure including the interceptor sewer network and marine outfalls as well as an upgrade to the existing coastal revetment.	2021-2024	2025 onwards	Potential for temporal overlap of operation with the Proposed Development construction and operation and maintenance phases.

Project/Plan	Status	Distance from Array Area (km)	Distance from Export Cable Corridors	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
				80% Complete as of 2022.			
Development to the south of South Quay Arklow- ABWP2 Operations and Maintenance Facility (OMF)	Approved	4.3	11.9	Relates to ABWP2. As part of the works, a pontoon is proposed along with up to 4 cranes for loading & unloading of vessels. Additionally, dredging of approximately 6,000 m^3 of material from the nearshore is also proposed, to provide for navigational depth, berthing area and manoeuvring area for vessels.	2026-2030	2030 onwards	Potential for temporal overlap of construction and operation with the Proposed Development construction and operation and maintenance phases.
Irish Mussel Seed Company Ltd.	Operational	9.9	5.3	Aquaculture	Complete	Ongoing	Potential for temporal overlap of operation with the Proposed Development construction and operation and maintenance phases.

Project/Plan	Status	Distance from Array Area (km)	Distance from Export Cable Corridors	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Hibernia Atlantic Telecom	Operational	15.4	14.8	Telecom	Complete	2021 onwards	Potential for temporal overlap of operation with Proposed Development construction and operation and maintenance phases.
Tier 3							
ABWP1 Decommissioning Assumptions	Anticipated future project	0	0	Constructed in 2003/04 consisting of seven wind turbines with a capacity of 25.2 MW. Included as part of the baseline environment.	Anticipated duration of four months during 2025-2027	N/A	Potential for temporal overlap of decommissioning with Proposed Development construction and operation and maintenance phases.
Phase 1 Projects							
Codling Wind Park (formerly known as Codling I and Codling II)	Pre-planning application	10.3	9.4	Application expected to be made under the Maritime Area Planning (MAP) Act 2021.	2027 - 2028	2028 onwards	Potential for temporal overlap of construction and operation with Proposed Development construction and operation and maintenance phases.

Project/Plan	Status	Distance from Array Area (km)	Distance from Export Cable Corridors	Description of Project/Plan	Dates of Construction	Dates of Operation	Justification for screening in
Dublin Array	Pre-planning application	25.8	24.9	Application expected to be made under the MAP Act 2021.	2028-2032	2032 onwards	Potential for temporal overlap of construction and operation with Proposed Development construction and operation and maintenance phases.

9.11.1.5. Table 9.21 presents the potential impacts, development phase, and the list of projects / plans with which the two Project Design Options have been cumulatively assessed.

Table 9.21: Cumulative assessment impacts, phases, scenarios, and projects to be considered cumulatively

Potential cumulative impact	Phase			Projects considered cumulatively	Justification for projects considered cumulatively
	C	O	D		
Temporary subtidal habitat loss	✓	✓	✓	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Hibernia Atlantic Telecom **Tier 3** • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	Temporary habitat loss will result from construction activities, as well as repair activities associated with those projects.
Increased suspended sediment concentrations and associated deposition	✓	✓	✓	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Hibernia Atlantic Telecom	Increased suspended sediment concentrations and associated sediment deposition will result from construction activities, as well as repair activities associated with these projects.

Potential cumulative impact	Phase C O D	Projects considered cumulatively	Justification for projects considered cumulatively
		Tier 3 • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	
Injury and/or disturbance from underwater noise and vibration	✓ × ×	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Hibernia Atlantic Telecom **Tier 3** • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	Injury and/or disturbance from underwater noise and vibration will result from construction activities for these projects.
Long-term subtidal habitat loss/change	× ✓ ×	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Hibernia Atlantic Telecom	Long-term subtidal habitat loss/change could result from the presence of infrastructure and rock protection associated with these projects.

Potential cumulative impact	Phase C O D	Projects considered cumulatively	Justification for projects considered cumulatively
		Tier 3 • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	
Colonisation of hard structures	✓ ✓ ✓	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Hibernia Atlantic Telecom **Tier 3** • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	Colonisation of hard structures could result from the presence of infrastructure and rock protection associated with these projects.
Alteration of seabed habitat from effects on physical processes	× ✓ ×	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow- ABWP2 OMF • Hibernia Atlantic Telecom	Alterations of seabed habitats arising from changes in physical processes could result from the presence of infrastructure and rock protection associated with these projects.

Potential cumulative impact	Phase C O D	Projects considered cumulatively	Justification for projects considered cumulatively
		Tier 3 • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	
Removal of hard substrates resulting in loss of colonising communities	× × ✓	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Hibernia Atlantic Telecom **Tier 3** • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	Loss of colonising communities could result from the removal of infrastructure and rock protection associated with these projects.
Increased risk and introduction of invasive and non-native species	✓ ✓ ✓	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Irish Mussel Seed Company Ltd.	Increased risk and introduction of invasive and non-native species could occur from the presence of vessels during the construction, operational and maintenance and decommissioning

Potential cumulative impact	Phase C O D	Projects considered cumulatively	Justification for projects considered cumulatively
		• Hibernia Atlantic Telecom **Tier 3** • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	phases of these projects.
Accidental pollution	✓ ✓ ✓	Project parameters associated with Project Design Option 1 or 2 plus the following projects: **Tier 1** • ABWP Power Cable 1 • ABWP 1 • Arklow Waste Water Treatment Plant • Arklow - ABWP2 OMF • Irish Mussel Seed Company Ltd. • Hibernia Atlantic Telecom **Tier 3** • ABWP1 Decommissioning Assumptions **Phase 1 Projects** • Codling Wind Park • Dublin Array	Accidental pollution could occur from construction activities, as well as repair activities associated with these projects.

9.12 Cumulative impact assessment

9.12.1.1. A description of the significance of cumulative effects upon Benthic Subtidal and Intertidal Ecology arising from each identified impact is given below.

9.12.1.2. Tier 1 projects screened in include ABWP1, subsea cables for ABWP1 and Hibernia Atlantic, Arklow Wastewater Treatment Plant, ABWP2 OMF and aquaculture for the Irish Mussel Seed Company Ltd. All Tier 1 projects other than ABWP2 OMF will be operational at the time

construction works of the Proposed Development commence and the operation of these projects may overlap with the construction, operational and maintenance and decommissioning phases of the Proposed Development. The construction of ABWP2 OMF may overlap with the construction and operational and maintenance phases of the Proposed Development, whilst the operation of ABWP2 OMF may overlap with the operational and maintenance and decommissioning phases of the Proposed Development. Although the majority of works associated with ABWP2 OMF will be completed onshore, some elements will exist within the offshore environment. For example, plans for the development of the ABWP2 OMF will include a pontoon for vessels and dredging of approximately 6,000 m^3 of material from a nearshore area.

9.12.1.3. The only Tier 3 project screened in is the decommissioning of ABWP1 infrastructure, which will involve the cutting of monopiles at a depth of 2 m below seabed, removal of monopiles and cutting, burial and backfilling of proportions of the inter-array cables. Decommissioning is anticipated to take 4 months between 2025 and 2027 and may overlap with the construction phase of the Proposed Development.

9.12.1.4. Phase 1 projects screened in include Codling Wind Park and Dublin Array. The construction phase of Codling Wind Park and Dublin Array may overlap with the construction phase of the Proposed Development. The operation phase of Codling Wind Park and Dublin Array may overlap with the construction and operation phases of the Proposed Development. Plans for Dublin Array indicate that the proposed development will comprise a maximum of 61 WTGs, three OSP's and three export cables (Innogy, 2020). Plans for Codling Wind Park indicate that the proposed development may comprise 60 to 70 WTGs and up to three OSPs. Phase 1 projects show similar construction, operation and decommissioning activities and therefore the impacts and magnitudes of the impacts are expected to be similar in nature to that of the Proposed Development.

9.12.1.5. A description of the significance of cumulative effects upon Benthic Subtidal and Intertidal Ecology arising from each identified impact is given below.

9.12.2 Project Design Option 1 and 2 - Impact 1 - Temporary subtidal habitat loss/disturbance

SENSITIVITY OF THE RECEPTOR

9.12.2.1. The sensitivity of the receptors is described in detail in section 9.9.1 and was determined to be Low to Medium.

Construction phase

TIER 1

MAGNITUDE OF IMPACT

9.12.2.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be **Low** for the construction phase. The Proposed Development, together with the Tier 1 projects and plans identified, may lead to cumulative temporary habitat loss/disturbance.

9.12.2.1. For the Tier 1 projects, temporary subtidal habitat loss/disturbance may occur as a result of the installation of the pontoon and associated dredging required for ABWP2 OMF during construction. All other Tier 1 projects will be operational during the construction phase of the Proposed Development and therefore, temporary subtidal habitat loss/disturbance may also occur as a result of any operational and maintenance activities required for these projects. Any cumulative temporary subtidal habitat loss/disturbance as a result of the construction phase of the Proposed Development and the construction and operation of Tier 1 projects, is expected to be localised,

small in the context of the available habitats within the Benthic Subtidal and Intertidal Ecology Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

TIER 3

MAGNITUDE OF IMPACT

9.12.2.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase. Temporary subtidal habitat loss/disturbance may occur as a result of the anticipated decommissioning of seven wind turbines for ABWP1. Any cumulative temporary subtidal habitat loss/disturbance as a result of the construction phase of the Proposed Development and decommissioning of ABWP1, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.2.3. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.2.4. For the Phase 1 projects, temporary subtidal habitat loss/disturbance may occur as a result of the installation of WTGs, OSPs and associated cables during the construction phase of Codling Wind Park and Dublin Array, and during any repair and maintenance activities associated with Codling Wind Park. Any cumulative temporary subtidal habitat loss/disturbance as a result of the construction phase of the Proposed Development and the construction and operation of Codling Wind Park and Dublin Array is expected to be localised, small in the context of the available habitat within the Benthic Subtidal and Intertidal Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + TIER 3 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.2.5. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.2.6. Any cumulative temporary subtidal habitat loss/disturbance as a result of the construction phase of the Proposed Development and the construction, operation and decommissioning of the Tier 1, Tier 3 and Phase 1 projects, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.2.7. Overall, the cumulative magnitude of the impact has been assessed as **Low.**

9.12.2.8. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary subtidal habitat loss/disturbance is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.2.9. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is Medium (as indicated in section 9.9.1, the sensitivity of 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect

from temporary subtidal habitat loss/disturbance is considered to be **Slight** adverse, which is not significant in EIA terms.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.2.10. The magnitude of the impact for both Project Design Option 1and 2 was determined to be Negligible for the operational and maintenance phase.

9.12.2.11. For the Tier 1 projects, temporary subtidal habitat loss/disturbance may occur as a result of the installation of the pontoon and associated dredging required for the Arklow ABWP2 OMF during construction and any repair and maintenance required during operation. All other Tier 1 projects will be operational during the operational and maintenance phase of the Proposed Development and therefore, temporary subtidal habitat loss/disturbance may also occur as a result of any operational and maintenance activities required for these projects. Any cumulative temporary subtidal habitat loss/disturbance as a result of the operational and maintenance phase of the Proposed Development and the construction and operation of other Tier 1 projects, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Ecology Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Negligible.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.2.12. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Negligible for the operational and maintenance phase.

9.12.2.13. For the Phase 1 projects, temporary subtidal habitat loss/disturbance will occur as a result of the installation of WTGs, OSPs and associated cables during the construction phase of Dublin Array, and during any repair and maintenance activities associated with Codling Wind Park and Dublin Array. Any cumulative temporary habitat loss/disturbance as a result of the operational and maintenance phase of the Proposed Development and the construction and operation phases of the Phase 1 projects, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Ecology Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Negligible.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.2.14. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Negligible for the operational and maintenance phase. Any cumulative temporary subtidal habitat loss/disturbance as a result of the operational and maintenance phase of the Proposed Development and the construction and operation of the Tier 1 and Phase 1 projects, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Negligible.

SIGNIFICANCE OF EFFECT

9.12.2.15. Overall, the cumulative magnitude of the impact has been assessed to be **Negligible.**

9.12.2.16. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary subtidal habitat loss/disturbance is considered to be **Not Significant**, which is not significant in EIA terms.

9.12.2.17. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (as indicated in section 9.9.1, the sensitivity of 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from temporary subtidal habitat loss/disturbance is considered to be **Not Significant**, which is not significant in EIA terms.

Decommissioning phase

TIER 1

MAGNITUDE OF IMPACT

9.12.2.18. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.2.19. For the Tier 1 projects, temporary subtidal habitat loss/disturbance may occur as a result of any repair and maintenance activities to the pontoon and maintenance dredging for ABWP2 OMF, subsea cables for ABWP1 and Hibernia Atlantic and infrastructure for ABWP1 during operation. Any cumulative temporary subtidal habitat loss/disturbance as a result of the decommissioning phase of the Proposed Development and the operation of Tier 1 projects, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Ecology Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.2.20. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.2.21. For the Tier 2 projects, temporary subtidal habitat loss/disturbance may occur as a result of repair and maintenance activities associated with Codling Wind Park and Dublin Array. Any cumulative temporary subtidal habitat loss/disturbance as a result of the decommissioning phase of the Proposed Development and the operational phase of Codling Wind Park and Dublin Array, is expected to be similar in nature to that described for the cumulative impact during the construction phase, but less substantial as some infrastructure such as cables and associated cable protection will remain *in situ* following decommissioning. The cumulative impact will be localised, small in the context of the available habitat within the Benthic Subtidal and Intertidal Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.2.22. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase. Any cumulative temporary subtidal habitat loss/disturbance as a result of the decommissioning phase of the Proposed Development and the operation of the Tier 1 and Phase 1 projects, is expected to be localised, small in the context of the available

habitats within the Benthic Subtidal and Intertidal Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.2.23. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.2.24. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from temporary subtidal habitat loss/disturbance is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.2.25. The sensitivity of the '*Sabellaria* on Stable Sediments' IEF is **Medium** (as indicated in section 9.9.1, the sensitivity of 'Reef' IEF (if present) is also **Medium**). Therefore, the significance of effect from temporary subtidal habitat loss/disturbance is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.3 Project Design Option 1 and 2 - Impact 2 - Increased suspended sediment concentrations and associated deposition

SENSITIVITY OF THE RECEPTOR

9.12.3.1. The sensitivity of the receptors is described in detail in section 9.9.2 and was determined to be Negligible to Medium.

Construction phase

TIER 1

MAGNITUDE OF IMPACT

9.12.3.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.3.3. For the Tier 1 projects, increased suspended sediment concentrations and associated deposition may occur as a result of the installation of the pontoon and associated dredging required for the ABWP2 OMF. All other Tier 1 projects will be operational during the construction phase of the Proposed Development. However, increased suspended sediment concentrations and associated deposition may occur as a result of any repair and maintenance activities required to infrastructure for ABWP1, ABWP1 and Hibernia Atlantic subsea cables and the long sea outfall for the Arklow Wastewater Treatment Plant. Changes in SSCs during construction and maintenance activities as part of Tier 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

TIER 3

MAGNITUDE OF IMPACT

9.12.3.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.3.5. Increased suspended sediment concentrations and associated deposition may occur as a result of the anticipated decommissioning of seven wind turbines for ABWP1. Changes in SSCs during

the decommissioning of ABWP1 is expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.3.6. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.3.7. For the Phase 1 projects, increased suspended sediment concentrations and associated deposition will occur as a result of the installation of WTGs, OSPs and associated cables during the construction phase of Codling Wind Park and Dublin Array, and during any repair and maintenance activities associated with Codling Wind Park. Changes in SSCs during construction and maintenance activities as part of the Tier 2 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + TIER 3 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.3.8. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.3.9. Changes in SSCs during construction and maintenance activities as part of the Tier 1, Tier 3 and Phase 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.3.10. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.3.11. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (as indicated in section 9.9.2, the sensitivity of 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from increased suspended sediment and associated deposition is considered to be **Imperceptible**, which is not significant in EIA terms.

9.12.3.12. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.3.13. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Slight** adverse, which is not significant in EIA terms.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.3.14. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.3.15. For the Tier 1 projects, increased suspended sediment concentrations and associated deposition may occur as a result of the installation of the pontoon and associated dredging required for the Arklow ABWP2 OMF during construction and any repair and maintenance required during operation. All other Tier 1 projects will be operational during the operational and maintenance phase of the Proposed Development and therefore, increased suspended sediment concentrations and associated deposition may also occur as a result of any operational and maintenance activities required for these projects. Changes in SSCs during construction and maintenance activities as part of the Tier 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.3.16. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.3.17. For the Phase 1 projects, increased suspended sediment concentrations and associated deposition may occur as a result of the installation of WTGs, OSPs and associated cables during the construction phase of Dublin Array, and during any repair and maintenance activities associated with Codling Wind Park and Dublin Array. Changes in SSCs during construction and maintenance activities as part of the Phase 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.3.18. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.3.19. Changes in SSCs during construction and maintenance activities as part of the Tier 1 and Phase 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.3.20. Overall, the cumulative magnitude of the impact has been assessed as **Low.**

9.12.3.21. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (as indicated in section 9.9.2, the sensitivity of 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Imperceptible**, which is not significant in EIA terms.

9.12.3.22. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.3.23. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Slight** adverse, which is not significant in EIA terms.

Decommissioning phase

TIER 1

MAGNITUDE OF IMPACT

9.12.3.24. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.3.25. For the Tier 1 projects increased suspended sediment concentrations and associated deposition may occur as a result of any repair and maintenance activities to the pontoon and maintenance dredging for ABWP2 OMF, subsea cables for ABWP1 and Hibernia Atlantic and infrastructure for ABWP1 during operation. Any cumulative temporary subtidal habitat loss/disturbance as a result of the decommissioning phase of the Proposed Development and the operation of Tier 1 projects, is expected to be localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Ecology Study Area and would be temporary and reversible. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.3.26. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.3.27. For the Phase 1 projects, increased suspended sediment concentrations and associated deposition may occur as a result of repair and maintenance activities associated with Codling Wind Park and Dublin Array. Any cumulative increased suspended sediment concentrations and associated deposition as a result of the decommissioning phase of the Proposed Development and the operation phases of Codling Wind Park and Dublin Array, is expected to be similar in nature to that described for the cumulative impact during the construction phase, but less substantial as some infrastructure such as cables and associated cable protection will remain *in situ* following decommissioning. Changes in SSCs during maintenance activities as part of the Phase 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.3.28. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.3.29. Changes in SSCs during construction and maintenance activities as a result of the decommissioning phase of the Proposed Development and the operation of the Tier 1 and Phase 1 projects are expected to be temporary and intermittent, with sediment plumes expected to quickly dissipate following cessation of activities. Any areas likely to be exposed to heavy sediment deposition are expected to be localised and small in the context of subtidal habitats within the Benthic Subtidal and Intertidal Study Area. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.3.30. Overall, the cumulative magnitude of the impact has been assessed as **Low.**

9.12.3.31. The sensitivity of the '*Sabellaria* on Stable Sediment' and 'Barren Coarse Intertidal Sediment' IEFs is **Negligible** (as indicated in section 9.9.2, the sensitivity of 'Reef' IEF (if present) is also **Negligible**). Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Imperceptible**, which is not significant in EIA terms.

9.12.3.32. The sensitivity of the 'Subtidal Sands', 'Subtidal Coarse and Mixed Sediment' and 'Moderate Energy Subtidal Rock' IEFs is **Low**. Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.3.33. The sensitivity of the 'Moderately Exposed Intertidal Rock' IEF is **Medium**. Therefore, the significance of effect from increased suspended sediment concentrations and associated deposition is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.4 Project Design Option 1 and 2 - Impact 3 - Injury and/or disturbance from underwater noise and vibration

SENSITIVITY OF THE RECEPTOR

9.12.4.1. The sensitivity of the receptors is described in detail in section 9.9.3 and was determined to be **Low.**

Construction phase

TIER 1

MAGNITUDE OF IMPACT

9.12.4.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.4.3. All Tier 1 projects, with the exception of ABWP2 OMF will be operational at the time construction works of the Proposed Development commence. As mentioned in section 9.9.3, the greatest effect is likely to occur from the noise generated during pilling for the Proposed Development and any potential piling required during construction of the pontoon for ABWP2 OMF may overlap with the construction phase of the Proposed Development. The underwater noise generated as a result of ABWP2 OMF in expected to be low in comparison to the noise generated by pilling for

WTG and OSP installation. Similarly, any underwater noise generated as a result of repair and maintenance activities for ABWP1 infrastructure, ABWP1 and Hibernia Atlantic and the long sea outfall for the Arklow Waste Water Treatment Plant will be low in comparison to the noise generated during the construction of the Proposed Development. Therefore, the cumulative magnitude has been assessed as no greater than the magnitude for the project alone and the magnitude of impact is considered to be Low.

TIER 3

MAGNITUDE OF IMPACT

9.12.4.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.4.5. The anticipated decommissioning of seven wind turbines for ABWP1 may overlap with the construction of the Proposed Development. However, the underwater noise generated as a result of the decommissioning of ABWP1 is expected to be low in comparison to the noise generated by pilling for WTG and OSP installation for the Proposed Development. Therefore, the cumulative magnitude has been assessed as no greater than the magnitude for the project alone and the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.4.6. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.4.7. For the Phase 1 projects, underwater noise will occur, as a result of the installation of WTGs, OSPs and associated cables during the construction phase of Codling Wind Park and Dublin Array and during repair and maintenance activities associated with Codling Wind Park. It is anticipated that any noise generated for any potential maintenance and repair required during the operational and maintenance phase of Codling Wind Park will be negligible. As summarised in section 9.9.3, the greatest effect is likely to occur from the noise generated during pilling of monopile foundations. However, the piling during the construction of Codling Wind park is due to take place the year before the pilling at the Proposed Development during 2027 and pilling for Dublin Array is due to take place the year after that of pilling at the Proposed Development during 2029. Should pilling at the Proposed Development, Codling Wind Park and Dublin Array coincide with each other, the effect may be greater than that for the project alone. However, piling operations during the construction of Phase 1 projects are expected to be similar to that of the Proposed Development and will be restricted to the near-field and immediately adjacent far-field areas in the vicinity of the noise source. The duration of the impact is anticipated to be short-term (i.e. days) and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. Therefore, the cumulative magnitude has been assessed as no greater than the magnitude for the project alone and the magnitude of impact is considered to be Low.

TIER 1 + TIER 3 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.4.8. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.4.9. The greatest risk of cumulative impacts from underwater noise has been identified as that generated during the piling of the construction phase of the Proposed Development along with the construction phases of the Phase 1 projects. However, piling operations during the construction of Phase 1 projects are expected to be similar to that of the Proposed Development and will be restricted to the near-field and immediately adjacent far-field areas in the vicinity of the noise source. The duration of the impact is anticipated to be short-term (i.e. days) and is anticipated to result in barely discernible change to key characteristics or features of benthic habitats. Therefore, the cumulative magnitude has been assessed as no greater than the magnitude for the project alone and the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.4.10. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.4.11. The sensitivity of benthic IEFs is **Low** (as indicated in section 9.9.3, the sensitivity of 'Reef' IEF (if present) is also **Low**). Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.5 Project Design Option 1 and 2 - Impact 4 - Long-term subtidal habitat loss/change

SENSITIVITY OF THE RECEPTOR

9.12.5.1. The sensitivity of the receptors is described in detail in section 9.9.4 and was determined to be High.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.5.2. The magnitude of the impact for both Project Design Options 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.5.3. For the Tier 1 projects, log-term subtidal habitat loss/change may occur as a result of the installation of the pontoon for ABWP2 OMF during construction. All other Tier 1 projects will be operational during the operational and maintenance phase of the Proposed Development and therefore, long-term subtidal habitat loss/change may also occur as a result of the presence of offshore infrastructure such as the WTGs, OSPs for ABWP1, cables and cable protected associated with ABWP1 and Hibernia Atlantic, and the long-sea outfall associated with the Arklow Wate Water Treatment Plant. The loss of seabed habitats associated with Tier 1 projects is will be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.5.4. The magnitude of the impact for both Project Design Options 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.5.5. For the Phase 1 projects, long-term subtidal habitat loss/change will occur as a result of the installation and presence of WTGs, OSPs, cables and associated cable protection during the construction and operational phases of Dublin Array and operational phase of Codling Wind Park.

The loss of seabed habitats associated with Phase 1 projects will be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.5.6. The magnitude of the impact for both Project Design Options 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.5.7. Any cumulative long-term subtidal habitat loss/change as a result of the operational and maintenance phase of the Proposed Development and the construction and operation of the Tier 1 and Phase 1 projects, is expected to be highly localised, small in the context of the available habitats within the Benthic Subtidal and Intertidal Study Area and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.5.8. Overall, the cumulative magnitude of the impact has been assessed as **Low** and the sensitivity of IEFs is **High** (as indicated in section 9.9.4, the sensitivity of 'Reef' IEF (if present) is also **High**). Therefore the significance of effect is considered to be **Moderate**. This has been deemed not significant in EIA terms based on professional judgement due to the small proportion of the Benthic Subtidal and Intertidal Ecology Study Area potentially affected by long-term subtidal habitat loss/change, and the extent of potentially affected biotopes in the wider area.

9.12.6 Project Design Option 1 and 2 - Impact 5 - Colonisation of hard structures

SENSITIVITY OF THE RECEPTOR

9.12.6.1. The sensitivity of the receptors is described in detail in section 9.9.5 and was determined to be Low.

Construction phase

TIER 1

MAGNITUDE OF IMPACT

9.12.6.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the construction phase.

9.12.6.3. For the Tier 1 projects, colonisation of hard structures may occur as a result of the installation of the pontoon structure associated with Arklow ABWP2 OMF. All other Tier 1 projects will be operational during the construction phase of the Proposed Development and therefore, colonisation of hard structures will occur as a result of the presence of offshore infrastructure such as the WTGs, OSPs for ABWP1, cables and cable protected associated with ABWP1 and Hibernia Atlantic, and the long-sea outfall associated with the Arklow Wate Water Treatment Plant. The colonisation of hard structures associated with Tier 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

TIER 3

MAGNITUDE OF IMPACT

9.12.6.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the construction phase.

9.12.6.5. Colonisation of hard structures may occur as a result of the presence of vessels during the anticipated decommissioning of ABWP1. The colonisation of hard structures associated with the decommissioning of ABWP1 is expected to be highly localised, restricted to vessels present within the project area. Therefore, the magnitude of impact is considered to be Medium.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.6.6. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the construction phase.

9.12.6.7. For the Phase 1 projects, colonisation of hard structures may occur as a result of the installation and presence of WTGs, OSPs, cables and associated cable protection during the construction and operational phases of Codling Wind Park and operational phase of Dublin Array. The colonisation of hard structures associated with Phase 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

TIER 1 + TIER 3 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.6.8. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the construction phase.

9.12.6.9. Any cumulative colonisation of hard structures as a result of the construction phase of the Proposed Development and the construction and operation of the Tier 1, Tier 3 and Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

SIGNIFICANCE OF EFFECT

9.12.6.10. Overall the cumulative magnitude of the impact has been assessed to be **Medium.**

9.12.6.11. The sensitivity of benthic IEFs is **Low** (as indicated in section 9.9.5, the sensitivity of 'Reef' IEF (if present) is also **Low).** Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.6.12. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the operational and maintenance phase.

9.12.6.13. For the Tier 1 projects, colonisation of hard structures may occur as a result of the installation of the pontoon structure associated with Arklow ABWP2 OMF. All other Tier 1 projects

will be operational during the construction phase of the Proposed Development and therefore, colonisation of hard structures will occur as a result of the presence of offshore infrastructure such as the WTGs, OSPs for ABWP1, cables and cable protected associated with ABWP1 and Hibernia Atlantic, and the long-sea outfall associated with the Arklow Wate Water Treatment Plant. The colonisation of hard structures associated with Tier 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.6.14. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the operational and maintenance phase.

9.12.6.15. For the Phase 1 projects, colonisation of hard structures may occur as a result of the installation and presence of WTGs, OSPs, cables and associated cable protection during the construction and operational phases of Dublin Array and operational phase of Codling Wind Park. The colonisation of hard structures associated with the other Phase 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.6.16. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the operational and maintenance phase.

9.12.6.17. Any cumulative colonisation of hard structures as a result of the operational and maintenance phase of the Proposed Development and the construction and operation of the Tier 1 and Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

SIGNIFICANCE OF EFFECT

9.12.6.18. Overall, the cumulative magnitude of the impact has been assessed to be **Medium.**

9.12.6.19. The sensitivity of benthic IEFs is **Low** (as indicated in section 9.9.5, the sensitivity of 'Reef' IEF (if present) is also **Low**)**.** Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

Decommissioning phase

TIER 1

MAGNITUDE OF IMPACT

9.12.6.20. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the decommissioning phase.

9.12.6.21. For the Tier 1 projects, colonisation of hard structures may occur as a result of the presence of offshore infrastructure such as the pontoon for ABWP2, WTGs, OSPs for ABWP1, cables and cable protected associated with ABWP1 and Hibernia Atlantic, and the long-sea outfall associated with the Arklow Wate Water Treatment Plant. The colonisation of hard structures associated with

Tier 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.6.22. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the decommissioning phase.

9.12.6.23. For the Phase 1 projects, colonisation of hard structures may occur as a result of the presence of WTGs, OSPs, cables and associated cable protection during the operational phase of Dublin Array and Codling Wind Park. The colonisation of hard structures associated with the Phase 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.6.24. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the decommissioning phase.

9.12.6.25. Any cumulative colonisation of hard structures as a result of the decommissioning phase of the Proposed Development and the operation of the Tier 1 and Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

SIGNIFICANCE OF EFFECT

9.12.6.26. Overall the cumulative magnitude of the impact has been assessed to be **Medium.**

9.12.6.27. The sensitivity of benthic IEFs is **Low** (as indicated in section 9.9.5, the sensitivity of 'Reef' IEF (if present) is also **Low).** Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.7 Project Design Option 1 and 2 - Impact 6 - Alteration of seabed habitat arising from effects on physical processes

SENSITIVITY OF THE RECEPTOR

9.12.7.1. The sensitivity of the receptors is described in detail in section 9.9.7 and was determined to be Negligible.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.7.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.7.3. For the Tier 1 projects, alteration of seabed habitats arising from changes in physical processes may occur as a result of the presence of offshore infrastructure such as the pontoon for ABWP2, WTGs, OSPs for ABWP1, cables and cable protected associated with ABWP1 and Hibernia

Atlantic, and the long-sea outfall associated with the Arklow Wate Water Treatment Plant. Any alteration of seabed habitat associated with the other Tier 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.7.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.7.5. For the Phase 1 projects, alteration of seabed habitats arising from changes in physical processes may occur as a result of as a result of the presence of infrastructure and rock protection associated with Codling Wind Park and Dublin Array. Alteration of seabed habitat associated with the Phase 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.7.6. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.7.7. Alteration of seabed habitats arising from changes in physical processes may occur as a result of the presence of infrastructure and rock protection associated with the Tier 1, Tier 3 and Phase one projects. However, alterations in physical processes are expected to be highly localised and restricted to discrete areas within the Proposed Development areas. Therefore, the magnitude remains as Low.

SIGNIFICANCE OF EFFECT

9.12.7.8. Overall the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.7.9. The sensitivity of benthic IEFs is **Negligible** (as indicated in section 9.9.6, the sensitivity of 'Reef' IEF (if present) is also **Negligible**)**.** Therefore, the significance of effect is considered to be **Imperceptible**, which is not significant in EIA terms.

9.12.8 Project Design Option 1 and 2 - Impact 7 - Removal of hard substrates resulting in loss of colonising communities

SENSITIVITY OF THE RECEPTOR

9.12.8.1. The sensitivity of the receptors is described in detail in section 9.9.7 and was determined to be Low.

Decommissioning phase

TIER 1

MAGNITUDE OF IMPACT

9.12.8.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the decommissioning phase.

9.12.8.3. All Tier 1 projects will be operational during the decommissioning phase of the Proposed Development and any removal of hard substrates resulting in loss of colonising communities as a result of repair and maintenance activities will be negligible. The removal of hard substrates associated with Tier 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.8.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the decommissioning phase.

9.12.8.5. All Phase 1 projects will be operational during the decommissioning phase of the Proposed Development and any removal of hard substrates resulting in loss of colonising communities as a result of repair and maintenance activities will be negligible. The removal of hard substrates associated with Phase 1 projects is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.8.6. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Medium for the decommissioning phase.

9.12.8.7. Any cumulative removal of hard substrates resulting in loss of colonising communities as a result of the decommissioning phase of the Proposed Development and the operation of the Tier 1 and Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Medium.

SIGNIFICANCE OF EFFECT

9.12.8.8. Overall, the cumulative magnitude of the impact has been assessed to be **Medium.**

9.12.8.9. The sensitivity of benthic IEFs is **Low** (as indicated in section 9.9.7, the sensitivity of 'Reef' IEF (if present) is also **Low).** Therefore, the significance of effect is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.9 Project Design Option 1 and 2 - Impact 8 - Increased risk of introduction and spread of invasive and non-native species

SENSITIVITY OF THE RECEPTOR

9.12.9.1. The sensitivity of the receptors is described in detail in section 9.9.8 and was determined to be Negligible to Medium.

Construction phase

TIER 1

MAGNITUDE OF IMPACT

9.12.9.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.9.3. For the Tier 1 projects, increased risk of introduction and spread of invasive and non-native species may occur as a result of the requirement of vessels during the construction of the pontoon structure and associated dredging as part of ABWP2 OMF. All other Tier 1 projects will be operational during the construction phase of the Proposed Development and the introduction and spread of invasive and non-native species may occur as a result of vessels required during operational and maintenance activities required. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

TIER 3

MAGNITUDE OF IMPACT

9.12.9.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.9.5. Introduction and spread of invasive and non-native species may occur as a result of vessels required for the removal of infrastructure associated with the anticipated decommissioning of ABWP1. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.9.6. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.9.7. For the Phase 1 projects, increased risk of introduction and spread of invasive and non-native species may occur as a result of the requirement of vessels during the construction and operation of Codling Wind Park and the construction of Dublin Array. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + TIER 3 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.9.8. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.9.9. Any cumulative increased rick and spread of invasive and non-native species as a result of the construction phase of the Proposed Development and the construction and operation of the Tier 1, Tier 3 and Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.9.10. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.9.11. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible,** which is not significant in EIA terms.

9.12.9.12. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.9.13. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (as indicated in section 9.9.8, the sensitivity of 'Reef' IEF is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.9.14. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.9.15. For the Tier 1 projects, increased risk of introduction and spread of invasive and non-native species may occur as a result of the requirement of vessels during the construction of the pontoon structure and associated dredging as part of ABWP2 OMF. All other Tier 1 projects will be operational during the construction phase of the Proposed Development and the introduction and spread of invasive and non-native species may occur as a result of vessels required during operational and maintenance activities required. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.9.16. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.9.17. For the Phase 1 projects, increased risk of introduction and spread of invasive and non-native species may occur as a result of the requirement of vessels during the construction and operation of Dublin Array and the operation of Codling Wind Park. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.9.18. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.9.19. Any cumulative increased rick and spread of invasive and non-native species as a result of the operational and maintenance phase of the Proposed Development and the construction and operation of the Tier 1 and Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.9.20. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.9.21. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible,** which is not significant in EIA terms.

9.12.9.22. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.9.23. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (as indicated in section 9.9.8, the sensitivity of 'Reef' IEF is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

Decommissioning phase

TIER 1

MAGNITUDE OF IMPACT

9.12.9.24. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.9.25. All Tier 1 projects will be operational during the decommissioning of the Proposed Development and increased risk of introduction and spread of invasive and non-native species may occur as a result of vessels required during operational and maintenance activities. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.9.26. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.9.27. For the Phase 1 projects, increased risk of introduction and spread of invasive and non-native species may occur as a result of the requirement of vessels during the operation of Codling Wind Park and Dublin Array. The introduction and spread of invasive and non-native species is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.9.28. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.9.29. Any cumulative increased rick and spread of invasive and non-native species as a result of the decommissioning phase of the Proposed Development and the operation of the Tier 1 and

Phase 1 projects, is expected to be highly localised and restricted to discrete areas within the project areas. Therefore, the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.9.30. Overall the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.9.31. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Negligible**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Imperceptible,** which is not significant in EIA terms.

9.12.9.32. The sensitivity of the 'Moderate Energy Sublittoral Rock' IEF is **Low**. Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.9.33. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment' and '*Sabellaria* on Stable Sediment' IEFs is **Medium** (as indicated in section 9.9.8, the sensitivity of 'Reef' IEF is also **Medium**). Therefore, the significance of effect from increased risk of introduction and spread of invasive and non-native species is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.10 Project Design Option 1 and 2 - Impact 9 - Accidental pollution

SENSITIVITY OF THE RECEPTOR

9.12.10.1. The sensitivity of the receptors is described in detail in section 9.9.9 and was determined to be Low to Medium.

Construction phase

TIER 1

MAGNITUDE OF IMPACT

9.12.10.2. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.10.3. For the Tier 1 projects, accidental pollution may occur as a result of vessels and machinery required during the construction phase of the Arklow ABWP2 OMF. All other Tier 1 projects will be operational during the construction phase of the Proposed Development and accidental pollution may occur as a result of vessels and machinery required during operational and maintenance activities. Any accidental pollution is predicted to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

TIER 3

MAGNITUDE OF IMPACT

9.12.10.4. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the construction phase.

9.12.10.5. Accidental pollution may occur as a result of vessels required for the removal of infrastructure associated with the anticipated decommissioning of ABWP1. Any accidental pollution is predicted to be of near-field and adjacent far field extent, short-term duration (any

pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.10.6. The magnitude of the impact for both Project Design Options 1 and 2 was determined to be Low for the construction phase.

9.12.10.7. For the Phase 1 projects, accidental pollution may occur as a result of vessels and machinery required during the construction and operation of Codling Wind Park and the construction of Dublin Array. Accidental pollution during the construction phase of the Proposed Development and the construction and operation phases of Phase 1 projects is predicted to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

TIER 1 + TIER 3 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.10.8. The magnitude of the impact for both Project Design Options 1 and 2 was determined to be Low for the construction phase.

9.12.10.9. Any cumulative accidental pollution as a result of the construction phase of the Proposed Development and the construction and operation of the Tier 1, Tier 3 and Phase 1 projects, is expected to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.10.10. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.10.11. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.10.12. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (as indicated in section 9.9.9, the sensitivity of 'Reef' IEF is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is **not significant** in EIA terms.

Operational and maintenance phase

TIER 1

MAGNITUDE OF IMPACT

9.12.10.13. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.10.14. For the Tier 1 projects, accidental pollution may occur as a result of vessels and machinery required during the construction phase of the Arklow ABWP2 OMF. All other Tier 1 projects will be operational during the operational phase of the Proposed Development and accidental

pollution may occur as a result of vessels and machinery required during operational and maintenance activities. Any accidental pollution is predicted to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.10.15. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.10.16. For the Phase 1 projects, accidental pollution may occur as a result of the requirement of vessels during the construction and operational phases of Dublin Array and the operational phase of Codling Wind Park. Accidental pollution during the construction phase of the Proposed Development and the construction and operation phases of other Phase 1 projects is predicted to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.10.17. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the operational and maintenance phase.

9.12.10.18. Any cumulative accidental pollution as a result of the operational phase of the Proposed Development and the construction and operation of the Tier 1 and Phase 1 projects, is expected to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.10.19. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.10.20. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.10.21. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (as indicated in section 9.9.9, the sensitivity of 'Reef' IEF is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is **not significant** in EIA terms.

Decommissioning phase

TIER 1

MAGNITUDE OF IMPACT

9.12.10.22. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.10.23. All Tier 1 projects will be operational during the decommissioning of the Proposed Development and accidental pollution may occur as a result of vessels and machinery required during operational and maintenance activities. Any accidental pollution is predicted to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.10.24. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.10.25. For the Phase 1 projects, increased risk of accidental pollution may occur as a result of the requirement of vessels and machinery required during the operation of Codling Wind Park and Dublin Array. Any accidental pollution is predicted to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

TIER 1 + PHASE 1 PROJECTS

MAGNITUDE OF IMPACT

9.12.10.26. The magnitude of the impact for both Project Design Option 1 and 2 was determined to be Low for the decommissioning phase.

9.12.10.27. Any cumulative accidental pollution as a result of the decommissioning phase of the Proposed Development and the operation of the Tier 1 and Phase 1 projects, is expected to be of near-field and adjacent far field extent, short-term duration (any pollutant will be quickly dispersed) and infrequent. Considering the low likelihood of a pollution event occurring the magnitude of impact is considered to be Low.

SIGNIFICANCE OF EFFECT

9.12.10.28. Overall, the cumulative magnitude of the impact has been assessed to be **Low.**

9.12.10.29. The sensitivity of the 'Barren Coarse Intertidal Sediment' and 'Moderately Exposed Intertidal Rock' IEFs is **Low**. Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is not significant in EIA terms.

9.12.10.30. The sensitivity of the 'Subtidal Sands Sediment', Subtidal Coarse and Mixed Sediment', '*Sabellaria* on Stable Sediment' and 'Moderate Energy Sublittoral Rock' is **Medium** (as indicated in section 9.9.9, the sensitivity of 'Reef' IEF is also **Medium**). Therefore, the significance of effect from accidental pollution is considered to be **Slight** adverse, which is **not significant** in EIA terms.

9.13 Transboundary effects

9.13.1.1. Transboundary effects are defined as those effects upon the receiving environment of other states, whether occurring from the Proposed Development alone, or cumulatively with other projects in the wider area. A screening of transboundary impacts has been carried out and has identified that there was potential for significant transboundary effects with regard to Benthic Subtidal and Intertidal Ecology from the Proposed Development upon the interests of other states.

9.13.1.2. As set out throughout sections 9.9 and 9.10, the majority of impacts on benthic subtidal and intertidal IEFs from the Proposed Development will be restricted to within the Proposed Development boundaries and the area immediately surrounding it. The only exception is the effect of underwater noise and vibration during the construction phase (particularly piling), which has the potential to result in injury and/or disturbance to benthic subtidal IEFs.

9.13.1.3. However, as outlined in sections 9.9.3 and 9.10.3., the magnitude of the impact for pilling is deemed to be **Low** and the sensitivity of the receptors is considered to be **Low**. The effect will, therefore, be of **slight** adverse significance, which is **not significant** in EIA terms.

9.14 Summary of effects

11.1.1.1 This chapter has investigated the potential effects on Benthic Subtidal and Intertidal Ecology receptors arising from the Proposed Development. The range of potential impacts and associated effects has been informed by the Scoping Opinion and consultation responses from stakeholders, alongside reference to existing legislation and guidance.

11.1.1.2 The assessment has been undertaken in the three following stages:

- The identification of the project parameters for Project Design Option 1 and 2 from the Offshore Project Description (Volume II, Chapter 4: Description of Development);
- The determination of the baseline physical environment (including potential changes over the Proposed Development lifetime due to natural variation); and
- Assessment of impacts to Benthic Subtidal and Intertidal Ecology arising from the project design options both for the Proposed Development on its own and in conjunction with other built and consented projects.

11.1.1.3 A wide range of potential impacts to Benthic Subtidal and Intertidal Ecology have been considered and have been assessed within this chapter.

11.1.1.4 Using a precautionary assessment approach, it has been found that for all receptor groups, the level of effect significance is either **Imperceptible, Not Significant, Slight adverse** or **Moderate** for all phases of development (Table 9.22 and Table 9.23). Accordingly, all of the potential effects to Benthic Subtidal and Intertidal Ecology receptors are therefore considered Not Significant in terms of the EIA Regulations.

Table 9.22: Summary of potential environmental impacts, mitigation and monitoring for Project Design Option 1

Description of impact	Phase			Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
	C	O	D							
1. Temporary subtidal habitat loss/disturbance	✓	✓	✓	Implementation of an EMP Adherence to the Rehabilitation Schedule. Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area prior to construction. Adherence to the Vessel Management Plan (VMP). Full details of factored-in measures can be found in section 9.7.3.	C: Low O: Negligible D: Low	C: Low to Medium O: Low to Medium D: Low to Medium	C: Slight adverse (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	N/A
2. Increased suspended sediment concentrations and	✓	✓	✓	Installation of scour protection as defined in Volume II, Chapter 4:	C: Low O: Low D: Low	C: Negligible to Medium	C: Imperceptible to Slight adverse (not	None	C: Imperceptible to Slight adverse (not	N/A

Description of impact	Phase C O D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
associated sediment deposition		Description of Development. Full details of factored-in measures can be found in section 9.7.3.		O: Negligible to Medium D: Negligible to Medium	significant in EIA terms) O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)		significant in EIA terms) O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)	
3. Injury and/or disturbance from underwater noise and vibration	✓ × ×	Adherence to soft starts and maximum piling energies as set out in Volume II, Chapter 4 Description of Development Full details of factored-in measures can be	C: Low	C: Low	C: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms)	N/A

Description of impact		Phase C	Phase O	Phase D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
					found in section 9.7.3.						
4.	Long-term subtidal habitat loss/change	×	✓	×	Implementation of the EMP Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area prior to construction. Implementation of the INISMP Cables will be buried where possible and protected where not possible. Full details of factored-in measures can be found in section 9.7.3.	O: Low	O: High	O: Moderate (not significant in EIA terms)	None	O: Moderate (not significant in EIA terms)	N/A
5.	Colonisation of hard structures	✓	✓	✓	Implementation of the EMP	C: Medium O: Medium	C: Low O: Low	C: Slight adverse (not	None	C: Slight adverse (not	N/A

Description of impact	Phase C	Phase O	Phase D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area prior to construction. Adherence to the Rehabilitation Schedule. Implementation of the INISMP Full details of factored-in measures can be found in section 9.7.3.	D: Medium	D: Low	significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)		significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	
6. Alterations of seabed habitats arising from changes in physical processes	×	✓	×	Volume II, Chapter 4: Description of Development sets out the cable laying techniques, cable burial depths and schedule of O&M activities.	O: Low	O: Negligible	O: Imperceptible (not significant in EIA terms)	None	O: Imperceptible (not significant in EIA terms)	N/A

Description of impact	Phase C	Phase O	Phase D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				Installation of scour protection as defined in Volume II, Chapter 4: Description of Development. Full details of factored-in measures can be found in section 9.7.3.						
7. Removal of hard structures resulting in loss of colonising communities	×	×	✓	Adherence to the Rehabilitation Schedule. Full details of factored-in measures can be found in section 9.7.3.	D: Medium	D: Low	D: Slight adverse (not significant in EIA terms)	None	D: Slight adverse (not significant in EIA terms)	N/A
8. Increased risk of introduction and spread of invasive and non-native species	✓	✓	✓	Adherence to the INISMP. Full details of factored-in measures can be	C: Low O: Low D: Low	C: Negligible to Medium O: Negligible to Medium	C: Imperceptible to Slight adverse (not significant in EIA terms)	None	C: Imperceptible to Slight adverse (not significant in EIA terms)	N/A

Description of impact	Phase C O D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
		found in section 9.7.3.		D: Negligible to Medium	O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)		O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)	
9. Accidental pollution	✓ ✓ ✓	Adherence to the MPCP. Full details of factored-in measures can be found in section 9.7.3.	C: Low O: Low D: Low	C: Low to Medium O: Low to Medium D: Low to Medium	C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	N/A

Table 9.23: Summary of potential environmental impacts, mitigation and monitoring for Project Design Option 2

Description of impact	Phase C	Phase O	Phase D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
1. Temporary subtidal habitat loss/disturbance	✓	✓	✓	Implementation of an EMP Adherence to the Rehabilitation Schedule. Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area prior to construction. Adherence to the Vessel Management Plan (VMP). Full details of factored-in measures can be found in section 9.7.3.	C: Low O: Negligible D: Low	C: Low to Medium O: Low to Medium D: Low to Medium	C: Slight adverse (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms) O: Not Significant (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	N/A
2. Increased suspended sediment concentrations and	✓	✓	✓	Installation of scour protection as defined in Volume II, Chapter 4:	C: Low O: Low D: Low	C: Negligible to Medium	C: Imperceptible to Slight adverse (not	None	C: Imperceptible to Slight adverse (not	N/A

Description of impact	Phase C O D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
associated sediment deposition		Description of Development. Full details of factored-in measures can be found in section 9.7.3.		O: Negligible to Medium D: Negligible to Medium	significant in EIA terms) O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)		significant in EIA terms) O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)	
3. Injury and/or disturbance from underwater noise and vibration	✓ × ×	Adherence to soft starts and maximum piling energies as set out in Volume II, Chapter 4 Description of Development Full details of factored-in measures can be	C: Low	C: Low	C: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms)	N/A

Description of impact	Phase C O D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
		found in section 9.7.3.						
4. Long-term subtidal habitat loss/change	× ✓ ×	Implementation of the EMP Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area prior to construction. Implementation of the INISMP Cables will be buried where possible and protected where not possible. Full details of factored-in measures can be found in section 9.7.3.	O: Low	O: High	O: Moderate (not significant in EIA terms)	None	O: Moderate (not significant in EIA terms)	N/A
5. Colonisation of hard structures	✓ ✓ ✓	Implementation of the EMP	C: Medium O: Medium	C: Low O: Low	C: Slight adverse (not	None	C: Slight adverse (not	N/A

Description of impact	Phase C O D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
		Confirmatory surveys to be undertaken within the Array Area and Cable Corridor and Working Area prior to construction. Adherence to the Rehabilitation Schedule. Implementation of the INISMP Full details of factored-in measures can be found in section 9.7.3.	D: Medium	D: Low	significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)		significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	
6. Alterations of seabed habitats arising from changes in physical processes	× ✓ ×	Volume II, Chapter 4: Description of Development sets out the cable laying techniques, cable burial depths and schedule of O&M activities.	O: Low	O: Negligible	O: Imperceptible (not significant in EIA terms)	None	O: Imperceptible (not significant in EIA terms)	N/A

Description of impact	Phase C	Phase O	Phase D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
				Installation of scour protection as defined in Volume II, Chapter 4: Description of Development. Full details of factored-in measures can be found in section 9.7.3.						
7. Removal of hard structures resulting in loss of colonising communities	×	×	✓	Adherence to the Rehabilitation Schedule. Full details of factored-in measures can be found in section 9.7.3.	D: Medium	D: Low	D: Slight adverse (not significant in EIA terms)	None	D: Slight adverse (not significant in EIA terms)	N/A
8. Increased risk of introduction and spread of invasive and non-native species	✓	✓	✓	Adherence to the INISMP. Full details of factored-in measures can be	C: Low O: Low D: Low	C: Negligible to Medium O: Negligible to Medium	C: Imperceptible to Slight adverse (not significant in EIA terms)	None	C: Imperceptible to Slight adverse (not significant in EIA terms)	N/A

Description of impact	Phase C O D	Factored-in measures	Magnitude of impact	Sensitivity of Receptors	Significance of effect	Additional measures	Residual effect	Proposed monitoring
		found in section 9.7.3.		D: Negligible to Medium	O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)		O: Imperceptible to Slight adverse (not significant in EIA terms) D: Imperceptible to Slight adverse (not significant in EIA terms)	
9. Accidental pollution	✓ ✓ ✓	Adherence to the MPCP. Full details of factored-in measures can be found in section 9.7.3.	C: Low O: Low D: Low	C: Low to Medium O: Low to Medium D: Low to Medium	C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	None	C: Slight adverse (not significant in EIA terms) O: Slight adverse (not significant in EIA terms) D: Slight adverse (not significant in EIA terms)	N/A

9.15 References

Aberkali, H. B. and Trueman, E. R. (1985) Effects of environmental stress on marine bivalve molluscs. Advances in Marine Biology, 22, 101-198.

Aguilar de Soto, N., Delorme, N., Atkins, J., Howard, S., Williams, J. and Johnson, M. (2013) Anthropogenic noise causes body malformations and delays development in marine larvae. Nature Scientific Reports, 3 Article number: 2831. doi:10.1038/srep02831

André, M., Kaifu, K., Solé, M., van der Schaar, M. and Akamatsu, T. (2016) 'Contribution to the understanding of particle motion perception in marine invertebrates', in 'The Effects of Noise on Aquatic Life II. Advances in Experimental Medicine and Biology', Eds A. N. Popper and A. Hawkins (New York: Springer). p. 47–55.

Aqua-fact International Services Ltd (2008) Proposed Dredge Disposal Sites for Arklow Harbour Commissioner. http://www.epa.ie/licences/lic_eDMS/090151b28037c91c.pdf [Accessed: February 2024].

Aquatic Services Unit (2010) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey June 2009. A Report to Arklow Energy. February 2010.

Aquatic Services Unit (2016) Sediment chemistry sampling to support dredge dumping as sea permit application for Arklow Bank Wind Park Phase 1.

Atalah, J., Fitch, J., Coughlan, J., Chopelet, J., Coscia, I. and Farrell, E. (2013) Diversity of demersal and megafaunal assemblages inhabiting sandbanks of the Irish Sea. Marine Biodiversity, 43(2), pp.121-132.

Bell, J. J. and Barnes, D. K. (2000) The distribution and prevalence of sponges in relation to environmental gradients within a temperate sea lough: inclined cliff surfaces. Diversity and Distributions, 6 (6), 305-323.

Bell, J. J. and Smith, D. (2004) Ecology of sponge assemblages (Porifera) in the Wakatobi region, south-east Sulawesi, Indonesia: richness and abundance. Journal of the Marine Biological Association of the UK, 84 (3), 581-591.

Bioconsult (2006) Benthic communities at Horns Rev, before, during and after construction of Horns Rev offshore wind farm. Final annual report 2005.

Blanchard, M. (2009) Recent expansion of the slipper limpet population (Crepidula fornicata) in the Bay of Mont-Saint-Michel (Western Channel, France). Aquatic Living Resources, 22 (1), 11-19.

Bohn, K., Richardson, C. A. and Jenkins, S. R. (2015) The distribution of the invasive non-native gastropod Crepidula fornicata in the Milford Haven Waterway, its northernmost population along the west coast of Britain. Helgoland Marine Research, 69 (4), 313.

BOWind (2008) Barrow Offshore Wind Farm Post Construction Monitoring Report. First annual report. 15 January 2008, 60pp.

Bradshaw, C., Veale, L. O., Hill, A. S. and Brand, A. R. (2002) The role of scallop-dredge disturbance in long-term changes in Irish Sea benthic communities: a re-analysis of an historical dataset. Journal of Sea Research, 47, 161-184.

Breitburg, D., Levin, L. A., Oschlies, A., Grégoire, M., Chavez, F. P., Conley, D. J., Garçon, V., Gilbert, D., Gutiérrez, D., Isensee, K., Jacinto, G. S., Limburg, K. E., Montes, I., Naqvi, S. W. A., Pitcher, G. C., Rabalais, N. N., Roman, M. R., Rose, K. A., Seibel, B. A., Telszewski, M., Yasuhara, M., Zhang, J. (2018) Declining oxygen in the global ocean and coastal waters. Science, 359, p.1–13.

Bryan, G. W. (1984) Pollution due to heavy metals and their compounds. In Marine Ecology: A Comprehensive, Integrated Treatise on Life in the Oceans and Coastal Waters, vol. 5. Ocean Management, part 3, (ed. O. Kinne), pp.1289-1431.

Cabioch, L., Dauvin, J. C. and Gentil, F. (1978) Preliminary observations on pollution of the sea bed and disturbance of sub-littoral communities in northern Brittany by oil from the Amoco Cadiz. Marine Pollution Bulletin, 9, 303-307.

Capasso, E., Jenkins, S., Frost, M. and Hinz, H. (2010) Investigation of benthic community change over a century-wide scale in the western English Channel. Journal of the Marine Biological Association of the United Kingdom, 90 (06), 1161-1172.

Castège, I., Milon, E. and Pautrizel, F. (2014) Response of benthic macrofauna to an oil pollution: Lessons from the “Prestige” oil spill on the rocky shore of Guéthary (south of the Bay of Biscay, France). Deep Sea Research Part II: Topical Studies in Oceanography, 106, 192-197.

Caswell, B., Paine, M. and Frid, C. (2018) Seafloor ecological functioning over two decades of organic enrichment. Marine Pollution Bulletin, 136, p.212-229.

CIEEM (2018) Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (version 1.2 – Updated April 2022).

Collie, J. S., Escanero, G. A. and Valentine, P. C. (1997) Effects of bottom fishing on the benthic megafauna of Georges Bank. Marine Ecology Progress Series, 155, 159-172.

Connor, D. W., Allen, J. H., Golding, N., Howell, K. L., Lieberknecht, L. M., Northen, K. O. and Reker, J. B. (2004) The Marine Habitat Classification for Britain and Ireland. Version 04.05. ISBN 1 861 07561 8. In JNCC (2015), The Marine Habitat Classification for Britain and Ireland Version 15.03. [2019-07-24]. Joint Nature Conservation Committee, Peterborough.

Constantino, R., Gaspar, M., Tata-Regala, J., Carvalho, S., Cúrdia, J., Drago, T., Taborda, R. and Monteiro, C. (2009) Clam dredging effects and subsequent recovery of benthic communities at different depth ranges. Marine Environmental Research, 67, 89-99.

Creane, S., O’Shea, M., Coughlan, M. and Murphy, J. (2023) Hydrodynamic Processes Controlling Sand Bank Mobility and Long-Term Base Stability: A Case Study of Arklow Bank. Geosciences, 13(2), p.60.

Cronin, M., McGovern, E., McMahon, T. and Boelens, R. (2006) Guidelines for the Assessment of Dredge Material for Disposal in Irish Waters, Marine Environment and Health Services, No 24, April 2006 ISSN No 1649-0053.

CWP (2020) Codling Wind Park Offshore Scoping Report. November 2020.

DCHG (Department of Culture, Heritage and the Gaelteacht) (2014a) Wicklow Reef SAC Site Synopsis, 002274_Rev13. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002274.pdf [Accessed: February 2024].

DCHG (Department of Culture, Heritage and the Gaelteacht) (2014b) Blackwater Bank SAC Site Synopsis, 002953_Rev13. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002953.pdf [Accessed February 2024].

Dernie, K. M., Kaiser, M. J., Richardson, E. A. and Warwick, R. M. (2003) Recovery of soft sediment communities and habitats following physical disturbance. Journal of Experimental Marine Biology and Ecology, 285-286, 415-434.

Devoy, R. J. N., (2008) Coastal vulnerability and the implications of sea-level rise for Ireland. Journal of Coastal Research 24(2): 325–341.

Dubois, S., Commito, J. A., Olivier, F. and Retière, C. (2006) Effects of epibionts on Sabellaria alveolata (L.) biogenic reefs and their associated fauna in the Bay of Mont Saint-Michel. Estuarine, Coastal and Shelf Science, 68 (3), 635-646.

Dye, S., Hughes, S., Tinker, J., & Berry, D., Holliday, N., Kent, E., Kennington, K., Inall, M., Smyth, T., Nolan, G., Lyons, K., Andres, O. and Beszczynska-Moeller, A. (2013) Impacts of climate change on temperature (air and sea). MCCIP Science Review 2013. 1-12. 10.14465/2013.arc01.001-012.

EcoServe (2001b) Volume 3, Appendix 15 of the Arklow Bank EIS. A marine ecological study of the Arklow Bank for a proposed offshore windpark development. Chapter 1. Baseline survey. April 2001.

EGS (2011) Lynn and Inner Dowsing Offshore Wind Farms Post-Construction Survey Works (2010) Phase 2 – Benthic Ecology Survey Centrica Contract No. CREL/C/400012, Final Report. 184pp.

Elliot, M., Nedwell, S., Jones, N. V., Read, S. J., Cutts, N. D. and Hemingway, K. L. (1998) Intertidal sand and mudflats & subtidal mobile sandbanks (Vol. II). An overview of dynamic and sensitivity for conservation management of marine SACs. Prepared by the Scottish Association for Marine Science for the UK Marine SACs Project.

EPA (2014)

EPA (2022) Guidelines on the Information to be Contained in Environmental Impact Assessment Reports.

EUSeaMap (2021) EMODnet broad-scale seabed habitat map for Europe. https://emodnet.ec.europa.eu/en/euseamap-2021-emodnet-broad-scale-seabed-habitat-map-europe [Accessed: February 2024].

Fehily Timoney & Co (2001) Environmental Impact Assessment Arklow Bank Wind Park.

Ferns, P. N., Rostron, D. M. and Siman, H. Y. (2000) Effects of mechanical cockle harvesting on intertidal communities. Journal of Applied Ecology, 37, 464-474.

GE Wind Energy (2011) Arklow offshore wind farm environmental monitoring benthic ecology survey report June 2010.

GE Wind Energy (2012) Arklow offshore wind farm environmental monitoring benthic ecology survey report June 2011.

Green Rebel (2022) Arklow Bank Wind Park (ABWP): Geophysics and Hydrographic Data Processing and Interpretation Report February 2023.

GW Wind Energy (2021) Arklow offshore wind farm environmental monitoring benthic ecology survey report September 2021.

Hawkins, A. D. and Popper, A. N. (2016) A sound approach to assessing the impact of underwater noise on marine fishes and invertebrates. ICES Journal of Marine Science, 74 (3): 635-651.

Hendrick, V., Foster-Smith, R., Davies, A. and Newell, R. (2011) Biogenic Reefs and the Marine Aggregate Industry. Marine ALSF Science Monograph Series, Cefas, 60pp.

Houghton, J. P., Lees, D. C., Driskell, W. B., Lindstrom and Mearns, A. J. (1996) Recovery of Prince William Sound intertidal epibiota from Exxon Valdez oiling and shoreline treatments, 1989 through 1992. In Proceedings of the Exxon Valdez Oil Spill Symposium. American Fisheries Society Symposium, no. 18, Anchorage, Alaska, USA, 2-5 February 1993, (ed. S.D. Rice, R.B. Spies, D.A., Wolfe & B.A. Wright), pp.379-411.

Hubert, J., van Bemmelen, J. J. and Slabbekoorn, H. (2021) 'No negative effects of boat sound playbacks on olfactory-mediated food finding behaviour of shore crabs in a Tmaze', Environ. Pollut. 270, 116184.

HydroServ Projects Ltd (2004) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report Spring 2004. Document: J3023 Arklow monitoring v1.1 Dec 2004.

HydroServ Projects Ltd (2005) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report. Surveys October 13th –15th October 2004. Document: J3023 Arklow monitoring v1.0 July 2005.

HydroServ Projects Ltd (2006a) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report. Surveys 24th –26th June 2005. Document: J3023 Arklow monitoring June 05 v1.1 prepared Jan 2006.

HydroServ Projects Ltd (2006b) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report. Surveys 9th –10th November 2005. Document: J3023 Arklow monitoring Nov 05 prepared June 2006.

HydroServ Projects Ltd (2007a) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report. Survey June 2006. A Report to HydroServ Projects Ltd February 2007.

HydroServ Projects Ltd (2007b) Arklow Bank Offshore Windfarm Environmental Monitoring Benthic Ecology Survey Report Survey May 2007. A Report to HydroServ December 2007.

HydroServ Projects Ltd (2009) Environmental Monitoring Benthic Ecology Survey Report. Survey May 2008. A Report to HydroServ For Arklow Energy Ltd. January 2009.

Invasive Species Ireland (2020) Species Accounts. Available online: http://invasivespeciesireland.com/species-accounts [Accessed: 17/07/2023].

IPCC (2013) Climate change 2013: the physical science basis. In: Working Group I Contribution to the IPCC Fifth Assessment Report of the Intergovernmental Panel on Climate Change, UK and New York, p. 1535.

Irish Hydrodata Limited. (2018). Arklow WWTP Investigation of the Impact of Treated Wastewater Discharges to the Irish Sea. Appendix 15.2. Available online: Appendix - d49c0f87-f318-4e6a-b53c-2b556acbf249.pdf (www.gov.ie) [Accessed: March 2024].

Jackson, A. (2004) *Nemertesia ramosa*, A hydroid. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews [on-line]. http://www.marlin.ac.uk/species/detail/1318 [Accessed: February 2024].

Keegan, B., O'Connor, B., McGrath, D., Konnecker, G. and O'Foighill, D. (1987) Littoral and Benthic Investigations on the South Cats of Ireland: II. The Macrobenthic Fauna of Carnsore Point, Proceedings of the Royal Irish Academy. Section B: Biological, Geological, and Chemical Science, Vol 87B, pp1-14.

Kinne, O. (ed.) (1984) Marine Ecology: A Comprehensive, Integrated Treatise on Life in Oceans and Coastal Waters.Vol. V. Ocean Management Part 3: Pollution and Protection of the Seas - Radioactive Materials, Heavy Metals and Oil. Chichester: John Wiley & Sons.

Kõuts, T., Sipelgas, L. and Raudsepp, U. (2006) High resolution operational monitoring of suspended matter distribution during harbour dredging. EuroGOOS Conference Proceedings, pp. 108-115.

Kröncke, I. (1995) Long-term changes in North Sea benthos. Senckenberg Marit, 26, p.73-80.

Kröncke, I. (2011) Changes in Dogger Bank macrofauna communities in the 20th century caused by fishing and climate. Estuarine, Coastal and Shelf Science, 94, p.234-245.

Last, K. S., Hendrick V. J., Beveridge C. M. and Davies A. J. (2011) Measuring the effects of suspended particulate matter and smothering on the behaviour, growth and survival of key species

found in areas associated with aggregate dredging. Report for the Marine Aggregate Levy Sustainability Fund, Project MEPF 08/P76, 69 pp.

Levin, L. A., Ekau, W., Gooday, A. J., Jorissen, F., Middelburg, J. J., Naqvi, S. W. A., Neira, C., Rabalais, N. N., Zhang, J. (2009) Effects of natural and human-induced hypoxia on coastal benthos. Biogeosciences, 6, p. 2063–2098.

Lindeboom, H. J., Kouwenhoven, H. J., Bergman, M. J. N., Bouma, S., Brasseur, S., Daan, R., Fijn, R. C., de Haan, D., Dirksen, S. and van Hal, R. (2011) Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6 (3).

Mahaffey, C., Palmer, M., Greenwood, N. and Sharples, J. (2020) Impacts of climate change on dissolved oxygen concentration relevant to the coastal and marine environment around the UK. MCCIP Science Review 2020, 31–53.

Marine Protected Area Advisory Group (2023) Ecological sensitivity analysis of the western Irish Sea to inform future designation of Marine Protected Areas (MPAs). Report for the Department of Housing, Local Government and Heritage, Ireland. gov - Ecological Sensitivity Analysis of Irish Sea – Main Report (www.gov.ie) [Accessed: July 2023].

McBreen, F., Wilson, J., Mackie, A. and Aonghusa, C. (2008) Seabed mapping in the southern Irish Sea: predicting benthic biological communities based on sediment characteristics, Hydrobiologica, 606:93-103.

Meucci, A., Young, I. R., Hemer, M., Kirezci, E., and Ranasinghe, R. (2020) Projected 21st century changes in extreme wind-wave events. Science advances, 6(24).

NPWS (2013) Conservation Objectives: Wicklow Reef SAC 002274. Version 1. National Parks and Wildlife Service, Department of Arts, Heritage and the Gaeltacht. https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002274.pdf [Accessed: February 2024].

NPWS (2014a) Wicklow Reef SAC - Site Synopsis. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002274.pdf [Accessed: February 2024].

NPWS (2014b) Blackwater Bank SAC - Site Synopsis. https://www.npws.ie/sites/default/files/protected-sites/synopsis/SY002953.pdf [Accessed: February 2024].

NPWS (2019) Ireland's Biodiversity Sectoral Climate Change Adaptation Plan. Consultation Draft. https://www.npws.ie/news/public-consultation-irelands-biodiversity-sectoral-climate-change-adaptation-plan [Accessed: February 2024].

NPWS (2023) Conservation Objectives: Blackwater Bank SAC 002953. Version 2. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage. https://www.npws.ie/sites/default/files/protected-sites/conservation_objectives/CO002953.pdf [Accessed: February 2024].

Office of Public Works (OPW) (2023)

OREDP (2010) Strategic Environmental Assessment (SEA) of the Offshore Renewable Energy Development Plan (OREDP) in the Republic of Ireland.

Palmer, M., Howard, T., Tinker, J., Lowe, J., Brichenon, L., Calvert, D., Edwards, T., Gregory, J., Harris, G., Krijnen, J., Pickering, M., Roberts, C., and Wolf, J. (2018) UKCP18 Marine Report.

Panigrahi, J. K., Ananth, P. N. and Umesh, P. A. (2009) Coastal morphological modeling to assess the dynamics of Arklow Bank, Ireland. International Journal of Sediment Research, 24(3), pp.299-314.

Pearce, B., Hill, J. M., Grubb, L., Harper, G. (2011) Impacts of marine aggregate extraction on adjacent Sabellaria spinulosa aggregations and other benthic fauna. Rep. MEPF 08/P39, The Crown Estate.

Pearce, B., Taylor, J., Seiderer, L. J. (2007) Recoverability of Sabellaria spinulosa Following Aggregate Extraction: Marine Ecological Surveys Limited.

Perry, F. and Hill, J. M. (2015) Barnacles and fucoids on moderately exposed shores. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/33 [Accessed: February 2024].

Popper, A. N., Hawkins, A. D., Fay, R. R., Mann, D., Bartol, S., Carlson, Th., Coombs, S., Ellison, W. T., Gentry, R., Hal vorsen, M. B., Lokkeborg, S., Rogers, P., Southall, B. L., Zeddies, D. G. and Tavolga, W. N. (2014) Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSIAccredited Standards Committee S3/SC1 and registered with ANSI. Springer and ASA Press, Cham, Switzerland.

Popper, A. N. and Hawkins, A. D. (2018) The importance of particle motion to fishes and invertebrates J. Acoust. Soc. Am. 143(1), 470–488.

Ramboll Environ UK Ltd (2016) Dumping at Sea Permit Application Supporting Information Application by Arklow Energy Ltd. http://www.epa.ie/licences/lic_eDMS/090151b2805de16b.pdf [Accessed: February 2024].

Readman, J. A. J., and Watson, A. (2024) *Flustra foliacea* and *Hydrallmania falcata* on tide-swept circalittoral mixed sediment. In Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/74 [Accessed: February 2024].

Readman, J. A. J., Garrard, S. L., Lloyd, K. A., and Watson, A. (2023a) *Sertularia cupressina* and *Hydrallmania falcata* on tide-swept sublittoral sand with cobbles or pebbles. In Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/223 [Accessed: February 2024].

Readman, J. A. J., Lloyd, K. A., and Watson, A. (2023b) Sparse sponges, *Nemertesia* spp. and *Alcyonidium diaphanum* on circalittoral mixed substrata. In Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/119 [Accessed: February 2024].

Readman, J. A. J., Lloyd, K. A., and Watson, A. (2023c) *Flustra foliacea* on slightly scoured silty circalittoral rock. In Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/24 [Accessed: February 2024].

Robinson, K. A., Mackie, A. S., Lindenbaum, C., Darbyshire, T., van Landeghem, K. J. and Sanderson, W. G. (2012) Seabed Habitats of the Southern Irish Sea. In Seafloor Geomorphology as Benthic Habitat (pp. 523-537).

Roche, C., Lyons, D. O., Farinas Franco, J. and O'Connor, B. (2007) Benthic surveys of sandbanks in the Irish Sea. Irish Wildlife Manuals, No. 29. National Parks and Wildlife Service, Department of Environment, Heritage and Local Government, Dublin, Ireland.

RPS (2019a) Arklow Bank Wind Park, Phase 1 Intertidal Walkover Survey Report.

RPS (2019b) Review of Cable installation, protection, migration and habitat recoverability, The Crown Estate, Rev03.

RPS (2021a) Dublin Port Eight Year Maintenance Dredging Programme (2022 -2029) Application for Foreshore Licence. [pdf] Available at: 9606f75b-da65-4c21-a221-1ea7fac7506a.pdf (www.gov.ie) [Accessed February 2024].

RPS (2021b) Irish Coastal Wave and Water Level Modelling Study 2018 Phase 2 – Coastal Areas Potentially Vulnerable to Wave Overtopping.

Schönberg, C. H. L. (2015) Happy relationships between marine sponges and sediments–a review and some observations from Australia. Journal of the Marine Biological Association of the United Kingdom, 1-22.

Solan M., Hauton C., Godbold J. A., Wood C. L., Leighton T. G. & White P. (2016) Anthropogenic sources of underwater sound can modify how sediment-dwelling invertebrates mediate ecosystem properties. Scientific Reports. 6.

Solé, M., Kaifu K., Mooney T. A., Nedelec S. L., Olivier F., Radford A. N., Vazzana M., Wale M. A., Semmens J. M., Simpson S. D., Buscaino G., Hawkins A., Aguilar de Soto N., Akamatsu T., Chauvaud L., Day R. D., Fitzgibbon Q., McCauley R. D. and André M. (2023) 'Marine invertebrates and noise', Front. Mar. Sci. 10:1129057.

Soule, D. F. and Soule, J. D. (1979) Bryozoa (Ectoprocta). In Hart, C.W. & Fuller, S.L.H. (eds), Pollution ecology of estuarine invertebrates. New York: Academic Press, pp. 35-76.

Spiga, I., Caldwell, G. S., Bruintjes, R. (2016) Influence of pile driving on the clearance rate of the blue mussel, *Mytilus edulis* (L.). In: Proceedings of Meetings on Acoustics: Fourth International Conference on the Effects of Noise on Aquatic Life. July 10–16 2016, Volume 27, Dublin, Ireland.

Spiga, I., Cheesman S., Hawkins A., Perez-Dominguez R., Roberts L., Hughes D., Elliott M., Nedwell J. and Bentley, M. (2012) Understanding the Scale and Impacts of Anthropogenic Noise upon Fish and Invertebrates in the Marine Environment. SoundWaves Consortium Technical Review (ME5205).

Staehr, P. A., Pedersen, M. F., Thomsen, M. S., Wernberg, T. and Krause-Jensen, D. (2000) Invasion of Sargassum muticum in Limfjorden (Denmark) and its possible impact on the indigenous macroalgal community. Marine Ecology Progress Series, 207, 79-88.

Stebbing, A. R. D. (1981) Hormesis stimulation of colony growth in *Campanularia flexuosa* (Hydrozoa) by copper, cadmium and other toxicants. Aquatic Toxicology, 1, 227-238.

Suchanek, T. H. (1993) Oil impacts on marine invertebrate populations and communities. American Zoologist, 33, 510-523.

Tarr, M. A., Zito, P., Overton, E. B., Olson, G. M., Adhikari, P. L. and Reddy, C. M. (2016) Weathering of oil spilled in the marine environment. Oceanography, 29(3), 126-135.

Thompson, G. A. and Schiel, D. R. (2012) Resistance and facilitation by native algal communities in the invasion success of *Undaria pinnatifida*. Marine Ecology, Progress Series, 468, 95-105.

Tillin, H. and Tyler-Walters, H. (2014) Assessing the sensitivity of subtidal sedimentary habitats to pressures associated with marine activities. Phase 2 Report – Literature review and sensitivity assessments for ecological groups for circalittoral and offshore Level 5 biotopes. JNCC Report No. 512B, 260 pp. https://www.marlin.ac.uk/publications [Accessed: February 2024].

Tillin, H. M. and Hill, J. M. (2018) *Semibalanus balanoides*, *Patella vulgata* and *Littorina* spp. on exposed to moderately exposed or vertical sheltered eulittoral rock. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line].

Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/40 [Accessed: February 2024].

Tillin, H. M. and Watson, A. (2023) *Moerella* spp. with venerid bivalves in infralittoral gravelly sand. In Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. https://www.marlin.ac.uk/habitat/detail/1111 [Accessed: February 2024].

Tillin, H. M. and Budd, G. (2016) Barren littoral coarse sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom https://www.marlin.ac.uk/habitat/detail/16 [Accessed: February 2024].

Tillin, H. M., Budd, G. and Tyler-Walters, H. (2019) Barren littoral shingle. In Tyler-Walters H. and Hiscock K. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom https://www.marlin.ac.uk/habitat/detail/143 [Accessed: February 2024].

Tillin, H. M., Garrard, S. L., Tyler-Walters, H., Lloyd, K. A., and Watson, A. (2023a) Infralittoral mobile clean sand with sparse fauna. In Tyler-Walters H. Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom https://www.marlin.ac.uk/habitat/detail/262 [Accessed: February 2024].

Tillin, H. M., Hiddink, J. G., Jennings, S. and Kaiser, M.J. (2006) Chronic bottom trawling alters the functional composition of benthic invertebrate communities on a sea-basin scale. Marine Ecology Progress Series, 318, 31-45.

Tillin, H. M., Jackson, A. and Garrard, S.L. (2023d) *Sabellaria alveolata* reefs on sand-abraded eulittoral rock. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom https://www.marlin.ac.uk/habitat/detail/351 [Accessed: February 2024].

Tillin, H. M., Kessel, C., Sewell, J., Wood, C. A. and Bishop, J. D. D. (2020) Assessing the impact of key Marine Invasive Non-Native Species on Welsh MPA habitat features, fisheries and aquaculture. NRW Evidence Report. Report No: 454. Natural Resources Wales, Bangor, 260 pp.

Tillin, H. M., Marshall, C. E., Garrard, S. L., and Gibb, N. (2023b) *Sabellaria spinulosa* on stable circalittoral mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom https://www.marlin.ac.uk/habitat/detail/377 [Accessed: February 2024].

Tillin, H. M., Marshall, C. E., Gibb, N., Williams, E., Lloyd, K. A., and Watson, A. (2023c) *Sabellaria spinulosa*, didemnids and other small ascidians on tide-swept moderately wave-exposed circalittoral rock. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom https://www.marlin.ac.uk/habitat/detail/348 [Accessed: February 2024].

Tyler-Walters, H. and Ballerstedt, S. (2007) *Flustra foliacea* Hornwrack. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. http://www.marlin.ac.uk/species/detail/1609 [Accessed: February 2024].

Tyler-Walters, H. (2005) *Bugula turbinata* an erect bryozoan. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line].

Plymouth: Marine Biological Association of the United Kingdom http://www.marlin.ac.uk/species/detail/1715 [Accessed: February 2024].

Tyler-Walters, H., Tillin, H. M., d'Avack, E. A. S., Perry, F., Stamp, T. (2023) Marine Evidence–based Sensitivity Assessment (MarESA) - Guidance Manual. Marine Life Information Network (MarLIN). Marine Biological Association of the UK, Plymouth, pp. 170 https://www.marlin.ac.uk/publications [Accessed: February 2024].

Ultrabeam Limited. (2019) Arklow Bank Wind Park. Lease Area. Volume 2: Results Report. UHC19004 – July – August 2019.

van Dolah, R. F., Wendt, P. H. and Nicholson, N. (1987) Effects of a research trawl on a hard-bottom assemblage of sponges and corals. Fisheries Research, 5 (1), 39-54.

Vorberg, R. (2000) Effects of shrimp fisheries on reefs of Sabellaria spinulosa (Polychaeta). ICES Journal of Marine Science, 57, 1416-1420.

Vousdoukas, M. I., Ranasinghe, R., Mentaschi, L., Plomaritis, T. A., Athanasiou, P., Luijendijk, A., & Feyen, L. (2020). Sandy coastlines under threat of erosion. Nature climate change, 10(3), 260-263.

Vousdoukas, M. I., Mentaschi, L., Voukouvalas, E., Verlaan, M., Jevrejeva, S., Jackson, L. P. and Feyen, L. (2018) Global probabilistic projections of extreme sea levels show intensification of coastal flood hazard. Nature communications, 9(1), p.2360.

Zahn, R., Zahn, G., Müller, W., Kurelec, B., Rijavec, M., Batel, R. and Given, R. (1981) Assessing consequences of marine pollution by hydrocarbons using sponges as model organisms. Science of The Total Environment, 20 (2), 147-169.